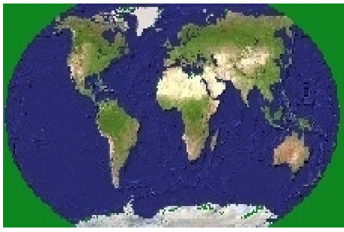
International Journal of Multidisciplinary Research and Development 2014; 1(6): 178-184



International Journal of Multidisciplinary Research and Development

IJMRD 2014; 1(6): 178-184
www.allsubjectjournal.com
Received: 16-10-2014
Accepted: 28-10-2014
e-ISSN: 2349-4182
p-ISSN: 2349-5979

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Effect of water temperature and time during tilapia processing to its fillet quality

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Abstract
In the last few years tilapia has captured the attention of consumers for its nutritional qualities. Tilapia are one of the most widely introduced fish globally that has clearly emerged as a promising group in aquaculture. *Oreochromis niloticus* was the first tilapia species to be taken up for large scale aquaculture. It is consumed widely due to its deliciousness and rich source of protein. During its processing, temperature and time are very important factors influencing to fish fillet characteristics. We have surveyed these criteria during tilapia processing. Our results show that in order to get the best fillet quality (texture, microorganism) we should pay attention to: the step before bleeding, washing fillets at 18-20°C in 10 minutes; after bleeding, washing fillets at 23-25°C in 20 minutes; after filleting, washing fillets at 18-20°C in 8 minutes; trimming fillets within 10 minutes.

Keywords: *Oreochromis niloticus, fillet, temperature, time, processing*

1. Introduction

Tilapia has become the 2nd most important fish farmed globally and next to Salmon. The “top 10 list of most consumed species” in USA indicates its critical position in the seafood market. Fish are a nutrient rich food but highly perishable due to its high water activity, protein content, neutral pH and presence of autolytic enzymes. This explains why fresh fish quality deteriorates rapidly if not properly stored and processed after catch such as use of low temperature. The implication is that improper processing of fresh fish negatively influences consumer taste of fish. Further, fresh fish that are not processed on time lose nutrients due to spoilage.

1.1 Stunning and Slaughtering Methods

In farmed fish, the method most farmers use is to plunge the fish directly into iced water. It is very important to check that the water is kept close to 0 °C at all depths. If the temperature should rise to 8 °C, the fish will not die of thermal shock but of asphyxia, and this will adversely affect as their appearance, color, and texture. In the case of sea bass, it is very important that crowding prior to cropping be kept to a minimum and that fish are swiftly killed (Smart 2001), otherwise considerable damage, such as de-scaling and other skin lesions, and bleeding around the belly can occur.

Slaughtering by electrical stunning can produce enough active movements to break vertebrae, rupture blood vessels (Kestin and others 1995), which can result in blood spots (Van de Vis and others 2003). On the other hand Robb and others (2003) recommend electricity as better method for salmon stunning than carbon dioxide as this causes an earlier onset and resolution of *rigor mortis*. Sigholt and others (1997) reported that a sensory panel test differentiated between stressed and unstressed salmon killed by carbon dioxide stunning. They found that the texture of the stressed fish was softer during storage, which is detrimental especially when slicing smoked salmon.Kiessling and others (2004) also compared slaughtering of salmons with CO_2 and with iso-eugenol. They found that although there are no differences in gaping, the meat is much softer when CO_2 is used. Iso-eugenol (AQUI-S™ New Zealand, LTD) continues to be used for preslaughter sedation of salmon in the aquaculture industry in New Zealand, in spite of concerns by Japanese consumers about flavor residues (Gregory 2005). Roth and others (2007) report that percussive stunning, biting on the head, is the optimal choice for meat quality of turbot (*Scophthalamus maximus*), but electric stunning by prolonged electric exposure is also good. On the other hand,Poli and others (2005) report that asphyxiated and electrically stunned fish were more stressed than spiked, knocked, or live-chilled fish.

Van de Vis and others (2003) reported that eel slaughtering by a quick method like electricity in combination with nitrogen gas results in a better quality of meat than for instance the so-called salt bath, in which eels take about 20 min to die. On the other hand, Tejada and Huidobro (2002) reported that 3 slaughter methods were tested on farmed gilthead seabream (*Sparus aurata*): immersion in an ice salt–water slurry, asphyxia in air, and percussive stunning followed by immersion in ice and water. The result of this study was inconclusive as the use of different methods had no clear influence on the meat quality.

