Available online at website: www.bbp4b.litbang.kkp.go.id/squalen-bulletin

Squalen Bulletin of Marine & Fisheries Postharvest & Biotechnology, 8 (2), 2013, 77-86

Quality Changes of Boiled Salted Carp Fish (*Cyprinus carpio)* Using Steaming and Boiling Methods, During Chilling Storage

*Perubahan Mutu Pindang Ikan Mas (*Cyprinus carpio*), yang Diolah dengan Teknik Pemanasan Berbeda Selama Penyimpanan pada Suhu Dingin*

Theresia Dwi Suryaningrum* and Syamdidi[1]

[1]Research and Development Center for Marine and Fisheries Product Processing and Biotechnology, Jl. K.S. Tubun Petamburan VI, Jakarta Pusat 10260, Indonesia
*Correspondence Author: theresiadwi@yahoo.com

Article history:
Received: 12 November 2012; Revised:1 May 2013; Accepted: 1 May 2013

ABSTRACT

Study on quality changes of boiled salted Carp fish, processed using different cooking methods during chilling storage has been conducted. The study was intended to obtain an information on the effect of cooking method on the shelf-life of boiled salted carp fish (*Cyprinus carpio*) at chilling temperatures. Fish was soaked in a 0.2% of alum solution and then marinated in condiment solution for 30 minutes. Fish were cooked for 4 h by two different methods *i.e* steaming and boiling, at 98-100 °C, and then dried in the oven at 80-90 °C for 1 hour. Boiled salted fish then were stored at chilling room (2-4 °C) and observed every 3 days for 15 days. The quality of boiled salted fish were analyzed *i.e* proximate at the beginning and the end of storage, while moisture content, pH, TVB, total plate count, mold and sensory test were conducted during chilling storage. The results showed that steamed boiled salted carp fish had higher protein content, pH and also have better product which was preferable by the panelists. Based on this result steaming method was recomended to be used as processing method for production of boiled salted carp fish from fresh water. Sensory test found that panelists preferred steamed product which had a good appearance, odor, taste and texture. However steamed product had faster increase of moisture content, TVB, and number of bacteria as well as the decrease of pH value and odor causing faster deterioration of product compared to boiling method. Based on microbiological tests, the boiled salted carp fish cooked by steaming methods were safe to be consumed before 6 days and the boiling method before 9 days, since storage exceed that periods resulted in number of bacteria already reached the maximum number allowed and became not suitable for human consumption.

Keywords: Boiled salted Carp fish, cooking method, quality, chilling storage

ABSTRAK

Penelitian kemunduran mutu pindang ikan mas yang diolah dengan teknik pemanasan yang berbeda dan disimpan pada suhu dingin telah dilakukan. Ikan mas (*Cyprinus carpio*) direndam dalam larutan tawas 0,2% kemudian direndam dalam bumbu masing-masing selama 30 menit. Ikan dipindang dengan variasi pemanasan (dikukus dan direbus) selama 4 jam, kemudian dioven pada suhu 80-90 °C selama 1 jam. Pindang disimpan pada suhu dingin (2-4 °C) dan diamati setiap 3 hari sekali selama 15 hari. Pengamatan mutu pindang dilakukan terhadap komposisi proksimatnya di awal dan akhir penyimpanan, kadar air, pH, TVB, angka lempeng total, kapang, *E coli*, uji mutu hedonik dan uji skor selama penyimpanan. Hasil penelitian menunjukkan pindang ikan mas yang dikukus mempunyai kadar protein dan pH yang lebih tinggi serta menghasilkan produk yang lebih disukai oleh panelis. Berdasarkan hasil penelitian, metode pengukusan lebih disarankan dalam pengolahan pindang air tawar. Pindang yang diolah dengan metode pengukusan mempunyai sifat sensori kenampakan, bau, rasa dan tekstur yang lebih baik dibandingkan dengan metode perebusan. Namun demikian pindang yang dikukus lebih cepat mengalami kenaikan kadar air, TVB dan jumlah bakteri serta penurunan pH dan bau yang menyebabkan pindang lebih mudah busuk. Berdasarkan uji mikrobiologi, pindang ikan mas sudah tidak layak dikonsumsi setelah disimpan selama 9 hari, karena angka lempeng totalnya telah melampaui batas maksimum yang diperbolehkan.

Kata Kunci: Pindang ikan mas, teknik pemindangan, mutu, peyimpanan suhu dingin

Permalink/DOI: http://dx.doi.org/10.15578/squalen.v8i2.89

1. Introduction

Boiled salted fish is one of Indonesian prefered traditional processed fish products because of its good tastes. The product specifically has low-salt, intact shape and able to be processed further into other food products. Boiled salted fish is generally prepared from small pelagic fish including mackerel (*Rastrellinger* sp.), herring (*Decapterus* sp.), skipjack (*Euthymus pelamis*) and brackish water fish including milkfish (*Chanos chanos*). During the resent years the availability of raw material from marine is facing a decline, but on the other hand the production of fresh water fish cultures is significantly increased. This creating an opportunity for fresh water fish to substitute marine fish as the raw material especialy in the production of boiled salted fish. This subtitution become one of potential solution in order to overcome the problem of over production. Boiled salted fish can be produced by two different cooking methods, namely boiling and steaming. Boiling method will reduce the moisture content and its nutritional value (Jamasuta & Permana, 1996), while steaming method produced higher acceptability to panelis (Jamasuta, 1990).

The problems found in boiled salted fish made from freshwater fish are mushy texture, as well as the frequent occurrence of geosmin odor (Nurjanah & Abdullah, 2010). To improve the texture, the fish can be soaked in alum solution. Alum ($Al_2(SO_3)$ $14H_2O$) is a food grade chemical salt which is according to the Food and Drug Administration is considered safe when it is used in the recommended number (Edwards, 2002). Alum is often used to improve the texture in the processing of pickles. The research conducted by Ratnasari (2002) showed that dipping fish carp in a 0,1% of alum solution can increase the texture boiled salted product. Moreover, research done by Haribi & Yusri (2004) on smoked tuna soaked with a 4-10% of alum solution for 30-150 minutes can produce a number of residue which is safe for human health. In addition, alum solution also can act as antibacterial compound (Nurahman, 2008). The research done by Helmiyati & Nurahman, (2010) showed that the addition of 1% alum solution was able to inhibit gram-positive bacteria, while gram-negative bacteria was inhibited by addition of 2% alum. Meanwhile, the addition of other ingredients on boiled salted product was intended to minimize its smell and mud odor (Mamat, 2011).

