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Hala Gindeel AA
Animal Resources Research Corporation, Fisheries Research Center Red Sea Fisheries Research Station, Sudan

Correspondence
Hala Gindeel AA
Animal Resources Research Corporation, Fisheries Research Center Red Sea Fisheries Research Station, Sudan

Quality changes of three marine fish preserved in ice

Hala Gindeel AA

Abstract
The objective of this study was to determine the effect of chilling with ice on the quality of three marine fish *Plectropomus areolatus, Caranx mate* and S*phyraena barracuda***.** The samples were preserved in crushed ice in a ratio of 1:2 (fish: ice). Chemical analysis and sensory evaluation was made at day 0 and with the end of preservation. Microbial assessment was made during preserving period. The chemical analysis of fresh samples showed that there was no significant effect ($p<0.001$) in all chemical composition parameters before chilling according to the species, while after chilling the effect was significant on acidity, Fat and ash. The results indicated no contamination of *Staphylococcus* spp, *Salmonella* spp and *Vibrio* spp in all fresh and preserved samples in the three species. *E.coli* appeared in some cases after 14 days of preservation. The species *S. barracuda* and *C. mate* is the most contaminated by *E.coli*. Total bacterial count increase with preservation and highest bacterial count being in *S. barracuda*. The sensory evaluation showed that all sensory parameter had been affected by chilled in ice. *P. areolatus* had a high degree of Sensory freshness followed by *C. mate* then *S. barracuda*. Chilling had effect on weight; weight increased at first rapidly then decreased, after that increased again with the end of preserving period, this change in weight was more in *C. mate*. Different species had some effect on chemical composition and sensory characteristics and microbiological assessment during and at the end of preserving period.

Keywords: Fish species, chilling, chemical, sensory change, microorganism.

1. Introduction
The Sudanese red sea coast (750 km long), is rich with many different resources of high economical value and blessed by a diversity in marine products based on a variety of marine species belonging to different groups [1]. There are 28 fishes species are of commercial value including, Serranidae, Carangidae and Sphyraenidae [2]. The peak fishing months are from April to September, which coincides with the hot summer months on the Red Sea coast. The remoteness of fishing villages, absence of efficient communication, and low level of education with poor extension services, lack of basic infra structural facilities are the major factors influencing poor handling and marketing of marine products. Loss of post harvest in Sudanese red sea coast is about 20-25% of present total catches [3]. Therefore, several preservation systems such as traditional ice [4], refrigerated seawater [5], and the addition of chemical preservation agents [6] have been applied to fish species. Marine species deteriorate rapidly post-mortem. The most common chilling medium for preserving fresh fish is ice. However, the quantity of crushed ice required for chilling fresh fish is quite substantial which is at least 1:1 ratio (wt/wt) and sometimes is even higher with tropical conditions [7] Its use has proven to slow down microbial growth [8], this leading to significant increases in the shelf life of a broad variety of chilled marine species such as lean fish [9], fatty fish [10] and crustaceans [11]. Chilling is the most important preserving method of gutted or whole fish in Sudanese red sea coast. Block ice is preferred by fishermen because it last longer and effectively for storage of fish and to make full use of its cooling power. First, it has to be crushed into small pieces in order to make good contact with the fish. When fishermen arrived to the shore they washed the fish by cold sea water, then they put the crushed ice layer in the bottom of the fiber reinforced plastic box followed by a fish layer then followed by ice. Generally if fish is not sold after 3-7 day it is washed and re iced again, sometimes fishermen spattered salt with ice to prolong preserving time. The rate of fish spoilage depends on handling during processing, acidity level, species of fish, weather, mode of storage and temperature during transportation [12]. The factors that affect intrinsic quality are related to the fish species, size, sex, condition and composition, parasites and other organisms, to naturally toxic fish and contamination with pollutants and

occasional peculiarities [13]. White fish in crushed ice remains edible for about 15 days but ice is not effective for long preservation because melting water bring about as sort of bleaching of valuable flesh contents which are responsible for flavour, taste and became dehydrated and loses texture, It has been widely reported that fish lose some of their nitrogenous constituents including proteins during preserving in ice [14]. There are three important aspects in the quality of fish product nutritional value, safety and sensory characteristic [13]. The present work is focused on the three abundant fish species (*Plectropomus areolatus*, *Caranx mate* and S*phyraena barracuda*) from the Sudanese red sea coast. In order to know about the effect of the chilling in the quality of different species and to optimize the fish quality and to provide consumers with fish of the highest quality and safety, refrigeration and storage of the above mentioned species. Chemical analyses, microbiological and sensory on such fish were compared during preservation.

