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Comparison of Meat Quality of *Portunus pelagicus* and *Portunus sanguinolentus*

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The meat quality of live and dead crabs of *Portunus pelagicus* and *Portunus sanguinolentus* in raw and cooked condition was compared by microbiological, biochemical and organoleptic quality indices. Bacteriological quality assessment revealed that raw meat of dead *P. sanguinolentus* had higher loads of aerobic plate count, spore forming bacteria, staphylococci, presumptive vibrios, faecal streptococci, total coliforms and faecal coliforms, while raw and cooked meat of live *P. sanguinolentus* had higher counts of sulphite reducing clostridia. *E. coli* and human pathogenic bacteria such as *Salmonella* sp., *Vibrio cholerae, V. parahaemolyticus* and *Listeria* sp. were not detected in both the species. Qualitative analysis of bacterial flora revealed a general dominance of gram positive bacteria in all samples contributed mostly by *Arthrobacter* and *Bacillus* in raw and cooked meat respectively. Raw meat of dead *P. sanguinolentus* had high moisture and ash content with low protein and glycogen content than other samples. Water extractable nitrogen, alpha amino nitrogen, timethylamine and total volatile base nitrogen contents of *P. sanguinolentus* were found to be higher than those of *P. pelagicus*. Meat of dead *P. pelagicus* scored higher than the meat of live *P. sanguniolentus* in the organoleptic evaluation. The results revealed that meat quality of *P.pelagicus* was superior to that of *P. Sanguinolentus*.

Key words : *Portunus pelagicus, Portunus sanguinolentus*, meat quality, quality indices, organoleptic score

Among shellfish, crab ranks second to shrimp in terms of production and export in India. During 1999 - 2003, about 8-10% of the total crustacean landings was contributed by crabs. Along Tuticorin coast, *Portunus pelagicus* (44%) predominated the crab fishery, followed by *P. sanguinolentus* (22%) during 2000 (CMFRI, 2001). Crab meat could serve as an excellent source of nutrition because of its high protein content with low fat and high free amino acids and mineral contents (Srinivasagam, 1979; Selvin *et al.*, 1998). Bacterial, biochemical and nutritional quality of freshly caught crabs vary with different species as influenced by environment, season and water quality. The microbiological flora found in raw crabs of different species (Craig *et*

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al., 1968; Sizemore *et al.*, 1975) and varying proximate composition and nutritive values among different species of portunid crabs (Srinivasagam, 1979; Selvin *et al.*, 1998; Goekoolu & Yerlikaya, 2003) have already been reported. This paper deals with the comparison of meat quality of live and dead crabs of *P. pelagicus* and *P. sanguinolentus* by microbiological, biochemical and organoleptic characteristics.

Materials and Methods

Live and dead crabs of *P. pelagicus* (blue swimming crab) and *P. sanguinolentus* (three spot crab) caught by bottom set gill nets, collected from Vellapatti landing centre near Thoothukudi, Tamil Nadu were transported to the laboratory within 30 minutes for the study. About half the quantity of both live and dead crabs of *P. pelagicus* and *P. sanguinolentus* was cooked in steam for 30 min. Samples were drawn in duplicate from raw and cooked crabs for microbiological and organoleptic evaluation and in triplicate for biochemical evaluation of quality.

