Comparison of Amount of TVN and Microbial Load in Silver Carp Fish During Preservation by Ice Powder

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Abstract

In this research, changes of volatile nitrogen and total microbial load as indexes of quality control in pectoral and tail muscles of Silver carp whole and gutted fish, during preservation by ice powder in the days of 0, 3, 6, 9, 12, 15 and 18 were analyzed. Total number of 42 Silver carp fish with weights of 1.8 to 2 Kilogram was purchased and in each time, pectoral and tail muscles of 3 whole and 3 gutted fish were analyzed. The amount of volatile nitrogen was measured by Distillation method, using Kjeldahl digestion apparatus and microbial load measured according to reference method. During preservation, the amount of volatile Nitrogen was increasing and finally in the day of 18, its amount in pectoral muscles of whole fish in comparison to other treatments with tail muscles, also gutted fish with tail and pectoral muscles was significant (P=0.003). After initial inertia until day 6, total bacterial load started, it's increasing slope and in day 18 total bacterial load in pectoral muscles of whole fish was more in comparison to other treatments in which this proliferation shows significant differences with pectoral and tail muscles of gutted fish (P=0.002) but not significant with tail muscles of whole fish. The result of this research shows that, both factors of type of muscles were effective in increasing the amount of volatile Nitrogen and whole or gutted fish had significant impact on increasing the total bacterial load in the day 18.

Keywords: Silver Carp, Duration of Preservation, volatile nitrogen, Microbial Load.

Introduction

Fresh seafood comprises 40.5% of global seafood production (Boziaris, 2014). Fresh fish is a perishable product due to its physical conditions. During their keeping time, these products undergo some changes whose result is reduced shelf life of fish and its products (Arashisara et al., 2004). Spoilage could be the result of metabolic activities of microorganisms, enzymes of the body, and due to oxidation of body fat. Among the changes created, one can mention microbial characteristics as well as total volatile nitrogen (TVN) (Kostaki et al., 2009). Elapsed time after catching the fish and temperature conditions under which the fish is kept are of the factors that determine the final quality of aquatic products (Olafsdottire et al., 2004). In terms of keeping cool using ice or refrigerated, the growth of spoilage microorganisms and enzyme and chemical activities are done slowly, but do not stop and will reduce fish quality over time (Cakli et al., 2007). In general, oxidation reactions and contamination with microorganisms are the main factors in reducing the shelf life of food and if not controlled effectively, they decrease the quality of products (Tokur and Ozyurt., 2010). Seafood contains large amounts of non-protein nitrogen compounds with low acidity (pH>6) providing the conditions for the rapid growth of microorganisms and are the main cause of corruption. After death, autolysis is created followed by the activities of enzymes in the body that first reduces fresh product features, causes undesirable odors and flavors, and softens the meat. For products in which microbial growth is delayed or prevented, non-biological mechanisms play a decisive role (Boziaris., 2014). The changes that arise because of enzymatic activities after the death loosen fish muscle tissue and reduce the elasticity power. Enzyme activities make the sweet taste of fish flesh that is different in different species become tasteless. Continuation of enzyme activity leads to the creation of many important compounds such as hypoxanthine and creates a bitter taste in the fish. Changes in the chemical composition due to the aforementioned reasons can lead to changes in the sensory properties such as taste, smell, texture, color, and appearance characteristics that ultimately affect the popularity of fish as food.
Among the tests to determine the quality of fish is measuring TVN. In recent years, biogenic amines are considered as one of the very factors valuable in the assessment of fish spoilage, especially as high levels of protein in the fish exacerbates the decomposition process (Krizek et al., 2004). In addition to chemical degradation, bacteria also have an important role in the quality and safety of seafood (Alsalvar et al., 2011). Microbial condition of seafood is a key factor in determining the consumability and human food safety. The risks of food exists in all land and sea food sources, such as foods derived from land resources, seafood can also carry risks pathogenic factors such as viruses, bacteria, and parasites are. Bacteria can be the cause of food spoilage and a number of species can cause diseases as well. Seafood contamination with bacteria has caused major concerns for public health. This contamination can happen before or during harvesting and processing, distribution, storage, or during the preparation of the product (Shahidi and Botta., 1994). Millions of bacteria and other microorganisms, some of which also have the power to create food spoilage, exist on the outer surface of fish gills and intestines. There are several pathogenic bacteria in water, some of which, such as cholera, *Clostridium botulinum* and *Aeromonas hydrophila* naturally exist in water, and some, such as *Salmonella* spp. can cause contaminate seafood. In addition, another group of bacteria such as *Listeria monocytogenes, Staphylococcus aureus*, and so on enter the food during processing (Boziaris., 2014). Bacteria grow slowly at first and then multiply very quickly, attack the tissues, and generate composite components with elements composing the tissues and these complex compounds cause changes in the smell and taste of the fish (Gram and Huss., 1996 and Huss., 1995). Reviewing changes created in fish over the period of keeping from the time of catching to supply plays a major role in offering solutions to increase product quality. Furthermore, the rate of spoiling is different in different species and it needs to be studied for different species raised in the country. Silver carp (*Hypophthalmichthys molitrix*) is among the raised fish harvested from raising farms in bulk. Due to the remoteness of the breeding centers from many cities and centers of consumption, considerable time passes from fishing to stores and ultimately to the client and even export to other countries. Thus, the need for quality control in order to achieve the factors for evaluating fish freshness in terms of appearance, chemical and physical, and microbiological features to ensure freshness and health of these fish is considered inevitable. Given the common practice in the country by using ice powder for cooling in maintenance and supplying silver carp, the present study was designed to evaluate changes of TVN and microbial load of the whole and gutted fish during storage in ice powder.