Other problem arising in boiled salted fish was related to its short shelf life which is only 2-3 days when stored at room temperature. This penomena continues to occur although it has been salted with concentration of 15% and 20% (Sarnianto et al., 1984 in Irianto & Pratiwi, 2009). Many efforts has been conducted to prolong boiled salted fish shelf life, including by soaking fish in chitosan solution (Aryani & Yenie, 2008), immersion in turmeric and tamarind solution (Retnowati et al., 2004) and the use of potassium sorbate combined with glycerol (Putro et al., 1984). Boiling skipjack in guava leaf extract (*Psidium guajava*) was showed to inhibit the rise of TBA and protect the oxidation of unsaturated fatty acids but unable to inhibit the growth of bacteria and TVB (Aryani et al., 2009). Preservation of boiled salted fish (*Restrelliger* sp.) using combination of sodium acetat, lactic acid bacteria culture and vacuum packaging can prolong the shelf life to 4 days storage at room temperature (Jenie et al., 2001).

The deterioration of boiled salted fish is mainly due to the growth of bacteria which is characterized by the formation of mucus and molds, and the soften of the texture because of its higher water activity (a_w) of boiled salted fish. Growth of bacteria, fungus and mold will decrease the sensory value as well as its aesthetically since the fish appears to be unattractive(Heruwati et al., 1985). The spoilage due to the growth of bacteria and fungi can be inhibited by storing the products at cold temperatures around -1 to 4 °C. At these temperatures, the growth of bacteria and biochemical processes will be hampered. Cold temperature will preserve fish for several days or several weeks, depending on the type of food. Preservation at cold temperatures does not kill microorganisms, but reduce the activity of microbial metabolism which is responsible for decaying process (Ashie et al., 1996). This research was intended to study the effect of cooking method on the shelf-life of boiled salted fresh water fish (*Cyprinus carpio*) stored at chilling temperatures.

2. Material and Methods

2.1. Material

Materials used for this research was live carp fish (*Cyprinus carpio)* with 4/kg weight each. The dimension of fish was 244.7 g weight, 23.63 cm total length, 18.97 cm, body length 6.96 cm width and 3.76 cm thick. Fish obtained from freshwater fish collector at Parung, Bogor. Other materials used were ice, salt, alum, sugar, spices including red onion and garlic, turmeric, galangal, ginger, lemongrass, and bay leaf.

2.2. Handling and Processing Method

Fish were killed by cold shock methods using iced water with temperature of 4-5 °C for 15 minutes. Then, fish were dressed by removing its internal organ/ visera and soaked in a solution of alum with a

concentration of 0.2% (w/v) (Taylor, 1980). Soaking in 0.2% alum solution was performed in 30 minutes with comparison between water and fish of 1 : 1, respectively. After that, fish was marinated with ingredients (seasoning) in the amount of 7.5% based on weight of fish. The ingredients consist of 1.2% garlic, 1% galangal, 1% turmeric, 0.2% ginger, 1% lemongrass, 1% bay leaf, 5% salt and 5% sugar (Muljanah & Suryaningrum, 2009). Grinding was conducted by using blender with addition of water (50% of the seasoning weight). Soaking the fish in seasoning was performed for 30 minutes, then the fish was transferred into a steamer pot, and cooked for 4 hours. Both of this equipments used in this study have 40 cm in diameter and 30 cm height for steamer pot, and 60 cm height cooker. Ratio of the water and fish during cooking is 1 : 1 and the temperature was 98-100 °C. Morever, fish were dried in the oven at 80-90 °C for 1 hour to reduce the moisture content. The end products were stored in chilling room at temperature of 1-2 °C for 15 days. The sample was analyzed every 3 days (0, 3, 6, 9, and 15 days).

2.3. Analysis

Observations were conducted on the proximate compisition including moisture, ash, protein, and fat content (BSN, 2006). pH was measured using pH meter (Apriyantono et al., 1988), and TVB using conway methods. Microbiological analysis were done for total plate count (TPC), *Escherichia coli* and molds (SNI 01-2332.3-2006). Meanwhile, sensory evaluation was conducted for the acceptance test using hedonic scale of 1-7 test and test score (SNI 01-2346-2006) (BSN, 2006). The study was conducted in triplicates and statistically analyzed by completely randomized design using SPF 16 program.

3. Result and Discussion

3.1. Quality of The Raw Material and Proximate of The Product

Proximate analysis of fresh carp used in this research were presented in Table 1.

Based on the fish composition of above, the freshwater Carp fish were classified to have low fat and medium protein content. According to Okada (1990), fish were classified into the low fat and medium protein group which have less than 5% fat and 10-15% protein. Alive Carp fish was used in this study as raw material thus the fish was considered as fresh. The raw material had neutral pH, TPC value below 5 x 10^5 colony/g and clearly from *E. coli* contamination. Result of the analysis was within the limits required by SNI 2006 for fresh fish (BSN, 2006). TVB content of fish was 11.76 mg/N%, less than that 30 mg/N% the recommended level of TVB for fresh fish, (Connel, 1990). Meanwhile, the proximate analysis of boiled salted fish at the beginning and end of storage can be seen in Table 2.

