World Journal of Fish and Marine Sciences 2 (3): 216-220, 2010
ISSN 2078-4589

Post Harvest Quality Changes in Wild *Tilapia melanotheron* and *Chrsyischtys nigrodigitatus* Obtained from Ogudu / Agboyi Lagoon South-west Nigeria

C.E. Oramadike, A.O. Ibrahim, O.A. Adejonwo, G.R. Akande and O. Kolade

Nigerian Institute for Oceanography and Marine Research, P.M.B. 12729, Lagos, Nigeria

Abstract: Post harvest quality changes in wild *Tilapia melanotheron* and *Chrsyischtys nigrodigitatus* from Ogudu/Agboyi lagoon in Lagos were investigated to obtain shelf-life information. *C. nigrodigitatus* and *T. melanotheron* retained satisfactory post-harvest quality condition for 19 and 23 days, respectively with total viable bacteria counts increasing thereafter. The initial total bacterial load at harvest were *T. melanotheron*: 4.56 x 10^6cfu/g and *C. nigrodigitatus*: 7.0 x 10^5 cfu/g without *Vibrio*, *Salmonella* and Hydrogen sulphide (H_2S) producers. At quality loss, total viable bacterial count was 3.82 x 10^9: 1.90 x 10^7 cfu/g and 5.68 x 10^9: 8.14 x 10^8cfu/g for H_2S producers in. *T. melanotheron* and *C. nigrodigitatus,* respectively in the absence of *Vibrio* and *Salmonella/Shigella*. Principal spoilage microbes identified during iced storage were *Pseudomonas spp.* and *Shewanella putrefaciens.* Quality loss assessment followed sensory evaluation with the minimum score of 2 out of a total of 5 indicating lowest limit of acceptance. Total volatile nitrogen (TVN) ranged from 13.70-40.32mg$^{-N/100g}$ and 14.57 - 51.70 mg$^{-N/100g}$ for *T. melanotheron* and *C. nigrodigitatus,* respectively, while their trimethylamine (TMA) range were 6.72– 24.19 mg$^{-N/100g}$ and 7.06-29.6 mg$^{-N/}$100g, respectively. TVN: TMA correlated at r^2=0.92 for *T. melanotheron* and r^2=0.97 for *C. nigrodigitatus*.

Key words: Ice storage · Tropical fish · *Shewanella putrefaciens* · *Pseudomonas spp*

INTRODUCTION

Fish is a perishable commodity, upon death a series of natural changes start, leading to spoilage which affecting its shelf life. Freshness or the extent of spoilage during storage under chilled conditions is the key determinant of the quality of fish and fishery products [1, 2]. Shelf life of fish is defined as the length of time it is fit for human consumption [3]. Spoilage due to microbial activity is the main limitation of the shelf life of iced or refrigerated fish. Off-odours and off-flavours, slime formation, gas production, discoloration and changes in texture are obvious signs of spoilage [4]. Lack of good transportation facility is a major reason causing the delay in getting the fish from hinterland to urban centers where as they fetch more money. The development of these spoilage conditions in fish and fishery products is due to a combination of chemical, autolytic and microbiological changes, but the spoilage rate can be reduced by taking preventive measures, the use of ice to extend the storage life of these fishes will undoubtedly produce fresh fish of good quality which in turn will fetch individual fish farmers good money. The need has now arisen to pay more attention to post- harvest handling of brackish water fishes.

According to Bonnell [5], controlling the temperature of fish is perhaps the most important element in the preservation of fresh fish. The proper cooling of fish has a number of advantages. Firstly, bacterial activity depends very much on temperature, the closer it is to 0°C, the slower the rate of bacterial spoilage. Likewise, enzyme activity also decreases as temperature falls, so the rate of autolytic spoilage is significantly slowed. Chemical spoilage or development of rancidity can be prevented by rapid handling onboard and storage of products under anaerobic conditions. A rise in product temperature accelerates deterioration and reduces quality. If the rate of deterioration is known, it should be possible to determine the quality at any time by continuously monitoring the time and temperature history of fish *post mortem* [1].