1.2 Bleeding

Bleeding is recommended by several sources (Storm and Lien 1984; Valdimarsson and others 1984). On the other hand, other researchers (Meyer and others 1986; Moser 1986) have concluded that bleeding before gutting and gilling have no effect on parameters such as sensory, color, trimethylamine, and hypoxanthine concentration and surface bacterial load test. In the bibliography, there are many discrepancies about bleeding, this is the reason why it is not universally applicable, and that there are many factors to be considered, such as the type of species, the size, the season of capture, and so on.

Although bleeding is not generally recommended in wild fish, the bleeding produced should be profuse and should be done immediately after the fish is caught. Thus, some researchers (Botta and others 1986) have shown that bleeding is only effective in Atlantic salmon if conducted within 1 to 2 h of capture. Sohn and others (2007) report that simply removing a portion of the blood from live yellowtail by bleeding, is not sufficient to prevent lipid oxidation in the early stages of ice storage.

Bleeding is frequently used in farmed fish. Robb (2001) reported that large farmed fish needed to have the blood removed from the muscle and recommended cutting the gills with a sharp knife; this allows the fish to swim and so die from anoxia caused by blood loss. Robb and others (2003) concluded that exsanguinations generally reduce blood spots, but they could not say which methodology was better. They also reported that although bleeding affects the number of spots in smoked salmon, other factors can play an important role. In farmed halibut (*Hippoglossus hipoglossus*), Aske and Midling (2001) reported only small differences in hem iron muscle residues between bled and unbled lots, and they added that halibut killed by a blow to the head bled better than specimens anaesthetized with CO_2.

Olsen and others (2006) reported that the amount of residual blood on salmon was influenced by the anaesthetizing and slaughtering procedures. Fish that were chilled alive and anaesthetized and then directly gutted had less residual blood in the fillet as compared to the standard industrial procedure of gill cutting and bleeding before gutting. Use of anesthesia on live-chilled fish killed by gill cutting did not result in a reduction of residual blood as compared to live-chilled unanesthetized fish killed by gill cutting. This was because blood coagulation time was prolonged at low temperature, possibly improving bleeding. Roth and others (2005) reported that the bleeding method was of less importance in trout and salmon than the timing of the bleeding. They observed no significant difference in blood spotting between fish that were bled live by a gill cut and those that were percussively killed and bled by gutting, so the industry would be well to gut directly. They also reported that drainage of blood in the fish muscle seemed to occur within the first hour postmortem, so that *rigor mortis* did not mediate in this processing.

1.3 Gutting and Washing

The main reason for gutting is to prevent autolytic spoilage rather than bacterial spoilage (Shewan 1961). Industrial gutting and beheading are mechanized in developed countries today, but on board this operation is traditionally done by hand with a knife, and only in large ships are machines used. Gutting is usually done by cutting, but there are machines that perform gutting by sucking the viscera out and cleaning the belly part through the mouth. This method obviates the need to open the belly, but it makes it difficult to be sure how well the fish is cleaned. When gutting is performed, fish should be thoroughly washed to remove traces of blood and debris and to wash bacteria and intestinal content out of the gut cavity, skin, and gills of the fish. Erkan (2007) reported advantages when washing is included in the processing of sea bream. Other researchers, for example Samuels and others (1984), have reported that the practice of washing after gutting is more effective in removing remnants that in eliminating bacterial contamination. Kosak and Toledo (1981) reported that microbial decontamination with chlorine on the storage stability of iced finfish was highly effective. On the other hand Samuels and others (1984) found no advantage in dipping fish in a hypochlorite solution.