**Materials and methods**

Forty-two pieces of fresh silver carp weighing 1.8 to 2 kg were bought from fish breeding ponds and after washing the body surface and the gills, in half of the fish by cutting the abdomen, abdominal contents and the gills were removed. After washing again, both group were individually kept within two polystyrene boxes of powdered ice and shipped to the laboratory. There was no contact between fish and polystrene body. To start placing ice, first, a layer of ice powder fully carpeted the bottom of the polystyrene body and then to cover the fish full, the method of one ice powder layer and a layer of fish with the ratio of 2 to 1 was used. Ice used was full in powder form provided from drinking water and in full contact with fish. During the experiment, on a daily basis, water and blood water from melting ice was evacuated and replaced by new ice powder. Microbial and chemical tests were regularly done on days 0, 3, 6, 9, 12, 15, and 18. For each test, three fish were selected randomly and TVN and total number of bacteria in the pectoral and tail muscles of the fish were studied. A) Measuring TVN: this was done using the distillation and Kjeldahl device (Fazlara et al., 2011). B) Microbial test: for microbial culture, 10 g of each of the muscles of the pectoral and tail above the lateral line of the fish were removed separately and were completely homogenized and leveled in sterile conditions inside a porcelain mortar. Then ten serial dilutions were prepared in physiology serum (Institute of Standards and Industrial Research of Iran., No: 8923-3., 2007) and were cultured in nutrient media. Plates were placed at 30 °C for 48 hours and then colonies were counted. To be more precise, each dilution was poured on two plates and the average was considered as the yardstick. Colony count was done based on Regulation 9899 of Institute of Standards and Industrial Research. Data obtained were presented as the logarithm of the average colony counted per gram of muscle with standard deviation (Log cfu / g ± SD). Equations used and statistical models: data collected was
analyzed by SAS software and statistical analysis Proc Mixed (SAS, 1999). The following statistical model is used to study the changes of volatile nitrogen and bacterial load of each treatment per unit of time

\[ Y_{ij} = \mu + T_i + \epsilon_{ij} \]

In this model, \( Y_{ijkl} \) is the dependent variable, \( \mu \) is the total average, \( T_i \) is the effect of time \( i \) and \( \epsilon_{ij} \) is the error effect. The following model was considered to assess the variables that had the effects of iteration at time (the amount of TVN and microbial load that has been repeated in units of time)

\[ Y_{ijkl} = \mu + A_i + B_j + T_{ik} + AB_{ij} + AT_{ik} + BT_{jk} + ABD_{ijk} + \epsilon_{ijkl} \]

In this model, \( Y_{ijkl} \) is the dependent variable, \( \mu \) total average, \( A_i \) is visceral i discharge effect, \( B_j \) effect of muscle j, \( T_{ik} \) the effect of sampling time k, \( BT_{jk} \) is the interaction of muscle type j at sampling time k, samples j k ABij interaction discharge of visceral i the type of muscle j, \( AT_{ik} \) interaction discharge of i visceral in the sampling time K, \( BT_{jk} \) is interaction of muscle j at the sampling time k, \( ABD_{ijk} \) is the interaction of i visceral discharge in j muscle in k sampling time, and \( \epsilon_{ijkl} \) is the error effect.