2. Materials and Methods

2.1 Samples and Treatment

The specimen used in this study, *Plectropomus areolatus*, *Caranx mate* and S*phyraena barracuda*. Samples were collected from Port Sudan; freshly caught fish were kept in ice boxes and transported immediately to the Red Sea Fisheries Research Station. All samples were thoroughly washed with tap water, blot dry, weighed to the nearest gm, chilled in crushed ice kept in fiber reinforced plastic boxes, with drain holes to allow the escape of melted ice. Melting ice was replaced daily with new crushed ice. The samples were preserved in crushed ice in ratio of 1:2 (fish: ice). On day 0 and with the end of preservation, the samples were weighted and then subjected to chemical analysis and sensory evaluation. Microbial assessment was made during preserving period in day 0, 7, 14, 21 and 28.

2.2 Chemical Analysis

PH was measured using a pH meters (Lutron pH-206, l930533) [15], acidity was measured by titration against 0.1N NaOH according to the methods in the literature [15]. Protein, fat, ash and moisture of fresh and chilled fish were determined according to the methods in the literature [16].

2.3 Microbiological Test

According to [17] Method was used for assessed total bacterial count and detection of the presence of *Coliform* spp., *Salmonella* spp., *Staphylococcus* spp., *Vibrio* spp.

2.4 Sensory evaluation test

According to [18] and quality index method [19], fish samples were subjected to sensory evaluation by random panelist consisting of 10 persons. A score of 5to7 indicate a high quality of sensory freshness, a score of 3to 1 indicate low quality of sensory freshness, 4 indicates midst.

2.5 Statistical Analysis

Statistical analyses were performed using SPSS to determine the effects of different species on physical and chemical composition (pH, acidity, moisture, ash, protein and fat) as well as sensory characteristics (slime, smell, colour, form and colour of eyes, mucus and colour of gill, skin, and firmness of flesh) for fresh and chilled fish. Confidence interval at ($p<0.05$) was used in all cases.

3. Results and Discussions

Freshness loss in iced, whole fish depends on the species and ambient temperature [20] and [21]. Also the achievable extension of shelf life depends on species, fat content, initial microbial population, gas mixture, and most importantly, storage temperature. Moor over the choice of cooling agents and packaging methods depends on species and characteristics of the products [22]. In this study statistical analysis showed that there was no significant effect in all chemical composition parameter before chilling, however the chemical analysis of fresh samples which present in Table 1 showed that higher protein and fat content values were found in species *S. barracuda*. Species in this study distinguished as lean fish, where by the fat content was lower than 5% by weight [23]; the identified species based on the fat content, S. *barracuda* then *C. mate* then *P. areolatus*. *P. areolatus* showed a great value in moisture. This agreed with [24] and [25] they reported that low-fat fish species have higher water content and, as a result, their flesh is whiter in color. On the other hand, there is no significant difference in protein content between species in this study. The crude protein content ranged from 70.52% (*S. barracuda*) to 65.14% (*C. mate*). Protein ratio in the studied species can be graded as S. *barracuda* (second grade) then *P. areolatus* (first grade) and *C. mate* (second grade), this indicates to that ongoing grading is not based on nutritive value, but probably on taste flavour, colour, flesh: bone ratio, appearance and consumer preference. Crude ash ranged from 4.75% in *C. mate* to 3.84 % in *P. areolatus*. These differences in chemical composition according to different species agreed with [20] who mentioned that The chemical composition of fish affected by various factors such as species, age, size, sex, stage of maturity, month of capture and genetic traits or due to starvation migration and spawning or because of external factors such as shortage of food the feed composition. The result showed that all chemical parameters decreased by chilling except pH and moisture, which increased, these results are in Table 2, agreed with [26] who mentioned that according to storage period, a decline was observed in the pH values of fish species. Degradation process is carried out at first by muscle enzymes and later by microbial enzymes [27] and [28]. On the other hand [26] reported that pH value is a reliable indicator of the degree of freshness or spoilage. Also during storage, reduction in protein was corroborated with increase in TVN while low pH confirms increased putrefaction (spoilage) has been suggested to be caused by the activity mechanisms on microorganisms to alteration of cell membranes, decrease or inhibition of enzyme reactions, penetration of bacterial membranes leading to intracellular pH changes and direct changes in physio-chemical properties of proteins [29]. The highest pH value was obtained in species *P. areolatus*. In fat content reduction could have been due to oxidation and fat break down to other components [30]. Statistical analysis showed that after chilling the effect from different species were on acidity, Fat and ash. But differences between the species were not significant ($p < 0.05$) in terms of pH and protein values. The composition and the amount of protein in fish varies a little from species to species the protein content for meat and for fish is roughly comparable [31], this agreed with [32], and [33] who recorded that the moisture contents of the fresh fish types were slightly, but not statistically different [8]. Mentioned that for each fish species, statistical analysis evidenced that the differences found in both constituents throughout the experiment should be attributed to fish-to-fish variation and not to the chilling system or storage time. The

