Journal of

Fisheries and Aquatic Science

ISSN 1816-4927

Academic
Journals Inc.

www.academicjournals.com

Journal of Fisheries and Aquatic Science 8 (1): 213-217, 2013
ISSN 1816-4927 / DOI: 10.3923/jfas.2013.213.217

Effects of Ice Storage on the Biochemical Composition of *Macrobrachium vollenhovenii* (Herklots, 1857)

[1]S.L. Akintola and [2]S.B. Bakare
[1]Department of Fisheries, Faculty of Science, Lagos State University, Ojo, Lagos State, Nigeria
[2]Department of Microbiology, Faculty of Science, Lagos State University, Ojo, Lagos State, Nigeria

Corresponding Author: S.L. Akintola, Department of Fisheries, Faculty of Science, Lagos State University, Ojo, Lagos State, Nigeria Tel: 234-08038100507

ABSTRACT

Changes in biochemical properties of freshwater prawn stored with two ice conditions, Direct Contact with Ice (DCI) and Without Direct Contact with Ice (WCI) for day 0, 2, 4, 6, 8 and 10 were investigated. Proximate composition defined in terms of moisture increased for the DCI as storage days increases (77.86% in day 0 to 84.62% in day 10) but relatively constant with treatments with WCI. Values of TVB-N (mg N/100 g) in prawn stored with DCI had inverse relationship with storage days but increased with storage days in the WCI. Changes in the values of ash and crude protein were relatively constant as the storage days increased in both treatments. Ice treatments recorded little changes in between storage days for fats. Values of NPN mg N/100 g decreased with days of storage with DCI but increased as the storage increased with WCI. These results obtained in this study showed that ice storage may have contrasting values and importance on the biochemical properties of the freshwater prawn.

Key words: *Macrobrachium vollenhovenii,* ice, biochemical, sensory, quality, shelf life

INTRODUCTION

Ice storage of prawns is the cheapest and the most common preservative method which is very efficient and utilized worldwide (Madrid and Phillps, 2000). Chemical and biochemical reactions responsible for quality deterioration during storage will slow down with decrease in storage temperature and the storage life will be prolonged at lower temperatures (Riaz and Qadri, 1990). The more rapid spoilage of the shellfish are due to higher water content, high free amino acid content, more rapid autolysis by the existing enzymes and less reaction of the flesh that favours microbial growth and the lower content of connective tissue as compared to other flesh foods.

Shellfishes are important source of dietary nutrients. Ravichandran *et al.* (2009) reported maximum level of protein, carbohydrate and moisture content in the flesh tissues and higher level of lipid, fibre and ash content in the shell part of the shrimp *Penaeus indicus*. Bello-Olusoji and Oke (2005) stressed that chemical composition and nutritional properties of aquatic crustaceans are important in their uses as sources of protein to significant proportion of the world population, particularly in developing countries where animal protein is expensive and beyond the reach of the poor man. Ehigiator and Nwangwu (2011) reported the proximate composition of *M. vollenhovenii* to be comparable to many of the shellfish of nutritional importance.

In spite of the aforementioned advantages of the shellfish, Zeng *et al.* (2005) mentioned that the high content of free amino acids and other soluble non-nitrogenous substances which partly contribute to the desirable, delicate sweet taste of shrimp (Konosu and Yamaguchi, 1982), can also serve as easily digestible nutrients for microbial growth. Consequently many techniques are evolved to slow down the rapid deterioration associated with marine species. Ice based techniques are prominent. Modern over traditional ice based systems are being applied such as slurry ice-also known as fluid ice, slush ice, liquid ice or flow ice-has been introduced as a promising technique for the preservation of fish products at sub-zero temperature (Rodriguez *et al.*, 2005).

The proximate and chemical composition of finfish and shellfish and from different literatures had been exhaustively reported by Krzynowek and Murphy (1987). Also, the impact of storage conditions on the freshwater prawn have been reported by Kye *et al.* (1988), for *Macrobrachium rosenbergii*, Dinakaran and Soundarapandian (2009) for *Macrobrachium idella idella*. Information on the impact of ice on the proximate composition on *Macrobrachium vollenhovenii* is rare. The objective of this study was to investigate the proximate composition fresh and ice stored *Macrobrachium vollenhovenii,* African giant river prawn.

MATERIALS AND METHODS

Live *Macrobrachium vollenhovenii* with mean weight of 30±25 g were purchased from fishers from Badagry Creek, longitude 2°42' and 3°23'E and latitude 6°23' and 6°28'N in hours of 7.00-8.00 am. Samples were packed into a sterile Thermocool® boxes containing chlorinated water (5 ppm) and transported within 1 h to the laboratory in the Department of Fisheries, Lagos State University.