Results of proximate analysis of boiled salted fish indicated that different cooking methods affected significantly on the protein and ash contents ($p \geq 0.05$). Steamed boiled salted fish had higher protein content (21.29%) compared to the boiled one (19.18%). Boiling method dissolves water-soluble proteins such as sarcoplasmic resulting in lower protein content. However, steamed boiled salted fish had lower ash content (4.06%) than boiled one

Table 1. Proximate Analysis and Freshness Level of Carp

Moisture Content (%)	Ash Content (%)	Protein Content (%)	Fat Content (%)	pH	TVB (mgN%)	Total Plate Count and *E coli*
79.4	1.34	14.29	2.8	6.71	11.76	4.6 x 10^4 cells/g E coli: negative

Table 2. Proximate Value of Boiled Salted Fish at the Beginning and the end of Storage

Responses	Steam		Boiling	
	0 day	15 days	0 day	15 days
Moisture content (%)	63.88 ± 1.52^a	67.89 ± 0.93^b	63.40 ± 2.02^a	63.85 ± 1.97^a
Ash content (%)	4.06 ± 0.33^a	3.66 ± 0.40^a	6.79 ± 0.96^b	6.29 ± 0.95^b
Protein content (%)	21.29 ± 1.27^a	20.96 ± 1.20^a	17.15 ± 1.23^b	19.18 ± 1.51^b
Fat content (%)	10.67 ± 2.24^a	6.74 ± 1.51^b	9.24 ± 0.34^a	9.33 ± 0.50^a

(6.79%). According to Ersoy & Ozeren, (2009) effect of cooking was increacing on Ca, K and Mg contents. Boiling was easer the access of seasoning into fish flesh such as mineral or non-volatile organic compounds which contribute to the increase of ash content than steaming one. Studies on salted boiled fish, processing with different boiling time, showed that the longer the boiling time the higher ash content of the product (Riyanto et al., 2011).

During chilling storage, boiled salted fish which were processed using boiling method, had no effect on the changes of proximate composition. Meanwhile, steamed product showed a decrease of fat content and an increace of moisture content during chilling storage. Fat in fish flesh is accumulate in the form of trigliserol. Then, trigliserol hydrolyzed by lipase producing acid glycerol and free fatty acids, resulting unpleasant odors and rancidity (Galy et al., 2010). Microbial activity on glycerol produces about 20 compounds including aldehyde compounds, organic acids, and other aliphatic compounds. Microbes also degrade free fatty acid chain into lower weight molecular compounds which will be oxidized futher to produce CO_2 and water (Fenema, 2007).

3.2. Deterioration Parameters of the Product During Chilling Storage

Moisture Content

Result showed that cooking methods did not significantly affect the moisture content of the product at the initial storage (day 0). The moisture content of boiled salted fish using steamed methods was 63.88%, while the boiled one was 63.60%. Even though reheating by oven was applied, this value was exceeded the standards of SNI year 2006 which stated that the maximum value of moisture content should be 60%. However, the value of moisture content in this research was not significantly different from other research results. Hidayat & Bustami (1996) found that moisture content of boiled salted mackerel which was cooked for 2-2.5 h was 62.01 to 62.10 %. Moisture content is an important parameter in food spoilage since it will trigger the biochemical reactions (Purnomo, 1995).

During chilling storage moisture content of the product processed by steaming method was significantly increased, but not for those processed by boiling method. Boiling causes the decrease of many protein, resulting in the decrease of water absorption. This is in compliment to the result (Table 1), showed that boiled carp product had lower protein content compared to steamed one. When the product was stored at chilling temperature, the boiled product absorb the water more slowly than those processed by the steaming method. The increase of moisture content of the product processed by steaming method also was in line with the decrease of fat during storage, due to the hydrolysis process which further generates CO_2 and water (Fenema, 2007).

Total Volatile Base (TVB)

Total volatile base (TVB) is one of parameters used to demonstrate the process of spoilage of fresh and processed fish products (Dalgraard et al, 2006). TVB is a volatile base compound resulted from the breakdown of the protein including ammonia, H_2S, mercaptans, phenol, cresol, indole and skatol expressing foul odors (Aurand et al., 1987). TVB formation occured in the muscle tissue is mostly composed of ammonia, trimethylamine (TMA) and dimethylamine (DMA) in which the levels vary among fish species and even within the same species. In this study, heating was carried out for 4 hours at 98-100 °C, causing to the formation of ammonia and amines volatile derived from creatine, cysteine, and

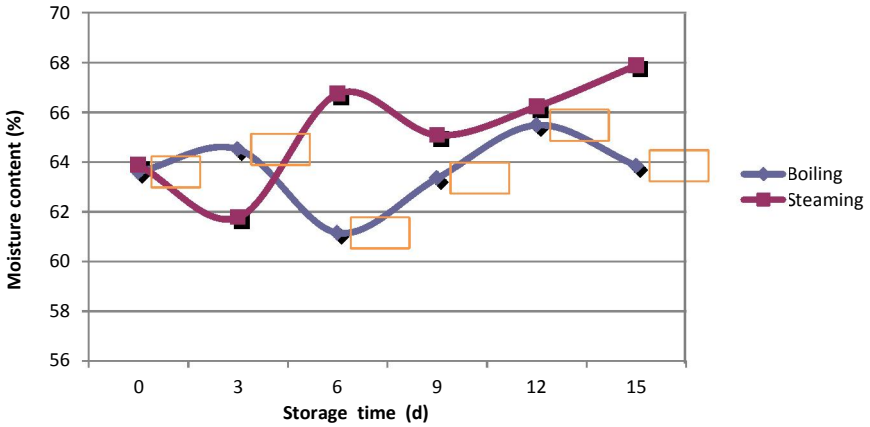

Figure 1. Moisture content of boiled salted fresh water fish processed by boiling and steaming method during chilling storage.