results indicated no contamination of *Staphylococcus* spp, *Salmonella* spp and *Vibrio* spp in all fresh and preserved samples in the three species. *E.coli* appeared in some cases after 14 days of preservation. The species *S. barracuda* and *C. mate* is the most contaminated by *E.coli*, this agreed with the results reported by [32] they found that spoilage was faster in round fish than flat fish when they were stored in ice. Total bacterial count increase with preservation and highest bacterial count being in *S. barracuda*. These results are shown in Tables 3 and 4. Less infection by *E.coli*, was in species *P. areolatus*. The sensory evaluation, which had been made for fresh and child fish (Table5 and 6); showed that all sensory parameter (general acceptability, slime, Odour, Colour of eyes, form of eyes, mucus in gill, Colour of gill, skin, press and scales) had been affected by chilled in ice. Species had significant differences in most of sensory characteristics in the end of preservation. The assessment of the sensory evaluation quality between species, *P. areolatus* had a high degree of sensory freshness followed by *C. mate* then *S. barracuda*. There is greater difference in flavour and texture between fish species; this was stated also by [26] that differences may be result from differences between fish species. Color, smell and taste criteria of *P. areolatus* were determined higher than other species. This leads to the resistance from *P. areolatus* the changes in the sensory characteristics at the end period of the preserving; this also what found was from the bacterial examination which clarified that other two species show higher infection by microbes. perhaps this is one of reasons which placed P. *areolatus* in grade 1 also it was excellent in eating and probably the most popular of all local fishes its flesh is white and delicate, the flesh of S. *barracuda* is fairly good but *C. mate* were rather dark flesh is not very tasty. The resulted showed that chilling had effect on weight; weight increased at first rapidly then decreased, after that increased again with the end of preserving period, this change in weight was more in *C. mate* (fig1). This in agreement with [34] who reported that fish immersed in iced gain weight at first then slowly lose weight during subsequent preserving but the gain is slow and continues for two or three weeks in some cases depending on species.

Table 1: Comparison of three fresh fish species (*P.areolatus*, *C. mate* and *S. barracuda*) in terms of Chemical composition (dry weight %)

Parameter	*P.areolatus*	*C. mate*	*S. barracuda*
pH	6.3±0.90[a]	6.615±0.4 [a]	6.54±0.40 [a]
Acidity **%**	1.23±0.69 [a]	1.61±0.65 [a]	1.09±0.04 [a]
Protein **%**	69.99±1.94 [a]	65.14±8.51[a]	70.52±0.89 [a]
Fat **%**	4.2±0.00 [a]	4.2±0.21 [a]	4.25±0.22 [a]
Ash **%**	3.84±1.15 [a]	4.75±0.35 [a]	4.53±0.39 [a]
Moisture **%**	79. 06±0.80[a]	75.69±1.80 [a]	76.22±0.28 [a]

*Means with similar superscript (in a row) are not statistically significantly different (p>0.05).

Table 2: Comparison of three fish species (*P.areolatus*, *C. mate* and *S. barracuda*) in terms of Chemical composition (% dry weight) in the end of preserving in ice

Parameter	*P.areolatus*	*C. mate*	*S. barracuda*
pH	6.87± 0.44 [a]	***6.65*** ± 0.44 [a]	6.79 ± 0.44 [a]
Acidity **%**	0.79 ± 0.20 [a b]	0.99 ± 0.20 [a b c]	1.27± 0.20 [b c]
Crude protein **%**	52.45 ± 0.83 [a]	52.66 ± 0.83 [a]	54.22 ± 0.83 [a]
Fat **%**	3.62 ± 0.245 [a]	3.64 ± 0.245 [a]	3.98 ± 0.246 [b]
Ash **%**	3.88± 0.271 [a b]	4.11± 0.272 [a b c]	4.33 ± 0.272 [b c]
Moisture **%**	79.70 ±5.08[a]	76.75 ± 5.08 [a]	78.82 ± 5.06 [a]

*Means with similar superscript (in a row) are not statistically significantly different (p>0.05), those with different superscript statistically significantly different (P<0.05).