1.4 Filleting

Many species are filleted to satisfy consumer demand. In general, filleting adds value to the product, although this depends very much on the type of market. Most companies that commercialize fillets use filleting-machines. Basically these machines cut along the upper and lower appendices on the spine, cutting the ribs, and vertebrae with a pair of symmetrical knives. Different standards of trimming are used, from removing only the backbone to removing visible fat, pin bones, and skin, and these different produce different yields. Fillet yield depends on the species, sex, size, and its structural anatomy (Røra and others 2001). Fish with large heads and frames relative to their musculature give a lower yield than those with smaller heads and frames. In farmed fish, yields can also be affected by farming conditions (feeding, water temperature, type of pond, and so on). Of commercially farmed fish species, tilapia (*Oreochromis* sp.) has the lowest fillet yield (33%) as compared to salmon (*Salmo salar*) (>50%), channel catfish (*Ictalurus punctatis*) (>38%), and striped bass (*Morone saxatilis*) (>40%). Sea bream and sea bass also give higher fillet yields than tilapia. Freshwater eel gives the highest fillet yield (60%). Filleting is traditionally performed after the onset of *rigor mortis*, but this should be weighed against loss of freshness and the cost of storage. If fish is processed in *rigor*, the yield will be poor and it may cause gaping (Laverty 1984; Huss 1995). Large farmed species like salmon are usually filleted once *rigor* has been resolved, normally 3 to 4 d after death. On the other hand, Shaw and others (1984) reported that filleting after 7 d rendered the longest shelf life. In any case, it is difficult to industrially control the onset of *rigor* in large catches of wild species; fish farming makes it easier to control all the parameters that culminate in *rigor*. Prerigor filleting has several advantages, one being that it ensures very fresh processed fish with little or no fillet gaping (Andersen and others 1994), although it changes the shape (Skjervold and others 2001; Kristoffersen and others 2007) and prerigor fillets are significantly thicker (Skjervold and others 2001). Also, the texture is softer than in rigor and certain operations such as the removal of pin bones are more difficult. The texture of prerigor fillets of farmed Atlantic cod (*Gadus morhua*) depends in part on dietary content; for instance, dietary inclusion of soybean oil has been found to result in faster reduction of breaking strength and darker muscle (Morkore 2006). However, there may be extensive loss of weight and proteins during subsequent storage if fish are filleted prerigor (Kristoffersen and others 2007). Prerigor processing then presents problems, but there are obvious advantages to processing immediately after slaughter: the products can be shipped to market 3 to 5 d earlier and a prolonged shelf life is a major economic benefit (Rosnes and others 2003; Tobiassen and others 2006).

In this research, we focus on investigation of water temperature and time during tilapia fillet processing steps (bleeding, filleting, and trimming) to its quality.

2. Material & Method

2.1 Material

Tilapia are purchased in Mekong river delta, Vietnam.

2.2 Research method

2.2.1 Experiment #1: Effect of temperature and time in the washing step (before bleeding) to fillet quality

Experiments are randomly arranged with two factors: temperature and time with 3 replications. Factor A: temperature (^{o}C); factor B: time (minutes).

A1B1: samples are washed at 8-10^{o}C in 5 minutes.
A1B2: samples are washed at 8-10^{o}C in 10 minutes
A1B3: samples are washed at 8-10^{o}C in 15 minutes
A2B1: samples are washed at 18-20^{o}C in 5 minutes
A2B2: samples are washed at 18-20^{o}C in 10 minutes
A2B3: samples are washed at 18-20^{o}C in 15 minutes
A3B1: samples are washed at 28-30^{o}C in 5 minutes
A3B2: samples are washed at 28-30^{o}C in 10 minutes
A3B3: samples are washed at 28-30^{o}C in 15 minutes

Testing parameters: Sensory evaluation (color, texture, and aroma); microrganism (*Coliforms*, TPC).

2.2.2 Experiment #2: Effect of temperature and time in the washing step (after bleeding) to fillet quality

Experiments are randomly arranged with two factors: temperature and time with 3 replications. Factor C: temperature (^{o}C); factor D: time (minutes).

C1D1: samples are washed at 13-15 ^{o}C in 10 minutes
C1D2: samples are washed at 13-15 ^{o}C in 20 minutes
C1D3: samples are washed at 13-15 ^{o}C in 30 minutes
C2D1: samples are washed at 18-20^{o}C in 10 minutes
C2D2: samples are washed at 18-20^{o}C in 20 minutes
C2D3: samples are washed at 18-20^{o}C in 30 minutes
C3D1: samples are washed at 23-25^{o}C in 10 minutes
C3D2: samples are washed at 23-25^{o}C in 20 minutes
C3D3: samples are washed at 23-25^{o}C in 30 minutes

Testing parameters: Sensory evaluation (color, texture, and aroma); microrganism (*Coliforms,* TPC).

2.2.3 Experiment #3: Effect of temperature and time in the washing step (after filleting) to fillet quality

*E*xperiments are randomly arranged with two factors: temperature and time with 3 replications**.** Factor E: temperature (^{o}C); factor F: time (minutes).

E1F1: samples are washed at 8-10^{o}C in 8 minutes
E1F2: samples are washed at 8-10^{o}C in 12 minutes
E1F3: samples are washed at 8-10^{o}C in 16 minutes
E2F1: samples are washed at 18-20^{o}C in 8 minutes
E2F2: samples are washed at 18-20^{o}C in 12 minutes
E2F3: samples are washed at 18-20^{o}C in 16 minutes
E3F1: samples are washed at 28-30^{o}C in 8 minutes
E3F2: samples are washed at 28-30^{o}C in 12 minutes
E3F3: samples are washed at 28-30^{o}C in 16 minutes

Testing parameters: Sensory evaluation (color, texture, and aroma); microrganism (*Coliforms*, TPC).