Samples were aseptically distributed randomly into two groups of prawn stored with Direct Contact with Ice (DCI) in ratio of 1:1 (w/w) in Thermocool® box labelled A while the samples without direct contact with ice were placed 0.006 mm thick polythene bags, 150 g prawn/bag following Kirshnick *et al.* (2006) and thereafter placed in the Thermocool® box labelled B. Melted ices in each box were replaced after 12 h and drained regularly through the tap on the Thermocool® box. Five prawns were withdrawn for proximate and chemical analyses the first day and thereafter every two days of storage (Day 0, 2, 4, 6, 8 and 10) from the two experimental set up under room temperature of 27-30°C while the fresh prawns served as control.

Moisture, ash, fat, crude proteins, muscle, pH, Thiobarbituric Acid (TBA), Total Volatile Bases-Nitrogen (TVB-N), were determined using the methods in AOAC (1984). Non-Protein-Nitrogen (NPN) determined by copper sulfate method (Osborne and Voogt, 1986).

Statistical analyses: The data were analysed by ANOVA using SPSS (version 15). Mean values were reported and significance was defined at $p<0.05$.

RESULTS AND DISCUSSION

The highest moisture content was obtained in day 10. Moisture in the DCI increased with storage days whereas values for WCI was relatively constant (Table 1). This agreed to the work of Joseph *et al.* (1998) and Basavakumar *et al.* (1998) both reported increased moisture content of *Penaeus indicus* and *Penaeus monodon* stored in DCI, respectively. Similarly, lower increase in moisture (1-5%) recorded in WCI agrees with Angel *et al.* (1986). The ash content remains fairly

Table 1: Change in ash, crude protein and total volatile base nitrogen (TVB-N) contents of *M. vollenhovenii*, affected by storage condition

		Storage (day)					
Parameter	Treatment	0	2	4	6	8	10
Moisture	DCI	77.86±16.2^{Ee}	79.38±20.8^{Rr}	81.76±16.2^{Rr}	82.14±27.2^{Tr}	83.94±12.0^{Tr}	84.62±29.2^{Tr}
	WCI	77.86±16.2^{Ee}	77.74±10.7^{Ee}	77.74±16.3^{Ee}	77.16±20.8^{Ee}	77.02±21.0^{Ee}	77.60±07.7^{Ee}
Ash (%)	DCI	1.64±0.07^{Ee}	1.60±0.12^{Ee}	1.62±0.06^{Ee}	1.56±0.08^{Ee}	1.52±0.04^{Ee}	1.48±0.08^{Ee}
	WCI	1.64±0.07^{Ee}	1.58±0.10^{Ee}	1.54±0.05^{Ee}	1.60±0.05^{Ee}	1.48±0.15^{Ee}	1.36±0.12^{Ee}
Crude protein (%)	DCI	19.12±0.19^{Ee}	17.80±0.50^{Rr}	17.10±0.21^{Rr}	16.16±0.39^{Tr}	15.22±0.40^{Tr}	14.34±0.42^{Tr}
	WCI	19.11±0.15^{Ee}	10.30±0.53^{Ee}	19.58±0.37^{Ee}	19.72±0.14^{Ee}	19.96±0.54^{Ee}	19.49±0.38^{Ee}
TVB-N (mg N/100 g)	DCI	17.35±1.16^{Ee}	14.87±0.94^{Rr}	11.33±0.63^{Tr}	08.67±0.33^{Tr}	06.88±0.49^{Zr}	04.85±1.06^{Er}
	WCI	17.35±1.16^{Ee}	18.51±2.06^{Re}	18.71±0.95^{Ee}	20.17±1.46^{ERe}	21.32±0.86^{ERe}	21.89±0.86^{Re}

Mean±SD values in the same row followed by different capital letter and of same parameter in the same columns within a block, followed by different lowercase letters, are significantly different at $p \le 0.05$, Mean values obtained from three samples analysed in triplicate, DCI: Direct contact with ice, WCI: Without direct contact with ice

constant in both storage conditions, Crude protein decreased in DCI with storage days but relatively constant for WCI. The crude protein content of WCI differed significantly ($p<0.05$) from DCI. Basavakumar *et al.* (1998) reported reduced protein values in muscle of *P. monodon* after 7 days of DCI which is due to the leaching out of the soluble component in water and to the dilution effect caused water absorption. This agrees with observed values in both treatments. Also Bauer and Eitenmiler (1974) suggested that loss of protein and non protein nitrogen in interstitial fluid may be due to cell rapture during ice storage. Values of the Total Volatile Base Nitrogen (TVB-N) decreased significantly ($p<0.05$) as the storage days increased from 17.35±1.1 mg N/100 g to 04.85±1.06% mg N/100 g in DCI whereas for WCI, values observed increased from 17.35±1.1 to 21.89±0.86 mg N/100 g with increased storage days. In this study, continuous reduction occurred in TVB-N in DCI storage sample while there was slight increase in the TVB-N content on the 10th Day in WCI storage contrary to the report of Mausse (2000). In this study the values of TVB-N obtained are within the acceptable limits reported for fish i.e., <30 mg N/100 g muscle (Kirshnick *et al.*, 2006).