Enumeration of bacteria and detection of pathogens were carried out by standard methods (Speck 1976; FDA, 1995; Surendran *et al.*, 2003). Aerobic plate count, staphylococci and presumptive vibrios were enumerated by spread plating on plate count agar (PCA) with 1% NaCl, Baird Parker agar (BPA) with egg yolk and potassium tellurite and thiosulphite citrate bile salt sucrose (TCBS) agar respectively. Spore formers were enumerated after heating the homogenate at 80°C for 15 min. followed by spread plating on PCA with 1% salt. Kenner Faecal (KF) agar was used for the enumeration of faecal streptococci, following pour plate method. All the bacterial groups were examined after incubating the plates at 37°C for 48 h. Three tube most probable number (MPN) method was followed for sulphite reducing clostridia using differential reinforced clostridial medium. MacConkey broth, brilliant green lactose broth (BGLB), EC broth and tryptone broth were used for determining total coliform bacteria, faecal coliform bacteria and *E. coli* following three tube MPN method. *Salmonella* was detected by pre-enrichment in lactose broth, selective enrichment in tetrathionate broth (TTB) and selenite cysteine broth (SCB), selective plating on bismuth sulphite agar (BSA) and xylose lysine deoxycholate (XLD) agar, followed by biochemical characterization of presumptive colonies and serological confirmation using poly 'O' and poly 'H' antisera (King Institute, Chennai). For detection of *Vibrio cholerae* and *V. parahaemolyticus*, crab meat was inoculated to alkaline peptone water (APW) with and without 2% salt for enrichment, followed by selective plating on TCBS agar and biochemical confirmatory tests. *Listeria* was detected by primary selective enrichment in UVM - I broth, selective enrichment in Fraser broth base, selective plating on listeria selective agar followed by biochemical confirmatory tests. The generic composition of bacteria present in the meat of *P. pelagicus* and *P. sanguinolentus* were analysed by purifying the colonies from PCA plates used for APC, following the scheme of Surendran *et al.* (2003). All microbiological media were prepared either by reconstituting the dehydrated media or from individual ingredients procured from HiMedia laboratories, Mumbai.

Moisture, protein, fat and ash contents of crab samples were determined by standard

methods (AOAC, 1995). By following spectrophotometric method, glycogen (Seifter *et al.*, 1950) and lactic acid (Jayaraman, 1981) were estimated. Water extractable nitrogen was determined by Lowry's method (Lowry *et al.*, 1951), alpha amino nitrogen by the method of Pope & Stevens (1939), total volatile base nitrogen and trimethylamine by Conway's micro diffusion technique of Beatty & Gibbons (1937). pH was determined using digital pH meter (Systronics 335, India) following standard procedures (AOAC, 1995).

Meat was separated from cooked crabs and used for organoleptic evalution by assessing various sensory attributes such as appearance, colour, texture, odour and taste following 5 point scale by a panel of six members. Overall quality was calculated by the mean of scores of all the attributes.

Results and discussion

Results of the quantitative bacteriological analysis of raw and cooked meat of live and dead crabs of *P. pelagicus* and *P. sanguinolentus* are shown in Table 1. In both the species of crabs, counts of all the microbiological parameters got reduced significantly upon cooking. Cockey & Chai (1991) reported that microflora of crabs were comprised largely of gram negative, heat sensitive bacteria which could be killed by proper boiling. Highest APC (1.7×10^5 cfu/g) was found in raw meat of dead *P. sanguinolentus* which was slightly higher than the microbiological standards of APC of 1×10^5 cfu/g specified for fresh crab meat by crab meat producing states of the USA (Cockey & Chai, 1991). Meat samples did not show much variation in counts of spore forming bacteria, staphylococci and presumptive vibrios, except the raw meat of dead

Table 1. Bacteriological quality of raw and cooked meat of *Portunus pelagicus* and *Portunus sanguinolentus*

Parameter	*Portunus pelagicus*				*Portunus sanguinolentus*			
	Live		Dead		Live		Dead	
	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
APC (cfu/g)	1.3×10^5	2.7×10^3	3.1×10^5	2.5×10^3	4.4×10^4	Est.7.8×10^2	4.7×10^5	1.9×10^3
SF (cfu/g)	Est.6.0×10^2	Est.1.1×10^3	Est.4.0×10^2	Est.1.0×10^3	Est.1.0×10^3	Est.2.0×10^2	9.7×10^3	Est.9.0×10^2
SC (cfu/g)	Est.8.0×10^2	Est.1.0×10^3	Est.1.1×10^3	Est.8.0×10^2	Est.1.5×10^3	Est.$<1.0 \times 10^2$	2.8×10^3	Est.2.0×10^2
PVC (cfu/g)	Est.2.0×10^2	Est.$<1.0 \times 10^2$	Est.7.0×10^2	Est. $< 1.0 \times 10^2$	Est.$1.8. \times 10^3$	Est.$<1.0 \times 10^2$	4.3×10^4	Est.$<1.0 \times 10^2$
PS (cfu/g)	8.9×10^2	Est.$<1.0 \times 10$	5.1×10^2	Est.1.0×10	9.5×10^3	Est.$<1.0 \times 10$	1.4×10^4	Est.$<1.0 \times 10$
SRC (MPN/g)	0.0	0.0	0.4	0.0	2.0	1.5	0.4	0.0
TC (MPN/g)	1.5	0.0	0.7	0.0	0.0	0.0	140.0+	0.0
FC (MPN/g)	0.7	0.0	0.3	0.0	0.0	0.0	140.0+	0.0
EC (MPN/g)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APC – Aerobic plate count
PVC – Presumptive vibrio count
TC – Total coliforms
SF – Spore formers
FS – Faecal streptococci
FC – Faecal coliforms
SC – Staphylococcal count
SRC – Sulphite reducing clostridia
EC – *E. coli*