Table 3: Microbiological viable counts (cfu/g) for three species (*P.areolatus*, *C. mate* and *S. barracuda*) during ice preserving period

Parameters	**Total bacterial count**		
preserving period	***P. areolatus***	***C. mate***	***S. barracuda***
0day	$3x10^3$	$2x10^3$	$4x10^3$
7day	$2.5x10^3$	$1.5x10^3$	$1x10^4$
14 day	$2.6\ x10^3$	$5.5x10^3$	$1.5x10^4$
21 day	$1.2x10^4$	$1.6x10^3$	$6.4\ x10^4$
28 day	$1.5x10^4$	$2.3x10^4$	$8.6\ x10^4$

Table 4: Microbiological detection *Salmonella* spp, *Staph* spp, *Vibrio* spp and *Coli form* spp for three species (*P.areolatus*, *C. mate* and *S. barracuda*) during ice preserving period

Parameters	***Coli form* Spp**			***Salmonella, Staphylo*coccus and *Vibrio* spp**		
preserving period	***P. areolatus***	***C. mate***	***S. barracuda***	***P. areolatus***	***C. mate***	***S. barracuda***
0day	-ve	-ve	-ve	-ve	-ve	-ve
7day	-ve	-ve	-ve	-ve	-ve	-ve
14 day	-ve	-ve	+ve	-ve	-ve	-ve
21 day	-ve	+ve	+ve	-ve	-ve	-ve
28 day	+ve	+ve	+ve	-ve	-ve	-ve

* (+ve) Positive
* (-ve) Negative

Table 5: Comparison of three fresh fish species (*P.areolatus*, *C. mate* and *S. barracuda*) in terms of sensory evaluation

Parameters	***P.areolatus***	***C. mate***	***S. barracuda***
acceptability	7 ± 0.01^{a}	6 ± 1.02^{a}	6 ± 1.02^{a}
Slime	7 ± 0.02^{a}	5 ± 1.02^{b}	7 ± 0.01^{a}
Odor and smell	7 ± 0.31^{a}	7 ± 0.02^{a}	7 ± 0.21^{a}
Color of eye	7 ± 0.02^{a}	6 ± 1.03^{a}	7 ± 0.11^{a}
Form of eye	7 ± 0.04^{a}	4 ± 1.08^{b}	6 ± 0.56^{a}
Color of gill	7 ± 0.04^{a}	5 ± 1.04^{b}	$6 \pm 0.81^{a\,b}$
Mucus in gill	7 ± 0.02^{a}	5 ± 1.02^{b}	7 ± 0.42^{a}
Skin	7 ± 0.02^{a}	5 ± 2.01^{b}	7 ± 0.48^{a}
flesh	7 ± 0.03^{a}	5 ± 1.05^{b}	$6 \pm 0.05^{a\,b}$
finger Pressed	7 ± 0.00^{a}	5 ± 1.23^{b}	5 ± 1.52^{b}
Scale	7 ± 0.01^{a}	6 ± 1.22^{a}	7 ± 0.11^{a}

*Means with similar superscript (in a row) are not statistically significantly different ($p>0.05$), those with different superscript statistically significantly different ($P<0.05$).

Table 6: Comparison of three fish species (*P.areolatus*, *C. mate* and *S. barracuda*) in terms of sensory evaluation in the end of preserving in ice