**Results**

A) TVN value: The value of TVN in pectoral and tail muscles of whole fish and gutted fish was measured. During the test, the amount of TVN after rest gradually increased and rate of increase was higher in the last days [Table 1].

**Table 1**: The amount of TVN in pectoral and tail muscles of whole and gutted silver carp at different times of storage in ice powder

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Day zero</th>
<th>Day3</th>
<th>Day6</th>
<th>Day9</th>
<th>Day12</th>
<th>Day15</th>
<th>Day18</th>
<th>p</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
<td>5.32d</td>
<td>6.46d</td>
<td>8.36c</td>
<td>9.12c</td>
<td>11.39b</td>
<td>13.29a</td>
<td>14.82a</td>
<td>0.0001</td>
<td>0.52</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>4.56e</td>
<td>4.94de</td>
<td>6.08d</td>
<td>7.60c</td>
<td>7.98c</td>
<td>9.50b</td>
<td>11.02a</td>
<td>0.0001</td>
<td>0.47</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>5.32c</td>
<td>5.32e</td>
<td>6.08de</td>
<td>7.22c</td>
<td>9.50c</td>
<td>11.02b</td>
<td>12.53a</td>
<td>0.0001</td>
<td>0.43</td>
</tr>
<tr>
<td>Treatment 4</td>
<td>4.18d</td>
<td>4.56d</td>
<td>6.46c</td>
<td>6.84bc</td>
<td>7.22bc</td>
<td>8.36b</td>
<td>10.26a</td>
<td>0.0001</td>
<td>0.57</td>
</tr>
</tbody>
</table>

1: experiment treatments consist of 1) pectoral muscle in whole fish, 2) tail muscle in whole fish, 3) pectoral muscle in gutted fish, 4) tail muscle in gutted fish

* Dissimilar letters in each row represent a significant difference (P<0.01).

According to [Table 1], in pectoral muscle of whole fish, the change in TVN during days zero to 3 does not have significant differences, but on days 6 and 9, compared to days zero to 3, it has significant increase. The same issue occurs on days 12, 15, and 18, and increase in the value of TVN on day 12 and days 15 and 18 is significant compared to other days (P<0.01). In tail muscle of the whole fish, change in TVN value is not significant between days zero and three, but on day 6, a significant increase is observed compared to day zero. On days 9 and 12, the rising trend continues. The difference between these two days is not significant, but it has a significant increase compared to previous days. On days 15 and 18, increasing trend continues significantly (P<0.01). In the pectoral muscles of gutted fish, changes in TVN during days zero, 3, and 6 despite the increase is not significant, but on day 9, it has a significant increase compared to days zero and 3. During the days 12, 15 and 18, TVN increase at every stage is significant compared to the previous stages (P<0.01). In tail muscle of the gutted fish, TVN changes during the days zero and 3 has statistically no significant difference, but on day 6, it has a significant increase compared to days zero days and 3. During the days 9, 12 and 15, TVN increase can be seen and TVN value change in these times compared to days zero and 3 is significant, and the increase on day 15 compared to day 6 has a significant difference. On day 18, TVN increase is significant compared to other days of sampling (P<0.01). TVN value in tail and pectoral muscles on similar days was different that was sometimes statistically significant [Table 2]. According to [Table 2] on day zero, there is no difference in terms of TVN value in different treatments (P>0.15), on day 3, value of TVN in the pectoral muscle of the whole fish is significantly higher than the tail muscle of the gutted fish (P<0.15). On day 6, value of TVN in pectoral muscle of the whole fish is significantly higher than other treatments (P=0.008), and on day 9, TVN value in the pectoral muscle of the whole fish is significantly more than in the tail muscle of the gutted fish (P<0.15). On day 12, no
significant difference was observed in TVN value between different treatments \((P>0.15)\). On day 15, a significant difference is observed in TVN value in various treatments except tail muscle of whole fish and tail muscle of the gutted fish \((P=0.001)\). On day 18, the value of TVN in pectoral muscle of the whole fish has a significant difference with all treatments. There is no significant difference between tail muscle of the whole fish and pectoral muscle of the gutted fish, but there is a statistically significant difference between pectoral and tail muscle of the gutted fish \((P=0.003)\).