P. sanguinolentus which also had higher total and faecal coliforms than the standards (MPN $\leq 1 \times 10^4$ and 0 to 93 / 100g) specified by crab meat producing states in the USA (Cockey & Chai, 1991). Raw meat of *P. sanguinolentus* had higher count of faecal streptococci than *P. pelagicus* which could be due to contamination during handling at the auction centre as *P. pelagicus* are handled with care because of higher unit value. Sulphite reducing clostridia were found to be more in raw and cooked meat of live *P. sanguinolentus*. All the samples were found to be free of *E. coli* and other human pathogenic bacteria namely *Salmonella* sp., *V. cholerae*, *V. parahaemolyticus* and *Listeria* sp. However, presence of pathogens such as *V. parahaemolyticus* and *Listeria monocytogenes* in raw and cooked crab meat have been previously reported (Weagant *et al.*, 1988; Rawles *et al.*, 1995; Shanthini *et al.*, 2004), nevertheless, the sources of contamination could not be established.

Table 2. Generic composition of bacterial flora (%) in the meat of *Portunus pelaticus* and *P. sanguinolentus*

Parameter	*Potunus pelagicus*				*Potunus sanguinolentus*			
	Live		Dead		Live		Dead	
	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
Arthrobacter	33.3	29.6	22.6	12.0	22.2	33.3	13.3	10.5
Bacillus	6.7	40.7	3.2	44.0	13.9	6.7	10.0	52.6
Lactobacillus	—	—	6.5	—	11.1	—	3.3	—
Micrococcus	23.3	14.8	12.9	32.0	8.3	33.3	—	10.6
Staphylococcus	6.7	14.8	9.7	12.0	11.1	26.7	20.0	26.3
Streptococcus	—	—	3.2	—	13.9	—	16.7	—
Alcaligenes	—	—	6.4	—	5.6	—	—	—
Enterobacteriaceae	3.3	—	3.2	—	—	—	3.3	—
Flavobacterium	—	—	—	—	5.6	—	3.3	—
Moraxella	10.0	—	12.9	—	5.6	—	6.7	—
Pseudomonas	16.7	—	16.1	—	—	—	16.7	—
Vibrio	—	—	3.2	—	2.7	—	6.7	—
Gram +ve	70%	100	58.1	100	80.5	100	63.3	100
Gram -ve	30%	—	41.8	—	19.5	—	36.7	—

In both the species of crab, there was a general dominance of gram positive bacteria over gram negative bacteria even in raw meat (Table 2). However, the meat from dead crabs had higher proportion of gram negative bacteria (41.8 and 36.7%) than in meat from live crabs (30 and 19.5%) of *Portunus pelagicus* and *P. sanguinolentus*. Among gram positive bacteria, non spore forming genera including *Arthrobacter* and members of micrococcaceae dominated over

Table 3. Biochemical characteristics of raw and cooked meat of *Portunus pelagicus* and *Portunus sanguinolentus*