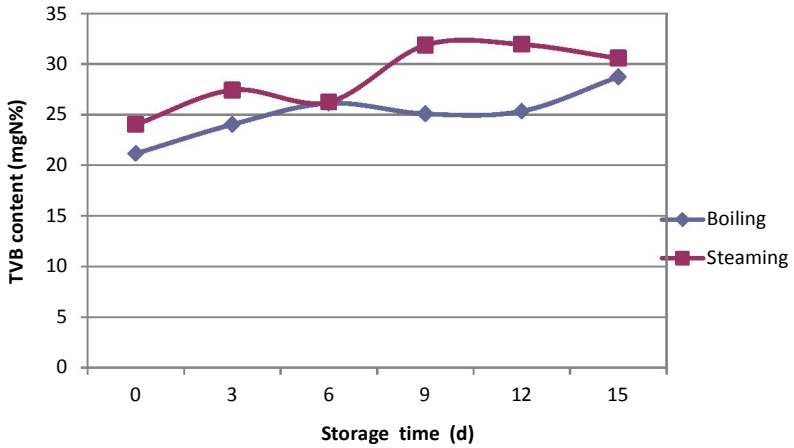

Figure 2. TVB value change of boiled- salted fresh water fish processed by boiling and steaming method during chilling storage.

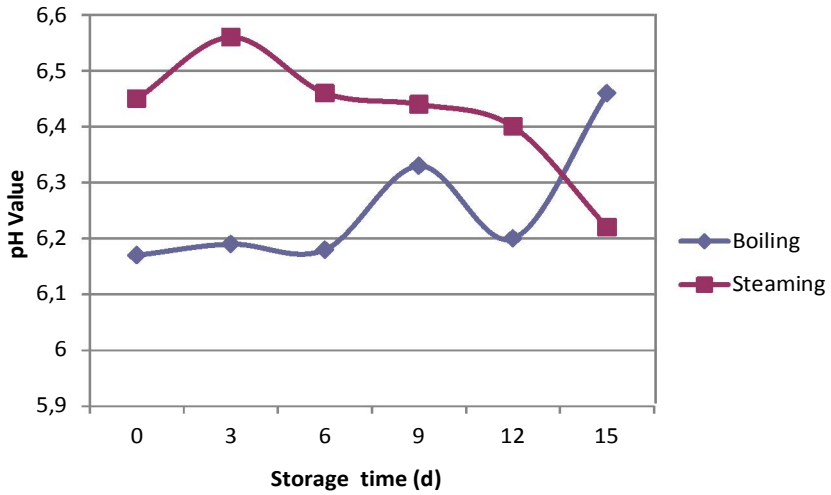

Figure 3. Changes in pH values of boiled- salted fresh water fish processed by boiling and steaming method during chilling storage

histidine (Hughes, 1964 In Sihombing 1985), and influents increasing TVB content of product compared to the fresh fish. TVB content of boiled salted fish by steaming method had higher value than fish cooked by boiling method.

During storage, TVB content was significantly increased ($p \geq 0.05$). The increase of TVB content of steamed method was faster than boiled one. This is in compliment to the result that, steamed product during storage had faster increase of moisture content and number of bacteria. TVB content of fresh water fish quite lower compared to marine fish, this was allegedly happened due to lower tri methyl amine oxidase (TMAO) in fresh water fish. While in marine fish, higher TMAO content was used as osmoregulation to avoid dehydration in high salinity environments (Galy et al., 2010). The increasing of TVB was related to the number of bacteria during storage at chilling temperatures (1-2 °C). The bacteria which play a role on boiled salted fish spoilage are psychrophillic bacteria growing at temperature of 1-5 °C such as *Shewanella putrifaciens*, *Aeromonas sp*, *Pseudomonas* sp. and *Vibrio* sp. Those bacteria will break down TMAO into *Tri Methyl Amine* (TMA) and subsequently formed ammonia compounds and other volatile compounds (Gram & Dalgaard, 2002). The average content of TVB at the initial storage for boiled salted fish product, processed with steaming method was 24.04 mgN% and at the end of storage reached 30.58 mgN%. On the other hand, those processed with boiling method produced TVB at the initial of storage around 21.17 mgN% and increased into 28.74 mgN% at the end of storage. TVB content of the product was still in the range of values for the freshness of processed fish products which is 100-200 MGN% (Connel, 1990).

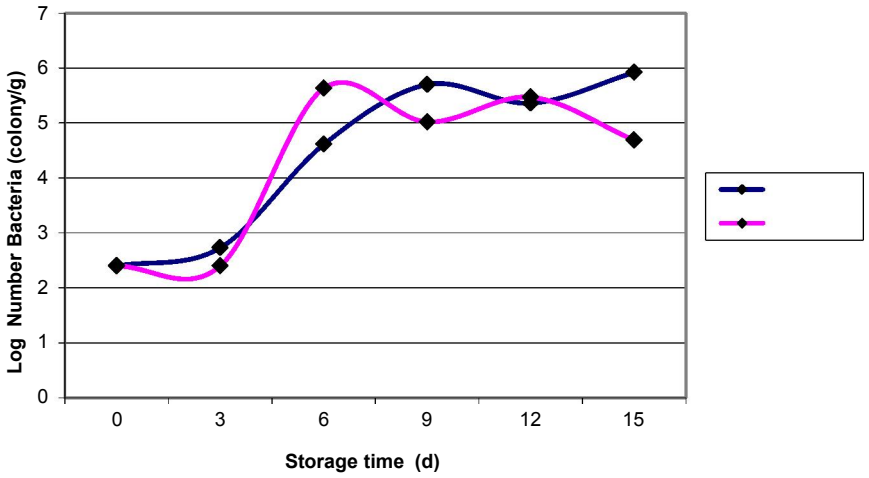

Figure 4. Changes in the number of bacteria of boiled salted fresh water fish processed by boiling and steaming method during chilling storage

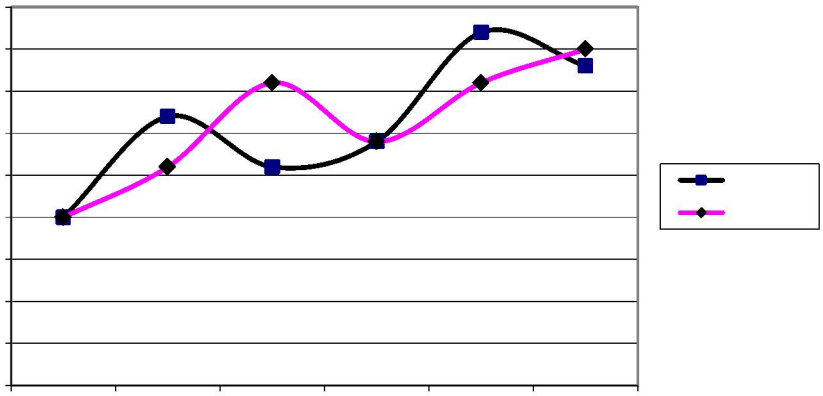

Figure 5. Changes in the number of mold of boiled salted fresh water fish processed by boiling and steaming method during chilling storage.