2.2.4 Effect of trimming time to fillet quality

Experiments are randomly arranged with one factor: time with 3 replications. Factor G: time (minutes).

G1: trimming time 10 minutes.
G2: trimming time 20 minutes.
G3: trimming time 30 minutes.

Testing parameters: Sensory evaluation (color, texture, and aroma); microrganism (*Coliforms*, TPC).

2.3 Statistical analysis

All data are processeed by STAGRAPHIC PLUS 3.0

3. Result & Discussion

3.1 Effect of temperature and time in washing (before bleeding) to quality of tilapia fillet

Table 1: Chemical composition in raw tilapia fillet

Composition	Percentage (%)
Protein	16.85
Lipid	3.34
Carbohydrat	6.50
Moisture	75-80

Table 2: Effect of temperature and time in washing (before bleeding) to sensory of fillet

Time (minutes)	Temperature (^{o}C)	Color	Texture	Aroma	Taste
5	8- 10	2.38^{a}	3.75^{ab}	4.50^{ab}	3.63^{a}
5	18- 20	4.38^{d}	4.00^{ab}	4.50^{ab}	4.38^{bc}
5	28- 30	3.63^{c}	3.88^{ab}	4.50^{ab}	4.00^{abc}
10	8- 10	3.00^{abc}	3.63^{a}	4.50^{ab}	4.00^{abc}
10	18- 20	4.38^{d}	4.75^{c}	4.88^{b}	4.63^{c}
10	28- 30	3.00^{abc}	4.25^{bc}	4.63^{ab}	4.13^{abc}
15	8- 10	3.00^{abc}	3.75^{ab}	4.50^{ab}	3.63^{a}
15	18- 20	3.13^{bc}	4.13^{ab}	4.50^{ab}	4.38^{bc}
15	28- 30	2.63^{ab}	3.63^{a}	4.25^{a}	3.75^{ab}

Table 3: Effect of temperature and time in washing step (before bleeding) to color of fillet

Time (minutes)	Temperature (^{o}C)	L	a	B
5	18- 20	56.05^{ab}	-0.23^{a}	-1.32^{cd}
5	28- 30	54.65^{ab}	-0.53^{a}	-1.89^{bcd}
10	8- 10	57.30^{ab}	-0.57^{a}	-1.02^{d}
10	**18- 20**	**57.63^{ab}**	**-0.71^{a}**	**-0.83^{d}**
10	28- 30	54.61^{ab}	-0.83^{a}	-3.00^{ab}
15	8- 10	52.90^{a}	-0.10^{a}	-3.48^{a}
15	18- 20	58.04^{b}	-0.79^{a}	-1.27^{cd}
15	28- 30	53.98^{ab}	-0.50^{a}	-2.58^{ab}

Table 4: Effect of temperature and time in washing (before bleeding) to texture of fillet

Time (minutes)	Temperature (^{o}C)	Texture
5	8- 10	418.7^{ab}
5	18- 20	842.0^{d}
5	28- 30	405.3^{ab}
10	8- 10	522.3^{bc}
10	**18- 20**	**646.0^{cd}**
10	28- 30	286.3^{a}
15	8- 10	353.3^{ab}
15	18- 20	482.7^{abc}
15	28- 30	345.0^{ab}

Table 5: Effect of temperature and time in washing (before bleeding) to TPC of fillet

Time (minutes)	Temperature (^{0}C)	TPC (cfu/g)
5	8- 10	3.2x10^{4}
5	18- 20	3.7x10^{4}
5	28- 30	5.6x10^{4}
10	8- 10	2.7x10^{4}
10	18- 20	5.3x10^{4}
10	28- 30	5.6x10^{4}
15	8- 10	3.5x10^{4}
15	18- 20	4.9x10^{4}
15	28- 30	20x10^{4}

Table 6: Effect of temperature and time in washing (before bleeding) to coliform of fillet

Time (minutes)	Temperature (^{o}C)	*Coliform* (cfu/g)
5	8- 10	120
5	18- 20	130
5	28- 30	180
10	8- 10	100
10	18- 20	140
10	28- 30	250
15	8- 10	150
15	18- 20	260
15	28- 30	370

From above results, washing at 18-20^{o}C in 10 minutes gives the best fillet quality about color, texture, and microorganism. So we choose these parameters for further experiments.