Parameter	*Portunus pelagicus*				*Portunus sanguinolentus*			
	Live		Dead		Live		Dead	
	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
Moisture (%)	75.74 ± 0.23	74.14 ± 0.07	74.20 ± 0.41	73.66 ± 0.28	76.60 ± 0.52	73.80 ± 0.38	79.06 ± 0.21	76.12 ± 0.71
Protein (%)	17.80 ± 0.24	21.56 ± 0.32	17.52 ± 0.17	21.62 ± 0.23	18.89 ± 0.12	22.17 ± 0.14	18.86 ± 0.22	21.2 ± 0.13
Fat (%)	0.56 ± 0.08	0.70 ± 0.04	0.55 ± 0.07	0.73 ± 0.07	0.81 ± 0.10	0.90 ± 0.11	0.81 ± 0.07	0.89 ± 0.08
Ash (%)	2.12 ± 0.12	2.06 ± 0.15	2.43 ± 0.18	2.07 ± 0.12	2.19 ± 0 17	2.24 ± 0.14	2.89 ± 0.33	2.63 ± 0.11
Glycogen (mg%)	277.96 ±15.12	252.15 ± 4.83	226.19 ± 8.76	178.99 ± 6.65	300.10 ± 4.11	203.80 ± 0.61	51.05 ± 3.74	48.76 ± 2.02
Water exactable nitrogen (mg%)	1077.17 ± 23.77	777.77 ± 43.80	1232.76 ±20.18	640.01 ± 20.19	2068.38 ± 11.25	1054.18 ± 30.99	2655.49 ±19.67	1562.23 ± 13.15
a - amino nitrogen (mg%)	224.65 ± 3.67	127.64 ± 1.89	250.53 ± 2.29	150.29 ± 0.52	269.05 ± 4.22	193.56 ± 0.57	257.62 ± 1.54	183.64 ± 1.78
Trimethylamine (mg%)	ND	ND	ND	ND	1.39 ± 0.29	1.40 ± 0.29	1.51 ± 0.14	1.50 ± 0.11
Total volatile base nitrogen (mg%)	12.81 ± 1.16	13.12 ± 0.56	13.18 ± 0.57	13.61 ± 0.86	19.56 ± 0.91	11.53 ± 0.25	22.46 ± 0.55	20.82 ± 0.86
Lactic acid (mg%)	300.60 ± 10.14	228.29 ± 14.03	263.19 ± 6.03	216.52 ± 13.90	242.99 ± 10.05	89.82 ± 8.67	340.69 ± 6.01	299.78 ± 7.82
pH	7.18 ± 0.10	6.99 ± 0.01	7.40 ± 0.08	7.22 ± 0.09	7.55 ± 0.05	8.12 ± 0.08	7.56 ± 0.11	8.15 ± 0.09

ND – Not detected

spore formers in raw meat from both live and dead crabs. Cooking eliminated all gram negative bacteria, and among gram positive bacteria *Bacillus* dominated in all samples except in cooked meat of live *P. sanguinolentus*. The bacterial flora from raw meat of dead crabs had more diverse generic composition than the bacteria flora from raw meat of live crabs, especially with gram negative bacteria which was dominated by *Pseudomonas* and *Moraxella* sp. Although the occurrence of *Vibrio* sp was very less in both the species of crabs, *Vibrio* spp were reported to be predominant in blue crabs (Sizemore *et al.*, 1975), followed by *Pseudomonas*, and *Acinetobacter*. However, Lee & Pfeifer (1975) observed highest proportion of *Moraxella* in Dungeness crabmeat. Fahri *et al* (1984) found that the bacteria flora on crabs taken from waters close to human habitation had higher proportion of members of enterobacteriaceae and were different from those from more isolated areas away form human habitation. Higher proportions of *Staphylococcus* and *Streptococcus* were also observed in *P. sanguinolentus* than in the meat of *P. pelagicus* in the study. These results clearly indicated that meat of *P. sanguinolentus* was microbiologically inferior to that of *P. pelagicus*.