pH

The cooking methods affected pH value of the product. Steaming method had higher pH value and significantly different (P≤0.05) than the boiling one. It was allegedly caused by the ingredients being used which consists of onions containing alisin (Jaelani, 2007) and acid from galangal (Yuliawati, 2004). Both of the seasoning caused the product have lower pH value (6.22- 6.46%) than fresh fish (6.71%). Boiling method seemed to allow the ingredients to penetrate into the flesh, causing the decrease of pH. The average pH value of steaming method product was 6.45 while the boilling method one was 6.17.

During storage the value pH of the product processed by steaming method decreased, but the product processsed by boiling increased significanly. The decline in pH of product processed by steaming method suspected by the action of the lactic acid bacteria that produce compounds such as lactic acid, acetate acid, formic acid, free fatty acids are acidic (Jennie et al, 2001). While the increase in pH can be attributed by microbial activity that causes degradation of the protein into volatile base (Buckle et al., 2009)

The value of pH in this product under the level optimum pH for the activity of bacterial TMAO – reducing enzyme namely 7.2-7.4 (Castro et al., 2006)

Microbial

Microbiological analysis on the fish product were conducted on total plate count, mold and *Escherichia coli*. The results of total plate count and molds development during storage can be seen in Figure 4 and 5. Different cooking methods did not result in

significant effect on the total bacteria number at the beginning of storage. However, the number of bacteria increased during chilling storage. The microbial content of the product at the begining storage was log 2,4 colony/g (< 25 X 10^1colony/g) and the end of storage were log 4,9 colony/g (2, 95 x 10^5colony/g) for the steamed method and log 5.69 colony/g (4,3 x 10^5 colony/g) for the boiling method.

On day 6 bacteria from fish product processed by steaming method grew faster than those from boiling method which is already exceeding the maximum value allowed by SNI 2717-3-2009 (maximum: 5.0 x 10^5 colonies/g) . In addition, low temperature of storage was not set to kill the microorganisms but only to inhibit the growth. Psychrophillic bacteria which are the decomposers such as *Bacillus subtilis*, *Streptococcus faecium*, *Lactobacillus* sp. and *Pseudomonas fluorescens* are able to grow at 0-5 °C (Prescott, 1999). However, the growth of bacteria the product from boiling method was slightly slower and exceeding maximum value on day 9. Winarno & Jenie (1983) stated that the growth of microorganism is mainly determinated by free water avalilable in the product which is shown by the high level of water activity (a_w). Buckle et al. (2009) stated that all bacteria is able to grow in food having water activity of 0.95–0.99. The a_w of salted boiled of fresh water product for the steaming method is 0, 99 and the boiling method is 0,97 (Suryaningrum et al., 2013) This condition of a_w is suitable for the growth of bacteria during storage. Bacterial growth causes various physical and chemical changes, producing undesirable products. Based on microbiological tests, this products were not eligible to be consumed after 9 days storage since the TPC value reached 1.2 x 10^5 colony/g for boiling method and 5.92 x 10^5 colony/g for steaming method. This results were similar with the result of previous research done by Irianto & Pratiwi (2009), who reported that the shelf life of boiled salted fish in chilling temperature was only 8 days.

Escheria coli were found negative during chilling storage. Acording to SNI (2006) maximum allowed *E. coli* for fish product is <3 APM/g. *E. coli* is an indicator of bacterial contamination originated from gastrointestinal tract. Most *E. coli* strains are harmless, but some serotypes can cause serious food poisoning in humans, and are occasionally responsible for product recalls due to food contamination. Foods containing *E. coli* if it consumed by humans could causes diarrhea (Todar, 2007).

The number of mold during storage showed an increase during storage for both boiled salted fish processed by steaming and boiling. The growth of molds was associated with moisture content and water activity (a_w). According to Fardiaz (1992), the minimum water activity (a_w) required to germinate the mold spore is 0.93 and to grow is 0.95 to 0.98. Pitt & Hocking (1991) stated that in tropical areas, *Aspergillus* sp. and *Eurotium* sp. were easily found in food as part of its spoilage activity. Mold species of *Aspergillus flavus* causing food poisoning by producing aflatoxin contributes for almost 45.50% to food spoilage which is higher compared to other *Aspergillus* sp.

Sensory Test of Preserved Fish

Sensory test was conducted by well-trained panelists to perform preference test using 1-7 hedonic scale. While the assessment for appearance, odor, texture, taste, presence of mucus and fungus is using score sheet test (scale 1-9) for salted boiled fish (SNI 2006). The result of hedonic test can be seen in figure 6.

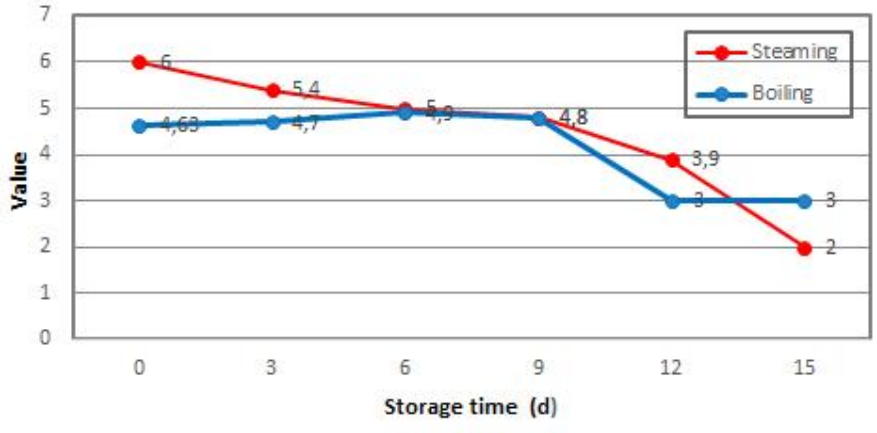

Figure 6. Hedonic test of boiled salted fresh water fish processed by boiling and steaming method during chilling storage.