3.2 Effect of temperature and time in washing step (after bleeding) to quality of tilapia fillet

Table 7: Effect of temperature and time in washing step (after bleeding) to sensory of fillet

Time (minutes)	Temperature (^{o}C)	Color	Texture	Aroma	Taste
10	13-15	2.67^{a}	3.89^{b}	3.89^{ab}	3.89^{a}
10	18-20	3.44^{cd}	3.56^{ab}	4.00^{b}	3.89^{a}
10	23-25	2.89^{ab}	3.56^{ab}	3.89^{ab}	3.67^{a}
20	13-15	3.33^{bcd}	3.11^{a}	4.22^{b}	4.00^{a}
20	18-20	4.00^{e}	3.78^{ab}	4.56^{b}	3.78^{a}
20	23-25	**3.78^{de}**	**3.33^{ab}**	**3.89^{ab}**	**3.89^{a}**
30	13-15	3.00^{abc}	3.67^{ab}	4.33^{b}	3.89^{a}
30	18-20	4.11^{e}	3.78^{ab}	4.22^{b}	4.11^{a}
30	23-25	3.00^{abc}	3.89^{b}	3.22^{a}	3.33^{a}

Table 8: Effect of temperature and time in washing step (after bleeding) to color of fillet

Time (minutes	Temperature (^{o}C)	L	a	b
10	13-15	53.35^{a}	-1.63^{ab}	-1.40^{ab}
10	18-20	52.37^{a}	-0.47^{ab}	-0.69^{ab}
10	23-25	52.12^{a}	1.03^{c}	-1.49^{a}
20	13-15	55.88^{a}	-0.75^{a}	-1.24^{ab}
20	18-20	56.68^{a}	-0.84^{a}	-0.01^{b}
20	**23-25**	**57.38^{a}**	**-0.41^{ab}**	**-0.22^{ab}**
30	13-15	56.34^{a}	-0.53^{ab}	-0.95^{ab}
30	18-20	50.89^{a}	0.29^{bc}	-0.20^{ab}
30	23-25	53.64^{a}	0.01^{ab}	-0.10^{ab}

Table 9: Effect of temperature and time in washing step (after bleeding) to texture of fillet

Time (minutes)	Temperature (°C)	Texture
10	13-15	517.7^{a}
10	18-20	897.0^{e}
10	23-25	607.3^{ab}
20	13-15	777.0^{cde}
20	18-20	781.3^{cde}
20	**23-25**	**828.0^{de}**
30	13-15	720.3^{bcd}
30	18-20	680.0^{bc}
30	23-25	698.3^{bc}

Table 10: Effect of temperature and time in washing step (after bleeding) to TPC of fillet

Time (minutes)	Temperature (°C)	TPC (cfu/g)
10	13-15	3.4x10^{4}
10	18-20	3.8x10^{4}
10	23-25	3.9x10^{4}
20	13-15	2.5x10^{4}
20	18-20	3.2x10 ^{4}
20	**23-25**	**6.4x10^{4}**
30	13-15	3.3x10^{4}
30	18-20	7.4x10^{4}
30	23-25	6.3x10^{4}

Table 11: Effect of temperature and time in washing (after bleeding) to *coliform* of fillet

Time (minutes)	Temperature (°C)	*Coliform* (cfu/g)
10	13-15	350
10	18-20	300
10	23-25	320
20	13-15	180
20	18-20	230
20	**23-25**	**130**
30	13-15	250
30	18-20	310
30	23-25	440

From above results, washing at 23-25°C in 20 minutes is suitable to maintain color and meet microorganism criteria.

3.3 Effect of temperature and time in washing step (after filleting) to quality of tilapia fillet

Table 12: Effect of temperature and time in washing step (after filleting) to sensory of fillet

Time (minutes)	Temperature (°C)	Color	Texture	Aroma	Taste
8	8- 10	4.00^{c}	2.71^{ab}	4.14^{a}	4.29^{ab}
8	**18- 20**	**3.71^{bc}**	**3.86^{d}**	**4.29^{a}**	**4.29^{ab}**
8	28- 30	2.43^{a}	3.71^{cd}	4.29^{a}	4.14^{ab}
12	8- 10	3.00^{ab}	2.57^{a}	3.86^{a}	3.57^{a}
12	18- 20	4.00^{c}	4.14^{d}	4.29^{a}	4.43^{b}
12	28- 30	4.29^{c}	3.43^{bcd}	4.29^{a}	4.43^{b}
16	8- 10	2.71^{a}	4.00^{d}	4.14^{a}	4.29^{ab}
16	18- 20	3.00^{ab}	3.71^{cd}	4.29^{a}	4.29^{ab}
16	28- 30	2.86^{a}	3.00^{abc}	4.57^{a}	4.00^{ab}