Biochemical quality characteristics of raw and cooked meats of live and dead *P. pelagicus* and *P. sanguinolentus* are shown in Table 3. Meat of dead *P. sanguinolentus* had high moisture, fat and ash content with low protein and glycogen content than that of *P. pelagicus* in raw condition (Table 3). Srinivasagam (1979) also observed higher content of moisture and low protein in *P. sanguinolentus* than in *P. pelagicus* meat. But Selvin *et al.*(1998) reported higher contents of moisture, protein, lipid and glycogen in the meat of *P. pelagicus* than in *P. sanguinolentus*. These variations could be expected in species of crabs where the proximate composition of meat depends on factors including season, sex, size and stages of moulting as already recorded (Srinivasagam, 1979; Radhakrishnan and Natarajan, 1979). Low glycogen content in the meat of dead *P. sanguinolentus* might have resulted from struggling of crabs before death or due to the time lag while glycolytic conversion of glycogen to lactic acid occur which was supported by the presence of higher lactic acid content (340.69 mg%). Water extractable nitrogen and alpha amino nitrogen (AAN) contents of *P. sanguinolentus* were higher than those of *P. pelagicus* and marked decrease was found in all the cooked samples. However, Selvin *et al.* (1998) reported almost equal level of AAN in the meat of *P. pelagicus* and *P. sanguinolentus*. Trimethylamine (TMA) and total volatile base nitrogen (TVB-N) contents of *P. sanguinolentus* were also higher than that of *P. pelagicus* meat. Tanikawa *et al.* (1953) reported that the determination of volatile base nitrogen is the best method of assessing the freshness of raw crab meat which could well be related to the meat quality in the present observation also, where

Table 4. Organoleptic characteristics of cooked meat from *Portunus pelagicus* and *Portunus sanguinolentus*

Characteristics	*Portunus pelagicus*		*Portunus sanguinolentus*	
	Live	Dead	Live	Dead
Appearance	4.73 ± 0.39	4.60 ± 0.47	4.50 ± 0.25	4.50 ± 0.25
Colour	4.50 ± 0.25	4.53 ± 0.47	4.33 ± 0.47	4.25 ± 0.13
Odour	5.00 ± 0.00	5.00 ± 0.00	4.75 ± 0.13	4.67 ± 0.33
Taste	5.00 ± 0.00	4.67 ± 0.47	4.50 ± 0.25	4.33 ± 0.47
Texture	5.00 ± 0.00	4.73 ± 0.47	4.50 ± 0.33	4.33 ± 0.47
Overall quality	4.85 ± 0.20	4.71 ± 0.16	4.52 ± 0.13	4.42 ± 0.15

the meat of dead *P. sanguinolentus* had higher levels of TVB-N than other samples. Tobin *et al.* (1941) reported that during the onset of spoilage, pH increased from 7.2 to 7.8 - 8.2. Raw meat of live and dead crabs of *P. pelagicus* had lower pH than those of *P. sanguinolentus* however, no clear conclusion could be drawn with variations in pH of the meat in this study. Although no reason could be attributed, the variation in meat quality of live and dead *P. pelagicus* was only marginal as the live crabs were allowed to die by storing them without icing and moisture for about 3 hours in the laboratory. Based on these results, the meat quality of *P. pelagicus* was considered to be of higher degree of freshness than that of *P. sanguinolentus*.

Organoleptic scores of cooked meat of live and dead *P. pelagicus* and *P. sanguinolentus* are presented in Table 4. Meat of *P. pelagicus* fetched higher score of overall quality than *P. sanguinolentus* with excellent appearance and characteristic odour, taste and texture. Taste and texture of meat from live and dead *P. pelagicus* was observed to be better than that of *P. sanguinolentus*. The overall score of the meat from dead *P. pelagicus* was higher than the meat of live and dead *P. sanguinolentus*, revealing superior quality.

Comparison of meat quality between *P. pelagicus* and *P. sanguinolentus* revealed biochemical variations in meat composition, which largely influenced the overall acceptability of the meat. Scores of organoleptic evaluation clearly indicated the preference of *P. pelagicus* meat over *P. sanguinolentus*. Although, the qualitative and quantitative microflora largely depends on the freshness of the material, the poor microbiological quality of *P. sanguinolentus* of even freshly landed crabs suggested the poor handling practices adopted for the species, because of the low unit value fetched for *P. sanguinolentus* than *P. pelagicus*.

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