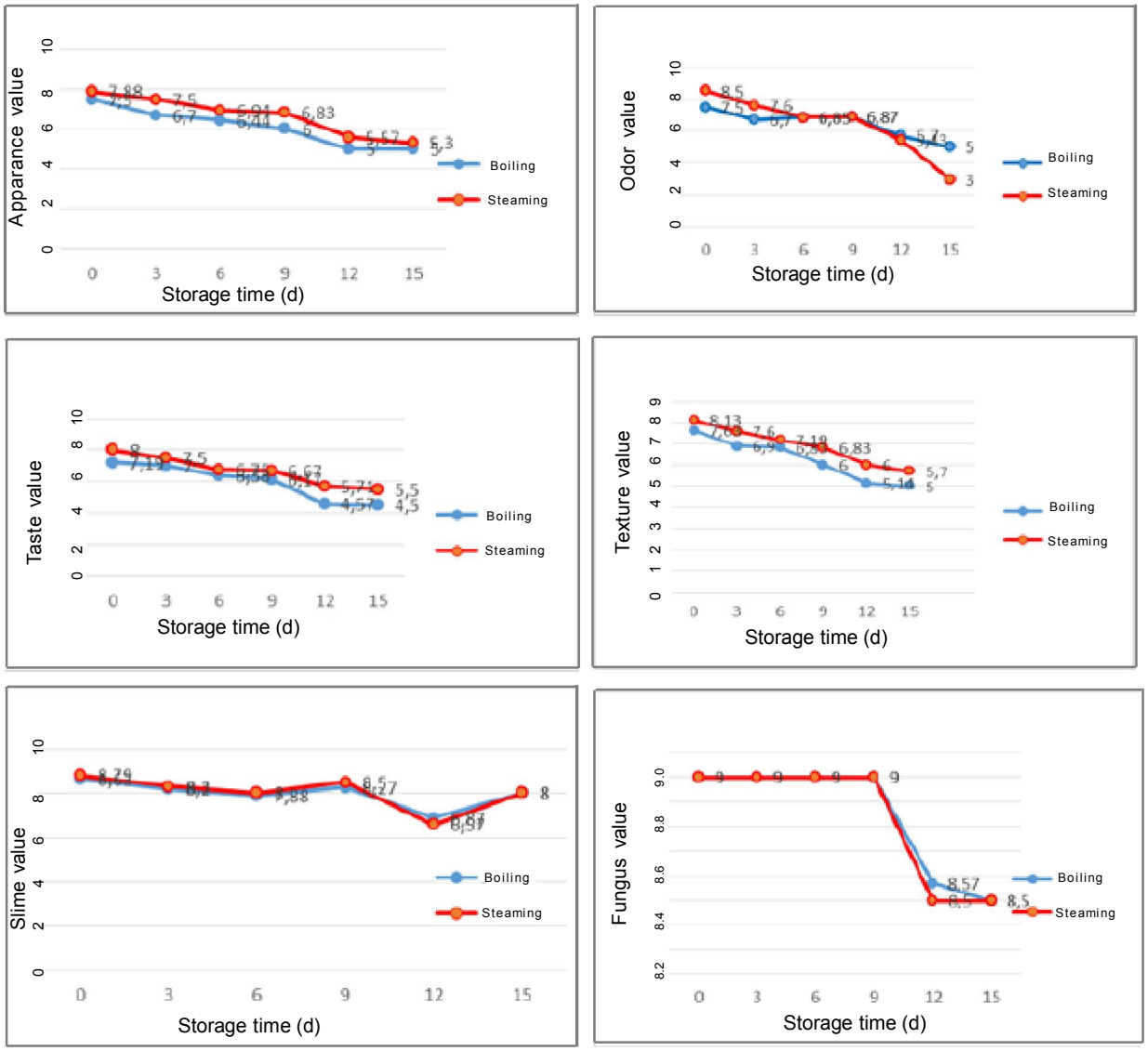

Figure 7. Sensory value of boiled salted fresh water fish processed by boiling and steaming method during chilling storage.

The preference test result showed that panelists preferred the product prepared using steaming method compared to boiling method. At the beginning of storage (0 days), panelists scored an average value of 6, for steaming method meaning “like”. However, product prepared using boiling method only received score around 4.63 meaning “neutral or in the middle of like and dislike”. It was allegedly occured due to dense texture, delicious taste and neat appearance of steaming method products. Boiling method products had less dense texture, higher saltiness, less neat appearance due to residual ingredients attached on the surface. This results were similar with the result of previous research on boiled salted Sardinella fish done by Jamasuta (1990) reported that steaming method produced highier acceptability to panelis.

The preference test value decreased during storage, but the boiling method products were still acceptable by the panelists until the end of storage with score 3. Mean while the steamed product was rejected by panelis with score 2, becaused of the underisable odor of the product.

The score for appearance, odor, texture, taste, as well as the presence of mucus and fungus can be seen in Figure 7. It was found that panelists seemed to prefer steamed products based on score test for attribute of appearance, odor, flavor and texture. Panelists scored 7.88 and 7.50 for the appearance of steamed and boiled products, respectively. These values mean the product was intact, neat, clean, and luminous color. Moreover, panelists scored 8.50 for the odor of steaming method product which means

smells fresh and fragrant, while the product from boiling method received odor score of 7.50 meaning less fresh and fragrant. Taste is also an important parameter for panelist acceptance. Panelists scored 8.0 for steamed product meaning better taste and savory, while for boiled one, panelists scored value of 7.19 meaning tasty but less savory. The better taste for product prepared using steaming method was in line with higher protein and fat content (Table 1). The taste of the salted boiled fish was affected by several factors such as the freshness of fish, species of fish, the amount of salt, spices and sugar (Riyanto et al*.,* 2011). Boiled product has more salty taste than steamed one. It occured since boiling method allowed bigger opportunity of salt penetration into fish flesh rather than steaming method. The limit amount for salty acceptance for tongue is 2-2.5 % (Tanako & Osako, 2009). It was considered that product prepared by boiling method had salinity more than 2-2.5%. Steamed product had a denser and more compact product with a value of 8.13, while the boiling one had a texture value of 7.63 meaning less dense texture. Steaming allowed the availability of protein in fish more higher than boiling (Table1) thus affected the texture of fish tissue becoming more dense and compact.