Table 13: Effect of temperature and time in washing step (after filleting) to color of fillet

Time (minutes)	Temperature (°C)	L	a	b
8	8- 10	52.07^{a}	0.95^{a}	-1.48^{a}
8	**18- 20**	**56.46^{abc}**	**1.14^{a}**	**-2.40^{a}**
8	28- 30	53.47^{ab}	0.82^{a}	-2.05^{a}
12	8- 10	57.24^{bc}	0.70^{a}	-2.55^{a}
12	18- 20	58.74^{c}	0.40^{a}	-3.78^{a}
12	28- 30	54.71^{abc}	0.56^{a}	-1.40^{a}
16	8- 10	56.72^{abc}	1.14^{a}	-1.60^{a}
16	18- 20	55.57^{abc}	0.57^{a}	-2.24^{a}
16	28- 30	57.54^{bc}	0.45^{a}	-2.13^{a}

Table 14: Effect of temperature and time in washing step (after filleting) to texture of fillet

Time (minutes)	Temperature (°C)	Texture
8	8- 10	620.3^{ab}
8	**18- 20**	**856.7^{de}**
8	28- 30	500.0^{a}
12	8- 10	734.3^{bcde}
12	18- 20	659.3^{abc}
12	28- 30	693.7^{bcd}
16	8- 10	832.7^{cde}
16	18- 20	858.0^{de}
16	28- 30	918.0^{e}

Table 15: Effect of temperature and time in washing step (after filleting) to TPC of fillet

Time (minutes)	Temperature (°C)	TPC (cfu/g)
8	8- 10	2.6x10^{4}
8	**18- 20**	**1.2x10^{4}**
8	28- 30	4.4x10^{4}
12	8- 10	3.9x10^{4}
12	18- 20	5.4x10^{4}
12	28- 30	8.7x10^{4}
16	8- 10	6.4x10^{4}
16	18- 20	7.4x10^{4}
16	28- 30	8.4x10^{4}

Table 16: Effect of temperature and time in washing step (after filleting) to coliform of fillet

Time (minutes)	Temperature (°C)	*Coliform* (cfu/g)
8	8- 10	200
8	**18- 20**	**200**
8	28- 30	250
12	8- 10	190
12	18- 20	220
12	28- 30	280
16	8- 10	260
16	18- 20	300
16	28- 30	440

From above results, washing at 18-20°C in 8 minutes is suitable to get the best sensory and microorganism.

3.4 Effect of trimming time to fillet quality

Table 17: Effect of trimming time to fillet sensory

Time (minutes)	Color	Texture	Aroma	Taste
10	**4.14^a**	**4.43^a**	**4.43^a**	**4.43^a**
20	3.71^a	4.29^a	4.29^a	4.29^a
30	4.14^a	4.00^a	4.14^a	4.43^a

Table 18: Effect of trimming time to fillet color

Time (minutes)	L	a	b
10	**52.26^a**	**-0.96^a**	**-1.60^b**
20	56.18^a	-0.96^a	-3.79^a
30	54.58^a	-0.43^a	-2.22^b

Table 19: Effect of trimming time to fillet texture

Time (minutes)	Texture
10	**389.0^a**
20	287.3^a
30	198.7^a

Table 20: Effect of trimming time to fillet TPC

Time (minutes)	TPC (cfu/g)
10	**$3.4x10^4$**
20	$3.7x10^4$
30	$15.0x10^4$

Table 21: Effect of trimming time to fillet coliform

Time (minutes)	*Coliforms* (cfu/g)
10	**130**
20	180
30	340

From above results, we conclude that 10 minutes for trimming is adequate.

4. Conclusion

Tilapia (Oreochromis niloticus) is one of the most important species in aquaculture because of its genetic, reproductive, and marketing characteristics. Although these fish can be raised under controlled conditions, their flesh is a complex biochemical structure that is easily metabolized by microorganisms and is rapidly affected by autolytic enzymes, due to its high water content, near-neutral pH, and predominance of unsaturated fat. Therefore, investigations of processing conditions that could enhance the safety of this important food by preserving its physical, chemical, microbiological, and sensory attributes over longer storage times without significantly altering its nutritional content are desirable.