### Table 2: The value of TVN in different body parts of the fish at similar storage time

<table>
<thead>
<tr>
<th>Storage time</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
<th>Treatment 4</th>
<th>(p)</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day Zero</td>
<td>5.32</td>
<td>4.56</td>
<td>5.32</td>
<td>4.18</td>
<td>0.4</td>
<td>0.57</td>
</tr>
<tr>
<td>Day3</td>
<td>6.46a</td>
<td>4.94ab</td>
<td>5.32ab</td>
<td>4.56b</td>
<td>0.09</td>
<td>0.46</td>
</tr>
<tr>
<td>Day6</td>
<td>8.36a</td>
<td>6.08b</td>
<td>6.08b</td>
<td>6.46b</td>
<td>0.008</td>
<td>0.38</td>
</tr>
<tr>
<td>Day9</td>
<td>9.12a</td>
<td>7.60ab</td>
<td>7.22ab</td>
<td>6.84b</td>
<td>0.13</td>
<td>0.63</td>
</tr>
<tr>
<td>Day12</td>
<td>11.39</td>
<td>7.98</td>
<td>9.50</td>
<td>7.22</td>
<td>0.27</td>
<td>0.98</td>
</tr>
<tr>
<td>Day15</td>
<td>13.29a</td>
<td>9.50c</td>
<td>11.02b</td>
<td>8.36c</td>
<td>0.001</td>
<td>0.38</td>
</tr>
<tr>
<td>Day18</td>
<td>14.82a</td>
<td>11.02bc</td>
<td>12.53b</td>
<td>10.26c</td>
<td>0.003</td>
<td>0.6</td>
</tr>
</tbody>
</table>

1: experiment treatments consist of 1) whole fish pectoral muscle, 2) whole fish tail muscle, 3) gutted fish pectoral muscle 4) gutted fish tail muscle  
* Dissimilar letters in each row represent a significant difference \((P<0.01)\).

TVN values status and comparing in situation in all four treatment groups is shown in [Figure 1].

**Figure 1:** Status of TVN value in the muscles of the pectoral and tail of whole and gutted silver carp

B) Bacterial load: logarithmic values of total bacterial load in the samples along with the results of minimum significant difference test results are shown in Tables 3 and 4. The total bacterial load in pectoral and tail muscles in whole and gutted fish after a period of similar inactivity increased. The ratio of increase on different days was sometimes significant \((P<0.01)\) [Table 3].

### Table 3: Changes in bacterial load (log cfu / g) in the muscles of the pectoral and tail of whole and gutted silver carp at different times of storage in ice powder

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Day zero</th>
<th>Day3</th>
<th>Day6</th>
<th>Day9</th>
<th>Day12</th>
<th>Day15</th>
<th>Day18</th>
<th>(p)</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
<td>-*</td>
<td>-</td>
<td>-</td>
<td>0.86</td>
<td>2.96a</td>
<td>3.24a</td>
<td>3.90a</td>
<td>0.0098</td>
<td>0.47</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.77b</td>
<td>2.40a</td>
<td>3.20a</td>
<td>3.70a</td>
<td>0.0055</td>
<td>0.43</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.81b</td>
<td>2.42a</td>
<td>3.06a</td>
<td>3.40a</td>
<td>0.0045</td>
<td>0.39</td>
</tr>
<tr>
<td>Treatment 4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.26a</td>
<td>2.74b</td>
<td>3.55a</td>
<td>3.85a</td>
<td>0.0001</td>
<td>0.57</td>
</tr>
</tbody>
</table>

1: experiment treatments consist of 1) pectoral muscle in whole fish , 2) tail muscle in whole fish , 3) pectoral muscle in gutted fish, 4) tail muscle in gutted fish  
* Samples lacking in bacterial load  
* Dissimilar letters in each row represent a significant difference \((P<0.01)\).

According to [Table 3]: pectoral and tail muscle of whole fish and pectoral muscle in gutted fish have been sterile up to day 6 and presence of bacteria was observed from day 9 until day 18 it had an increasing trend. This increase on days 12, 15, 18 and 9 had significant differences \((P<0.01)\). Tail muscle of the gutted fish
has been sterile up to day 9 and the presence of bacteria was observed from day 12 until day 18 it had an increasing trend. This increase on days 3, 12, 15 and 18 had significant differences (P<0.01).

The total microbial load in tail and pectoral muscles on the same days was different and sometimes, these differences were statistically significant [Table 4].