All the sensory attributes were decreasing during the chilling storage. The fastest decreasing during 15 days were observed for attributes odor and the appearance. The odor change of steamed product was faster than boiled product. The result were in line with TVB content, which increased during storage thus influencing to the odor change. This phenomenon was related to the increase of the number of total plate count during storage. Microbial activity causes breakdown of protein into amino acid and further, amino acids undergo deamination into volatile compounds such as ammonia, urea and various simple bases including indole, skatol, ammonia, H_2S, mercaptans, phenol, and cresol (Dalgraard et al., 2006). The appearence of salted boiled fish during storage became dull and less bright.

According to SNI (2009) good quality boiled salted fish requires no fungus grown on the product. Products were scored 9, if there was no fungus and 1 if there was fungus growth. In this study, the score of fungi was 8.5-9.0 showing that fungus does not appear on both products prepared by steaming and boiling methods (Figure 6). Fungus grows in high moisture content with a_w ranged from 0.70 to 0.85 (Purnomo, 1995). Fungus is not only lowering sensory or aesthetic value, but also is able to produce toxin.

Boiled salted fish is semi moist product with high moisture content and low salinity. This condition is suitable for growing of bacteria. The increase of bacteria number on the surface of fish will cause dull appearance since it is covered by mucus. Mucus is caused by bacteria that is growing on the surface of preserved salted boiled fish at day 12 (Heruwati, 2002). Acording to Irianto & Giyatmi (2009) development and activity bacteria of genus *Micrococcus* sp. was the most dominant in boiled salted fish. In this study mucus can be detected on the surfarce of product after being stored for 12 day. From sensory test in this study, steaming method had better apparence, odor, taste, and texture than boiling method, but steaming method had faster decrease in odor than boiling method.

4. Conclusion

Based on this result steaming methods was recomended to be used as processing method for production of boiled salted fish from fresh water. The fresh water fish processed by steaming method contained higher protein and ash than those of processed by boiling method. Sensory test also resulted that panelists preferred to steaming method product which had good appearance, odor, flavor and texture. However during chilling storage, steamed product had faster increase of moisture content, TVB and number of bacteria as well as the decrease of pH value and odor causing faster deterioration compared to boiling method. Microbiological tests showed that boiled salted fish were safe to be consumed only for 9 days, since storage exceed that periods resulted in the number of bacteria already reached the maximum number allowed.

References

Aryani, F., Murtini, J., & Siregar, T. H. (2012). Penggunaan ekstrak daun jambu (*Psidium guajava*) sebagai pengawet pindang tongkol*. Jurnal Pasca Panen dan Bioteknologi Kelautan dan Perikanan.* 7(1), 49-60.

Aryani, F. & Yennie, Y. (2008). Pengawetan pindang ikan layang (*Decapterus russellti*) menggunakan kitosan. *Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan*. 3(2), 139-146.

Apriyantono, A., Fardiaz, D., Puspitasari, N., Sedarnawati & Budiyanto, S. (1988). *Analisis Pangan*. IPB Press. Bogor. p. 33.

Ashie, I. N. A., Smith, J. P,. Simpson, B. K., & Haard, N. F. (1996). Spoilage and shelf-life extension of fresh fish and shellfish. Critical Rev. *Food Sci. Nutr*. 36, 87-121.

Aurand, L.W., Eoods, A.E., and Wells, M.R. (1987). *Food Composition and Analysis.* The Avi Published by Van Nostrand Reinhold Co. New York. 9 p.

Badan Standardisasi Nasional (BSN). (2006). *SNI-01.2354-2006* Standar Nasional Indonesia. Cara Uji Kimia pada Produk Perikanan.

Badan Standardisasi Nasional (BSN). (2006). *SNI-01.2332-2006* Standar Nasional Indonesia. Cara Uji Mikrobiologi pada Produk Perikanan.

Badan Standardisasi Nasional (BSN). (2006). *SNI - 01-2346-2006. Petunjuk Pengujian Organoleptik/ Sensori* .

Badan Standardisasi Nasional (BSN). (2009). *Mutu Ikan Pindang SNI 2717-3-2009*.

Buckle, K. A., Edward, R. A., Fleet, G. H., & Wooton. 2009. *Ilmu Pangan* . Translated by Hadi Purnomo and Adiono. UI Press. University of Indonesia. Jakarta. p. 365.

Castro, P., Padron, J. C. P., Cansino, M. J. C., Velazques, E. S., & De Larriva, R. M. (2006). Total Volatile base Nitrogen and its uses to asesss freshness in Eruropian sea bass stored in ice. *Food Control*. 17, 245-248.

Dalgaard, P., Madsen, H.L., Samieian, N., and Emberg, J. (2006). Biogenic Amine Formation and Microbial Spoiled in Chilled Garfish (*Belone belone*) effect of Modified Atmosphere Packaging and Previous Frozen Storage. *J. Applied Microbiological.* 101, 80-95.

Edwards, M. (2002). Solubility Controls on Alluminium Drinking Water at Relatively Low and High pH. *Water Research.* 36 (17): 4356 -4368.

Fenema , O. R. (2007). *Food Chemistry*. Fourth edition TF CRC. 1168 p.

Galy, A. E., Dave, S., Bugde, S., and Brooks, M.S. (2010). Fish Spoilage Mechanisme and Preservation Technicques. Review. *American Journal of Apllied Science*. 8(7): 859-877.