5. Reference

1. Andersen UB, Strømsnes A, Steinsholt K, Thomassen MS. Fillet gaping in farmed Atlantic salmon (*Salmo salar*) Norwegian J Aquac Sci. 1994; 8:165–79.
2. Aske L, Midling K. Slaughtering of Atlantic halibut (*Hippoglossus hippoglossus*): effect on quality and storing capacity. In: Kestin SC, Warriss PD, editors. Farmed fish quality. Oxford, England: Fishing News Book. Blackwell Science Ltd; 2001. p. 381.
3. Botta JR, Squires BE, Johnson J. Effect of bleeding/gutting procedures on the sensory quality of fresh raw Atlantic cod (*Gadus morhua*) Can Insti Food Sci Technol J. 1986;19:186–90.
4. Botta JR, Bonell G, Squires BE. Effect of method of catching and time of season on sensory quality of fresh raw Atlantic cod (*Gadus morhua L*) J Food Sci. 1987; 52:928–31.
5. Erkan N. Sensory, chemical and microbiological attributes of sea bream (*Sparus aurata*): effect of washing and ice storage. Int J Food Prop. 2007; 10:421–34.
6. Gregory NG. Recent concerns about stunning and slaughter. Meat Sci. 2005; 70:481–91.
7. Huss HH. Quality and quality changes in fresh fish. FAO fisheries technical. Rome: FAO Press; 1995. p. 348.
8. Kestin S, Wotton S, Adams S. Quality in aquaculture. Ghent, Begium: European Aquaculture Society; 1995. The effect of CO_2 concussion or electrical stunning of rainbow trout (*Onchoryncus mykiss*) on fish welfare; pp. 380–1. Special Publication 23.
9. Kiessling A, Espe A, Ruohonen K, Morkore T. Texture, gaping and colour of fresh and frozen Atlantic salmon flesh as affected by pre-slaughter iso-eugenol or CO_2 anaesthesia. Aquaculture. 2004; 236:645–57.
10. Kosak PH, Toledo RT. Effects of microbial decontamination on the storage stability of fresh fish. J Food Sci. 1981; 46:1012–4.
11. Kristoffersen S, Vang B, Larsen R, Olsen R. Pre-rigor filleting and drip loss from fillets of farmed Atlantic cod (*Gadus morhua L*) Aquac Res. 2007; 38:1721–31.
12. Laverty J. Gaping in farmed salmon and trout. Torry advisory note N° 90. Edinburgh: HMSO Press; 1984.
13. Meyer B, Samuels R, Flick G. A seafood quality program for the mid-Atlantic region, Part II. A report submitted to the Mid-Atlantic Fisheries Development Foundation. Blacksburg, Va: Virginia Polytechnic Inst. and State Univ., Sea Grant; 1986.
14. Morkore T. Relevance of dietary oil source for concentration and quality of pre-*rigor* filleted Atlantic cod, *Gadus morhua.* Aquaculture. 2006; 251:56–65.
15. Morkore T, Rorvik KA. Seasonal variations in grow, feed utilization and product quality of farmed Atlantic salmon (*Salmo salar*) transferred to seawater as O+smolts or 1+smolts. Aquaculture.2001; 199:145–57.
16. Moser MD. Gloucester, Mass: A report submitted to the New England Fisheries Development Foundation; 1986. Maine Groundfish Association vessel quality handling project.