### Table 4: Changes in bacterial load (log cfu / g) in different parts of the fish body at the same storage time

<table>
<thead>
<tr>
<th>Storage time</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
<th>Treatment 4</th>
<th>p</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day Zero</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Day 3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Day 6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Day 9</td>
<td>0.90</td>
<td>0.77</td>
<td>0.67</td>
<td>-</td>
<td>0.98</td>
<td>0.78</td>
</tr>
<tr>
<td>Day 12</td>
<td>2.76</td>
<td>2.46</td>
<td>2.76</td>
<td>2.26</td>
<td>0.40</td>
<td>0.2</td>
</tr>
<tr>
<td>Day 15</td>
<td>3.29</td>
<td>3.00</td>
<td>3.20</td>
<td>2.74</td>
<td>0.43</td>
<td>0.77</td>
</tr>
<tr>
<td>Day 18</td>
<td>3.92a</td>
<td>3.78ab</td>
<td>3.48bc</td>
<td>3.35c</td>
<td>0.02</td>
<td>0.11</td>
</tr>
</tbody>
</table>

1: experiment treatments consist of 1) pectoral muscle in whole fish, 2) tail muscle in whole fish, 3) pectoral muscle in gutted fish, 4) tail muscle in gutted fish.

* Samples lacking in bacterial load

* Dissimilar letters in each row represent a significant difference (P<0.01).

According to [Table 4]: on day 18, total bacterial load in the pectoral muscle of the whole fish with pectoral and tail muscles of the gutted fish had a significant difference (P=0.02).

Comparison of total bacterial load in all treatment groups is shown in [Figure 2].

**Figure 2:** bacterial load status in the pectoral and tail muscles of silver carp in whole and gutted fish

### Discussion

The supply of fresh fish is one of the common methods that are popular, but this method has always had problems in terms of quality and distribution. Thus, there is need for providing solutions to maintain the quality and principled distribution of fresh fish to maintain its quality for a longer time, and supply it to remoter areas where it is impossible to grow and produce it (Mendes and Goncalvez, 2008). Volatile nitrogen materials are compounds found in small amounts in fresh fish and by extending the storage time, its amount increase. When the fish is close to the stage of unacceptability as food, TVN value increases very fast. Volatile alkalis refer to a series of compounds such as ammonia, methylamines, and so on produced due to bacterial spoilage, and most of them are used as a chemical indicator to assess the quality, spoilage, and durability of offshore production (Masniyom et al., 2002 and Kilinc et al., 2009). Their amount is different depending on the species of fish, type of products, production and other factors. Non-protein nitrogen compounds are present at high levels in the muscles of fish and changes in them after fishing have a significant impact on the quality of fish. Thus, for evaluation of fish quality chemically, one can use free volatile nitrogen (Farhadi et al., 2009). TVN allowance is different in fresh and salt water fish, and the allowed limit for freshwater fish is 25 milligrams per hundred grams of sample (Fazlara., 2007). Among the other factors affecting fish spoilage are microorganisms. The flesh of healthy and fresh fish is sterile because of the immune system. After the death of fish following inactivation of the immune system,
bacteria can easily multiply and attack the meat during storage (Huss., 1995). Despite the abundant information available for tropical and cold water marine fish, there are few studies examining indicators of quality of freshwater fish during storage in ice (Gimenez et al., 2002). Silver carp is of warm water fish species that due to the use of the first level of the pyramid of food (phytoplankton), rapid growth, easy growing, high feed conversion ratio, and proper food value are widely raised in many countries of the world (Fan et al., 2008). In Iran, according to Iranian Fisheries Statistical Yearbook, warm water fish production in 2014 was equal to 170341 tons, most of which was silver carp. That is why its changes during storage is of utmost importance. In this study, the amount of TVN increased over time in all cases, but in none of the treatments, it exceeded the limit until the final day. Azizishirazi and Shekarforoush (2010) conducted a study on rainbow trout stored at different atmospheric conditions. They reported that TVN did not reach spoilage level until the end of the storage period and showed large fluctuations during the storage period.