Many tropical fish species from warm waters have been reported to have storage life of 20 to 28 days in ice [6, 7] compared with about 14 days for fish species from temperate waters [8]. The most widely acceptable

Corresponding author: C.E. Oramadike, Nigerian Institute for Oceanography and Marine Research, P.M.B. 12729, Lagos, Nigeria, E-mail: chigooramadike2007@yahoo.com.

explanation for the extended shelf-life of tropical fish species compared to temperate water species is that the relative number of psychropilic and psychrotropic spoilers are lower in tropical species and accordingly confer an extended shelf-life [9]. Furthermore, it has been observed that certain physical and chemical characteristics including the shape, size and fat content, can all combine to influence the length of storage life in ice [9, 10].

The present work examined the shelf-life of wild *T. melanotheron* and *C. nigrodigitatus* in ice. The two fishes are of great economic importance in Nigeria. They are obtained at most landing sites and tend to deteriorate rapidly if not properly handled. The short shelf-life of this fatty fish (*C. nigrodigitatus)* and the lean fish (*T. melanotheron)* especially when not iced at the appropriate time can render them unsuitable for the consumers.

MATERIALS AND METHODS

Sampling: Fresh wild *T. melanotheron* and *C. nigrodigitatus* were purchased at a fish market in Oworoshoki, Lagos from fishermen from the Ogudu/Agboyi lagoon fishing grounds, Lagos, Nigeria. The samples were transported in ice at the ratio not less than 1:1 ice to fish in a sterile insulated ice box to the Nigeria Institute for Oceanography and Marine Research Laboratory, Victoria island. The samples were stored in ice at the ratio not less than 1:1 ice to fish throughout the storage experiment, water being drained from a hole at the base of insulated box used in chilling the fish.

Analyses: Fish samples were randomly selected for chemical, microbial and sensory analyses. Triplicate determinations were carried out on each analysis.

Chemical analyses: Total Volatile Nitrogen (TVN) and Trimethylamine (TMA) of fish flesh were determined by the Conway Microdiffussion Technique [11].

Microbiological analysis: Microbiological analysis for all samples were done in triplicate on standard plate count agar (SPCA) for total viable count, Salmonella-shigella agar for Salmonella and shigella and iron agar [12] for H_2S-producers counts. The pure isolates were identified using morphological and biochemical characteristics according to Bergy's manual of systematic bacteriology [13] and reconfirmed with Analytical Profile Index 20E test kit (API 20E).

Sensory Assessments: The quality of Fresh wild *T. melanotheron* and *C. nigrodigitatus* stored in ice was judged on appearance, firmness, skin, eyes, gills and smell. Flavor, texture and odour of the cooked fish were also evaluated. Based on these parameters, average scoring was given on a scale ranging from one to five. A mean score of more than 3 out of 5 denoted the prime fresh condition of the fishes with very high acceptability. Samples with scores between 3 and 2 were considered as fair and less than 2 as of poor quality.

Statistical Analysis: Pearson's correlation analysis was carried on all observation.

RESULTS

Chemical Analysis: The quality of fresh wild *T. melanotheron* and *C. nigrodigitatus* stored in ice underwent chemical analysis regarding trimethylamine (TMA) and total volatile nitrogen (TVN) as presented in table 1. TVN values of the *T. melanotheron* during icing increased steadily during storage from 13.70 -40.32 mg-N/100g while the TVN value for *C. nigrodigitatus* ranged from 14.57 - 51.70 mg-N/100g at the point of rejection as shown in table 1. TMA value of the *T. melanotheron* ranged from 6.72 -24.19 mg-N/100g while the value for *C. nigrodigitatus* ranged from 7.06 -29.6 mg-N/100g at the point of rejection. The TMA:TVN correlated at r^2=0.92 for *T. melanotheron* and r^2= 0.97 for *C. nigrodigitatus.*

Microbiological Assessment: The bacteria counts of *C. nigrodigitatus* and *T. melanotheron* samples stored in ice, undertaken on day 0,4,8,15,19 and 23 is shown in Table 2. The values for total viable count (TVC) ranged from 4.56 x10^6 - 3.82 x 10^9Cfu/g for *T. melanotheron* while *C. nigrodigitatus* ranged from 7.0 x 10^5 - 5.68 x10^9 Cfu/g. On rejection, TVC's for both fishes were 10^9Cfu/g. However, organisms of public health significance e.g. *Salmonella*, *Vibrio* and *Shigella* were not found during the study. The initial bacteria composition changed at rejection. Principal spoilage organisms were *Pseudomonas spp, Proteus spp* and *Shewanella putrefaciens*, while *Pseudomonas spp* and *Shewanella putrefaciens* dominated the spoilage during icing. The H_2S producer counts ranged from 4.0 x 10^6- 1.9 x 10^7 Cfu/g from the 15day-23day for *T. melanotheron* while in *C. nigrodigitatus* H_2S producer count ranged from 8.0x 10^4-8.14 x 10^8 Cfu/g from 8 day-23 day. Suggesting that the H_2S producers play a prominent role in the spoilage of iced fishes.