17. Olsen SH, Sorensen NK, Stonno SK, Elvevoll EO. Effect of slaughter methods on blood spotting and residual blod in fillets of Atlantic salmon (*Salmo salar)* Aquaculture. 2006; 258:462–9.
18. Poli BM, Parisi G, Scappini F, Zampacavallo G. Fish wellfare quality as affected by pre-slaughter and slaughter management. Aquacult Int. 2005; 13:29–49.
19. Robb DHF. Bristol, U.K.: Univ. of Bristol; 1998. Some factors affecting the fish quality of salmonids: pigmentation, composition and eating quality. PhD thesis.
20. Robb DHF. The relationship between killing methods and quality. In: Kestin SC, Warriss PD, editors.Farmed fish quality Oxford. England: Fishing News Book, Blackwell Science Ltd; 2001. pp. 220–33.
21. Robb DHF, Frost S. Welfare and quality. What is the relationship? Presentation at Innovation for seafood'99, Surfer's Paradise. 1999. Queensland, Australia, 21–23 April.
22. Robb DHF, Philips AJ, Kestin SC. Evaluation of methods for determining the prevalence of blood spots in smoked Atlantic salmon and the effect of exsanguinations method on prevalence of blood spots.Aquaculture. 2003; 217:125–38.
23. Røra AMB, Morkore T, Einen R. Primary processing (evisceration and filleting) In: Kestin SC, Warriss PD, editors. Farmed fish quality. Oxford, England: Fishing News Book. Blackwell Science Ltd; 2001. pp. 249–60.
24. Rosnes JT, Vorre A, Folkvord L, Hovda Fjaera S, Skjervold P. Effect of pre-, in-, and post-rigor filleted Atlantic salmon (*Salmo salar*) on microbial spoilage and quality characteristics. J Aqua Food Prod Technol. 2003; 12:17–31.
25. Roth B, Torrissen OJ, Slinde E. The effect of slaughtering procedures on blood spotting in rainbow trout (*Oncorthynchus mykiss*) and Atlantic salmon (*Salmo salar*) Aquaculture. 2005; 250:796–803.
26. Roth B, Imsland A, Gunnarsson S, Foss A, Schelvis-Smith R. Slaughter quality and rigor contraction in fanned turbot (*Scophthalmus maximus*): a comparison between different stunning methods.Aquaculture. 2007; 272:754–61.
27. Samuels RD, DeFeo A, Flick GJ. Blacksburg, Va: Virginia Polytechnic Inst. and State Univ., Sea Grant; 1984. Demonstrations of quality maintenance program for fresh fish products. A report submitted to Mid-Atlantic Fisheries Development Foundation.
28. Shaw SJ, Bligh EG, Woyewoda AD. Effect of delay filleting on quality of cod fish. J Food Sci.1984; 48:979–80.
29. Shewan JM. Some bacteriological aspects of handling, processing and distribution of fish. J R Sanit Insti.1949; 59:394–402.
30. Shewan JM. The microbiology of seawater fish. In: Borgstrom G, editor. Fish as food. New York: Academic Press; 1961. pp. 487–560.
31. Sigholt T, Erikson U, Rustad T, Johansen S, Nordvedt T, Seland A. Handling stress and storage temperature affect meat quality of farm-raised Atlantic salmon (*Salmo salar*) J Food Sci. 1997; 62:898–905.
32. Skjervold PO, Røra AMB, Fjaera SO, Vegusdal A, Vorre A, Einen O. Effect of pre-, in- or post-rigor filleting of live chilled Atlantic Salmon. Aquaculture. 2001; 194:315–26.
33. Smart G. Problems of sea bass and seabream quality in the Mediterranean. In: Kestin SC, Warriss PD, editors. Farmed fish quality. Oxford, England: Fishing News Book, Blackwell Science Ltd; 2001. pp. 121–8.
34. Sohn JH, Ushio H, Ishida N, Yamashita M, Terayama M, Ohshima T. Effect of bleeding treatment and perfusion of yellowtail on lipid oxidation in post-mortem muscle. Food Chem. 2007; 04:962–70.
35. Storm T, Lien K. Fish handling on board Norwegian fishing vessels. In: Moller A, editor. Fifty years of fisheries research in Iceland. Reykjavik, Iceland: Jubilee Seminar of the Icelandic Fisheries Lab.; 1984. p. 15. 23–24 Sep.
36. Tejada M, Huidobro A. Quality of farmed gilthead seabream (*Sparus aurata*) during iced storage related to the slaughter methods and gutting. Eur Food Res Technol. 2002; 215:1–7.
37. Tobiassen T, Akse L, Midling K, As K, Dahl R, Eilertsen G. The effect or pre-rigor processing of cod (*Gadus morhua L.*) on quality and shelf life. In: Luten JB, Jacobsen C, Bekaert K, Saebo A, Oehlenschläger J, editors. Seafood research from sea to dish. Wageningen, The Netherlands: Wageningen Academic Publishers; 2006. pp. 149–59.
38. Valdimarsson G, Matthiansson A, Stefansson G. The effect of bleeding and gutting on the quality of fresh, quick frozen, and salted products. In: Moller A, editor. Fifty years of fisheries research in Iceland.Reykjavik, Iceland: Jubilee Seminar of the Icelandic Fisheries Lab; 1984. p. 61. 23–24 Sep.
39. Van De Vis H, Kestin SC, Robb D, Oehlenschläger J, Lambooij B, Münkner W, Kuhlmann H, Kloosterboer K, Tejada M, Huidobro A, Otterå H, Roth B, Kristian Sørensen N, Akse L, Byrne H, Nesvadba P. Is humane slaughter of fish possible for industry. Aquac Res. 2003; 34:211–20.