Arashisar et al. (2004) reported that in rainbow trout, there is no direct linear relationship between storage time and the value of TVN, and fluctuations are seen in its graph (a reduction on the sixth and eighth day). These fluctuations have been approved by Tejada and Huidoboro (2002), Kyrana and Lougovois (2002) and Dawood et al. (1986). However, in this study, no fluctuations were found in the value of TVN. TVN value increases very slowly in freshwater fish kept in cold conditions (Mol et al., 2007) observed in the results of the present study as well. Studies show that the initial value of TVN is variable in different species and conditions. In a study on Ctenopharyngodon idella by Fazlara et al. (2011), erratic changes were observed in TVN value that may be due to washing TVN during storage in ice. Scherer et al. (2006) reported that in Ctenopharyngodon idella, TVN has a weak relationship with (r=0.33) storage time and Psychrophilic bacteria. In the study conducted by Gram and Huss (1996), TVN increased slowly in the first 24 hours but then increased quickly. This is because in the early days of storage at refrigerator temperature, bacteria are at the base phase and increase slowly and the increase rapidly. In a similar study by Hossain et al. (2005), packing fillets and storing at low temperature made the initial phase of microbial growth longer. Thus, in the first 24 hours, TVN production rate was slower. Increase in TVN at the end of the storage period is due to bacterial spoilage caused by the bacterial population growth, which is almost consistent with the results of this study. In this study, TVN value almost from the sixth day onwards in pectoral muscle of whole silver carp, with very few exceptions, there was a significant difference compared to other treatments, which can be caused by the effects of digestive enzymes and bacteria in gastrointestinal system that after death gradually enter the abdominal area and then muscles and accelerate the process of spoilage. Lack of significant difference in days zero and 3 between whole and gutted treatments and day 6 for all whole fish treatments confirms it. In fact, during this period, the influence of enzymes and bacteria from the gastrointestinal tract into the abdominal cavity in whole fish has not happened yet. The value of TVN was less in tail muscle compared to pectoral muscle in whole and gutted fish that may be due to its distance from the abdominal cavity, as a result of which so it is affected by changes in the abdominal cavity in a longer period. In general, the process of increase of storage length is in such a way that, as the storage time is longer, this rate of increase of TVN is faster that is due to the conditions provided for muscles spoilage and the multiplication of bacteria. [Figure 1] shows the comparison of the increase in TVN during storage in ice powder in all treatments. The results showed that both the muscle location and whole or gutted are effective in increase of TVN on the final day (P=0.003). Microbial evaluation also indicates increased microbial load during the test and microbial load in pectoral muscle treatment of the whole fish on day 18 higher than other treatments, and this difference was statistically significant compared to treatments 3 and 4 of (P<0.05). In all treatments until the sixth day, the bacteria were not isolated from the muscles and this sterile state continued until day nine for treatment four. In [Figure 2], the comparison of the increase in bacterial load during storage in ice powder is observed in all treatments. The maximum permissible microbial load for freshwater fish for human consumption proposed by The International Commission on Microbiological Specifications for Foods (ICMSF) in 1986 is 10^7 cfu/g. Turhan et al. (2001), Antoine et al. (2005), and Ozogul et al. (2005) considered bacterial load 10^6 cfu/g as the threshold for poilage. In this study, the microbial load by the end of the experiment did not exceed the limit. Extreme bacterial spoilage occurs when the microbial load reaches more than 10^8 cfu/g (Gram and Huss 1996). The results showed that being whole or gutted affects increase of total bacterial load on the final day (P=0.002).
Conclusions
As stated, TVN value in both treatments in whole and gutted in the pectoral muscle was more than tail muscle. TVN increase occurs due to the hydrolysis of amines and bacterial activity during storage; this increase can be attributed to digestive enzymes and intestinal microbial load. Since the effect of these factors in thoracic cavity is more than in tail area, we see this difference. In the gutted fish due to opening of abdominal area and discharge of abdominal viscera, microbial load of the abdominal cavity was higher than the tail area that is intact, and this difference can be attributed to it. Muscles are sterile in healthy living fish and this sterility continues in the tail area after death, unlike the abdominal area. Pectoral muscles are affected by spoilage process after death sooner than tail muscles due to the high microbial load in abdominal area. Therefore, it can be concluded that the muscles of the tail area have better quality than the muscles of pectoral area. Caring advice and instructions is to empty the guts after catching the fish. Overall, the rate of increase in microbial load in the whole fish during the storage in ice powder was higher, which indicates the higher rate of further reduction of the quality of the product during storage. TVN value in pectoral muscle on day 18 of the tests in whole fish that had the highest microbial load (P<0.05) was significantly higher than other treatments (P=0.003). It should be noted that fishing, ice covering, and transferring fish in this experiment was in accordance with standard terms and without putting any pressure and impacts. In normal circumstances, the impact and pressure from fisheries and transportation are much higher and can lead to rupture of the intestinal tract and other tissue damage that can result in higher TVN and total microbial load, and finally more difference between whole and gutted fish while transporting.

References