The fat content in the muscle of iced stored freshwater prawn in this study had values which changed only by 4.34-13.03% consistently in the storage days for both storage conditions. In DCI storage, Thiobarbituric Acid (TBA) content remain almost same (<1.0) but increased from 0.05 to 1.16 mg malonaldehyde kg^{-1} of muscle on day 8 in WCI storage may be due to the oxidation of polyunsaturated fatty acids from the muscle, caused by the presence of oxygen inside the plastic bag (WCI). In DCI, the prawn sample was placed directly in ice which may probably reduced the contact with oxygen and delayed oxidation. Kanner and Karel (1976) reported that lower Thiobarbituric Acid (TBA) content was due to leaching out of Malonaldehyde together with amino acid accumulated during DCI storage (Table 2).

The Non-Protein Nitrogen (NPN) reduced from 461.56±16.6-170.28±29.2 mg N/100 g as the storage days increased for DCI while the values obtained for WCI increased as the storage days increased significantly ($p<0.05$) from 461.56±16.6-538.04±07.5 mg N/100 g (Table 2). Changes in the pH in the muscle of the freshwater prawn exposed to two ice storage conditions in this study was relatively constant as the days of storage increased.

Table 2: Change in fat, non protein nitrogen (NPN), thiobarbituric acid (TBA) and the pH in the muscle of *M. vollenhovenii* under different ice storage condition

		Storage (day)					
Parameter	Treatment	0	2	4	6	8	10
Fat (%)	DCI	0.46 ± 0.09^{Ee}	0.52 ± 0.07^{Ee}	0.48 ± 0.09^{Ee}	0.56 ± 0.10^{Ee}	0.54 ± 0.05^{Ee}	0.48 ± 0.04^{Ee}
	WCI	0.46 ± 0.09^{Ee}	0.48 ± 0.08^{Ee}	0.50 ± 0.16^{Ee}	0.52 ± 0.08^{Ee}	$0.48\pm=0.08^{Ee}$	0.44 ± 0.04^{Ee}
NPN (mg N/100 g)	DCI	461.56 ± 16.6^{Ee}	389.72 ± 19.0^{Er}	310.34 ± 16.6^{Rr}	215.64 ± 27.62^{Rr}	217.88 ± 12.26^{Tr}	170.28 ± 29.2^{Zr}
	WCI	461.56 ± 16.6^{Ee}	483.52 ± 09.9^{Re}	509.48 ± 16.7^{Tr}	514.63 ± 21.00^{RTA}	530.67 ± 21.00^{Te}	538.04 ± 07.5^{Te}
TBA (MA kg^{-1})	DCI	0.05 ± 0.06^{Ee}	0.06 ± 0.24^{Ee}	0.22 ± 0.10^{Ee}	0.40 ± 0.11^{Er}	0.55 ± 0.10^{Ee}	0.35 ± 0.06^{Er}
	WCI	0.05 ± 0.06^{Ee}	0.12 ± 0.16^{Ee}	0.85 ± 0.45^{RTE}	1.32 ± 0.48^{Rte}	1.16 ± 0.38^{TEe}	0.02 ± 0.51^{ZRe}
pH	DCI	6.83 ± 0.05^{Ee}	6.03 ± 0.09^{Re}	6.68 ± 0.06^{Ee}	6.63 ± 0.08^{Ee}	6.53 ± 0.04^{Ee}	6.46 ± 0.05^{Ee}
	WCI	6.83 ± 0.05^{Ee}	6.79 ± 0.07^{Re}	6.43 ± 0.23^{Ee}	6.48 ± 0.07^{Ee}	6.53 ± 0.13^{Ee}	6.49 ± 0.05^{Ee}

MA kg^{-1}: Malonaldehyde kg^{-1} of prawn muscle, DCI: Direct contact with ice, WCI: Without direct contact with ice, Mean±SD values in the same row followed by different capital letters and of the same parameter in the same columns within a block followed by different lowercase letters are significantly different at $p\leq0.05$, Mean values are obtained from three samples analysed in triplicate

CONCLUSION

Prawn stored in Direct Contact with Ice (DCI) and Without Contact with Ice (WCI) presented biochemical analyses that would permit the consumption for at least 8 days. However, this may be confirmed in further study in terms of market acceptability.

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