Table 1: Chemical assessment of *T. melanotheron* and *C. nigrodigitatus* stored in ice for 23 days

	T. melanotheron		*C. nigrodigitatus*	
Day	TMA mg-N/100g	TVN mg-N/100g	TMA mg-N/100g	TVN mg-N/100g
0	6.72	13.70	7.06	14.57
4	7.39	16.93	7.46	16.8
8	8.40	18.48	8.06	19.38
12	10.08	20.49	10.08	26.88
15	12.09	29.56	12.72	32.25
19	14.78	36.85	29.6	51.70
23	24.19	40.32	-	-

Table 2: Microbiological assessment of *T. melanotheron* and *C. nigrodigitatus* stored in ice for 23 days

	T. melanotheron		*C. nigrodigitatus*	
Days	PARAMETERS (Cfu/g)			
	TVC at20°C	H_2S Producers	TVC at20°C	H_2S Producers
0	4.56×10^6	0	7.0×10^5	0
4	4.8×10^6	0	2.9×10^6	0
8	5.0×10^6	0	4.0×10^6	8.0×10^4
12	ND	ND	ND	ND
15	1.02×10^9	4.0×10^6	6.4×10^8	3.8×10^6
19	1.49×10^9	5.3×10^6	3.68×10^9	1.4×10^7
23	3.82×10^9	1.9×10^7	5.68×10^9	8.14×10^8

Table 3: Sensory assessment of raw *T. melanotheron* and *C. nigrodigitatus* stored in ice for 23 days

	Raw *T. melanotheron*							Raw *C. nigrodigitatus*						
Day	0	4	8	12	15	19	23	0	4	8	12	15	19	23
Appearance	5	5	5-4	4	3	3	2	5	5-4	4	3	3	3	1
Firmness	5	5	5-4	4	3	3	2	5	5-4	4	3	3-2	2	1
Skin	5	5	4	3	3	3	2	5	5-4	4	3	3-2	2	1
Eyes	5	4	3	2	2	2	2	5	5-4	4-3	3	3-2	2	1
Gills	5	4	3	2	2	2	2	5	5-4	4	3	3-2	1	1
smell	5	5	4	3	3	2	2	5	4	4	3	3	2	1
Average	5	4.7	3.8	3	2.7	2.5	2.0	5	4.4	3.9	3	2.7	2.0	1.0

Evaluation score: 5= Excellent, 4= Good, 3= Average, 2= poor, 1= Very poor

Table 4: Sensory assessment of cooked *T. melanotheron* and *C. nigrodigitatus* stored in ice for 23 days

	Cooked *T. melanotheron*							Cooked *C. nigrodigitatus*						
Day	0	4	8	12	15	19	23	0	4	8	12	15	19	23
Texture	5	5-4	4	4	4	3	2	5	5-4	4	4-3	3	3-2	1
Flavour	5	5-4	4	3	3-2	3-2	2	5	5-4	4	3	2	2	1
Odour	5	5-4	4	3	3-2	3-2	2	5	5-4	4	4-3	3	2	1
Average	5	4.5	4	3.3	3	2.7	2.0	5	4.5	4	3.3	2.6	2.2	1.0

Evaluation score: 5= Excellent, 4= Good, 3= Average, 2= poor, 1= Very poor

A strong correlation of TVC in *T. melanotheron* and *C. nigrodigitatus* were r^2=0.99 and TMA:TVN correlated at r^2 =0.92 for *T. melanotheron* and r^2= 0.97 for *C. nigrodigitatus*.