Gram, L. and Dalgaard, P. (2002). Fish spoilage bacteria-problems and solutions. *Current Opinion Biotechnol.* 13, 262-266.

Haribi, R. & Yusri. (2004). Konsentrasi Almunium pada Ikan Asap yang direndam dalam larutan Tawas. *Jurnal Unimus.* 280-296.

Helmiyanti, A. F. & Nurrahman. (2010). Pengaruh Konsentrasi Tawas Terhadap Pertumbuhan Bakteri Gram Positif dan Gram negatif. *Jurnal Pangan dan Gizi*. 1(1), 1 -6.

Heruwati, E. S., Soedarsono, J., & Kamarijani. (1985). Pindang Bandeng Kudus. Kajian tentang penyebab perlendiran. *Laporan Penelitian Teknlogi Perikanan.* 45: 33- 42.

Heruwati, E. S. (2002). Pengolahan Ikan Secara Tradisional. Prospek dan Peluang Pengembangannya. *Jurnal Litbang Pertanian.* 21(3), 91 - 99.

Hidayat, A. & Bustami, I. (1966). Hubungan Nilai Gizi Protein dan lama Waktu Perebusan Ikan Pindang. *Bull Tek Hasil Perikanan*. II(2), 13.

Irianto, H. E. & Pratiwi, Y. S. (2009). Chemical and Organoleptik Changes in Pindang Cue during Storage at Ambient and Chill Temperature. *Jurnal Pasca Panen dan Bioteknologi Kelautan dan Perikanan.* 4 (Special edition): 67 – 71.

Irianto, H. E. & Giyatmi, S. (2009). *Teknologi Pengolahan Hasil Perikanan*, Jakarta. Universitas Terbuka. 530 p.

Jenie, B. S. L., Nuratifa, & Suliantari. (2001). Peservation of steamed fish (*Rastrelliger sp*) with combine method using Sodium Acetat, Lactic Acid Bacteria culture and vacuum Packaging. *Jurnal Teknologi dan Industri Pangan.* XII(1): 21-27

Jaelani. (2007). *Khasiat Bawang Merah*. Kanisius Yogyakarta.

Jamasuta, G. P. (1990). Penerapan Sistem Diskontitinus marinading suhu rendah pada pembuatan pindang kukus ikan lemuru. *Laporan Penelitian Universitas Udayana Denpasar.*

Jamasuta, G. P., & Permana, G. (1996). Pengaruh cara dan lama pemasakan terhadap karakteristik pindang ikan lemuru. *UNUD.* 2(2).

Nurjanah & Abdullah, A. (2010). *Cerdas memilih Ikan dan mempersiapkan olahannya.* IPB Press Bogor. p. 71.

Muljanah, I. & Suryaningrum, T. D. (2009). Pengaruh bumbu pepes dan pengemasan terhadap mutu lele dumbo (*Clarias gariepinus*) presto selama penyimpanan pasa suhu dingin *Prosiding Seminar Nasional Kelautan V Universitas Hangtuah Surabaya* 2 April 209. p. 10.

Nurrahman. (2008). Sifat anti Mikroorganisme Tawas yang digunakan dalam Proses Pengasapan Ikan Tongkol. *J. Kesehatan Masyarakat Indonesia.* 4 (2): 74 -82.

Pitt, J. I. & Hocking, A. D. (1991). Significance of fungi in stored products. In *Fungi and Mycotoxins in Stored Products. Eds by* B.R. Champ, E. Highley, A.D. Hockong, and J.I. Pitt. Proc. Int. Conf. Bangkok, Thailand, 23"26 April 1991. pp. 16-21.

Putro, S., Tranggono, M., Hadiwiyoto, S., & Sutardi. (1984). Pindang Processing in East Java ini Indonesia. *Laporan Teknologi Perikanan.* 33, 11-24.

Prescott, L. M., Harley, J. P., & Klein, D.A. (1999). *Microbiology*. 4th ed. WCB McGraw-Hill, Boston.

Purnomo, H. (1995). *Aktivitas Air dan Peranannya dalam Pengawetan Pangan*. UI Press. p. 87.

Ratnasari, I. (2002). Kajian penggunaan kation ligan untuk meningkatkan tekstur pindang ikan mas (*Caprinus carpio Lin)*. Thesis Pasca Sarjana IPB Bogor. p. 110.

Retnowati, N., Murniyati, & Nasran, S. (1984). Study on the Use of Spices to prolong shelt lie of pindang. *Laporan Teknologi Perikanan.* 29, 11-19.

Riyanto, S., Desmelati, & Sumarto. (2011). Quality Characteristized Boiled Fish Motan *(Thynnichthys polylepis*) with different Boiling Time. On line Jurnal Fak Perikanan dan Ilmu Kelautan Univ Riau. p. 8.

Suryaningrum, T. D, Peranginangin, R., Syamdidi, Muljanah, I., & Irianto, H. E. (2013). *Laporan Teknis Penelitian Peningkatan Nilai Tambah dan Diversifikasi Produk Olahan Ikan Air Tawar.* Balai Besar Penelitian dan Pengolahan Produk dan Bioteknologi Kelauan dan Perikanan. p. 96.

Tanako, M. & Osako, K. (2009). *Bantuan Teknis Untuk Industri Ikan dan Udang Skala Kecil dan Menengah di Indonesia.* Kerjasama DKP-JICA. p. 88.

Taylor, R. J. (1980). *Food Additives*. John Wiley and Sons. Chicchester New York. Brisbane, Toronto.

Todar, K. (2007). "Pathogenic *E. coli*". *Online Textbook of Bacteriology*. University of Wisconsin–Madison Department of Bacteriology.

Yuliawati, Y. (2004). Pemanfaatan Ikan Mas (*Caprinus carpio*) sebagai Produk Pindang Manis. *Skripsi* Institut Pertanian Bogor.

Winarno, F. G. & Jenie, B. S. L. (1983). *Kerusakan Bahan Pangan dan Cara Pencegahannya*. Center of Research and development for Food Technology. Bogor Agricultural University. Bogor.