Parameters	***P.areolatus***	***C. mate***	***S. barracuda***
acceptability	4.94 ± 1.39^{a}	4.72 ± 1.23^{a}	4.14 ± 1.41^{b}
Slime	4.55 ± 1.55^{a}	4.27 ± 1.38^{a}	4.11 ± 1.39^{a}
Odor and smell	4.83 ± 1.43^{a}	4.59 ± 1.29^{b}	3.89 ± 1.43^{c}
Color of eye	$4.07 \pm 1.69^{a\,b}$	$4.11 \pm 1.45^{a\,b\,c}$	$3.46 \pm 1.62^{b\,c}$
Form of eye	$4.42 \pm 1.70^{a\,b}$	$4.01 \pm 1.55^{a\,b\,c}$	$3.39 \pm 1.53^{b\,c}$
Color of gill	4.04 ± 1.69^{a}	3.56 ± 1.36^{a}	3.71 ± 1.40^{a}
Mucus in gill	4.15 ± 1.59^{a}	3.8 ± 1.44^{a}	3.83 ± 1.56^{a}
Skin	$4.53 \pm 1.66^{a\,b}$	$4.37 \pm 1.32^{a\,b\,c}$	$3.89 \pm 1.44^{b\,c}$
flesh	4.3 ± 1.58^{a}	4.16 ± 1.26^{a}	3.67 ± 1.58^{b}
finger Pressed	4.12 ± 1.41^{a}	4.2 ± 1.19^{a}	3.83 ± 1.58^{a}
Scale	4.37 ± 1.65^{a}	4.21 ± 1.45^{a}	3.91 ± 1.47^{a}

*Means with similar superscript (in a row) are not statistically significantly different ($p>0.05$), those with different superscript statistically significantly different ($P<0.05$).
*(Unacceptable (1), Very Bad (2), Bad (3), Acceptable (4), Good(5), Very Good (6) And Excellent (7)).

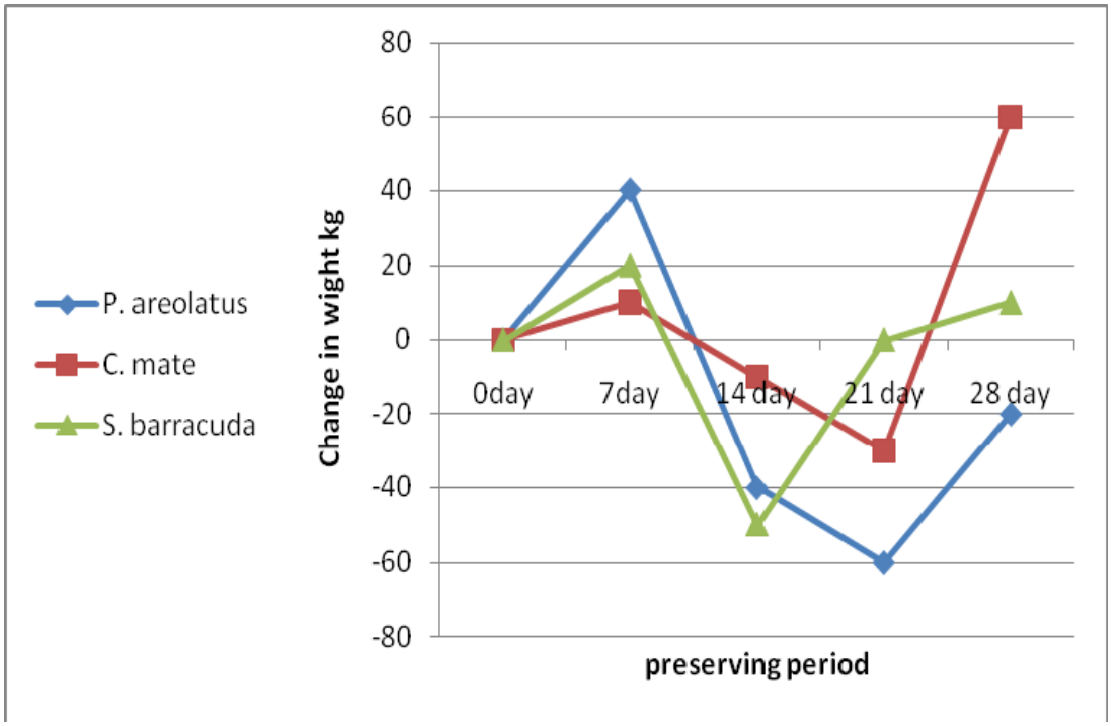

Fig 1: Change in weight of three fish species (*P.areolatus*, *C. mate* and *S. barracuda*) during ice preserving period.

4. Conclusions

Different species had some effect on chemical composition and sensory characteristics during and at the end of preserving period. The results indicated no contamination of *Staphylococcus* spp, *Salmonella* spp and *Vibrio* spp in the three species. *Plectropomus areolatuses* was the best in sensory characteristics, with less infection by *E. coli* and lower total count of microbes. S*phyraena barracuda* had a low degree of sensory characteristics and highest value in the chemical composition.

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