Sensory Quality Changes: The mean sensory scores of six panelists experienced at evaluating fish and fishery products for *T. melanotheron* and *C. nigrodigitatus* stored in ice for raw and cooked fish samples are

presented in Table 3, -4. Fish samples iced at zero days displayed all characteristics of a freshly caught fish with scores of 5.0 for *T. melanotheron* and *C. nigrodigitatus*. The eyes were clear and bulging, gills purple-red with some mucus and the flesh was firm and elastic. The general appearance of both fish species showed a bright opalescent fish with scales for *T. melanotheron* intact and no trace of bleaching. An average score of 2.0 was recorded on the 19th day for raw *C. nigrodigitatus*. A score regarded as the last limit of acceptability, while an average score of 2.0 was recorded on the raw *T. melanotheron* on the 23rd day,which is the last limit of acceptability. After the 19th day for *C. nigrodigitatus* and 23rd day of *T. melanotheron*, changes in various attributes were much more pronounced. The eyes were sunken, the gills dirty brown with much mucus and stale odour. The flesh was slightly firm without any elasticity and the skin was dull with loose scales. By the 23rd day in ice, the panelist had declined to an average score of 1.0 for *C. nigrodigitatus*.

The cooked flavor, odour and texture scores of *T. melanotheron* and *C. nigrodigitatus* stored in ice are presented in Tables 4 below. The results shows that *T. melanotheron* and *C. nigrodigitatus* the cooked odour scores of both fish samples showed a fresh, pleasant odour at day zero in ice with a score of 5.0 indicating a very good product. There was a gradual decline from these characteristics up to the score of 2.0 on the 23rd day for *T. melanotheron* while a score of 2.2 on the19th for *C. nigrodigitatus* which were the limit of acceptability.

DISCUSSION

The TMA and TVN values increased steadily during storage in ice with 10-15mg% (TMA) and 30-40mg% (TVN), being the limit of acceptability proposed for marine species [14]. The increase in levels of TMA and TVN may probably be due to the level of microbial spoilage or autolysis. However, TVN and TMA values increased near rejection, indicating that TVN and TMA may be useful as a measure of degree of spoilage rather than use to estimate the degree of freshness. The contents increasing steadily from 6.72-24.19 and 13.70-40.32 mg-N/100 g for *T. melanotheron* 7.06-29.6 and 14.51-51.70mg -N/100 g for *C. nigrodigitatus* and TMA and TVN, respectively after rejection by the taste panel.

The longer shelf-life found in the tropical fish species is mostly explained in terms of the microflora found on tropical fish. The flora found on tropical species which are mesophilic in nature will be adapted to live at higher temperatures, whereas the bacteria which cause spoilage of fish in ice are known to be psychropilic in nature [9, 15, 16] and these constitute the bulk of flora on temperate fish species. The initial total bacterial load of the *T. melanotheron* was 4.56×10^6 Cfu/g of flesh and the *C. nigrodigitatus* was 7.0×10^5 Cfu/g of flesh. On rejection by the taste panelists, the level rose to exceed 10^7 counts/g maximum microbiological limit for fresh fish recommended by the international commission of microbiological standards for foods [17]. The high microbial load at rejection may have been because of the environment were the fishes were caught. The H_2S producers counts at the point of rejection for both fish species were higher, suggesting an important role of H_2S producers during mesophilic spoilage. As shown in table 2, the initial load was quite diverse with mesophilic bacterial population predominating. During ice storage, *Pseudomonas spp* and *Shewanella putrefaciens* (psychrotrophs) increased in number and accounted for over 90% of the spoilage flora when fish were rejected by the taste panel. This suggests that, spoilage during iced storage is caused by *Pseudomonas spp* and *Shewanella putrefaciens* irrespective of the original bacterial flora. Similar spoilage patterns have been reported for temperate fish [9, 18, 7] also obtained similar spoilage pattern for some tropical fishes.

Based on the judgments of the taste panelists and using the score of 2 as that value which indicates the fish to be just unacceptable, maximum storage life of *T. melanotheron* was found to be 23 days in ice and *C. nigrodigitatus* to be 19 days in ice (Tables 3, -4). The 23 days storage life for *T. melanotheron* and 19 days for *C. nigrodigitatus* in ice is longer when compared with storage lives of temperate fish species but within the ranges obtained for tropical species [7, 19].

Statistical analysis showed a strong correlation between the total viable counts,H_2S and the values of TMA and TVN at the storage conditions, meaning that the formation of TMA and TVN at the storage conditions is bacterial in nature thus the observation of the strong offensive odours by the taste panelists at rejection.

In conclusion, based on the chemical, microbial, sensory and statistical analysis, the maximum storage life of wild *T. melanotheron* was found to be 23 days in ice and *C. nigrodigitatus* to be 19 days in ice.

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