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Microbial Quality of Post-Tsunami Seafood of the Visakhapatnam Coast

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Forty seafood samples comprising marine fish (28 spp), shrimp (4 spp) and squid (1sp) were collected from Visakhapatnam fishing harbour at regular intervals after the tsunami of 26th December 2004 and analyzed for microbiological and chemical quality. The microbiological and chemical quality of post-tsunami seafood was assessed and compared with pre-tsunami samples. The levels of total plate count (TPC), H_2S producing bacteria, total volatile base nitrogen (TVBN) and peroxide value (PV) waswithin limits. With regard to indicator bacteria coliforms, E.coli and coagulase positive *Staphylococci* the quality of post-tsunami seafood was poor, having levels higher than the maximum permissible limit in majority of the samples. Similar trend was noted in the pre-tsunami and post-tsunami seafood quality. Human pathogens, *Sal monella* and *Vibrio cholerae* were not detected in all the post-tsunami seafood samples. The results suggest that no major deviation in the seafood quality occurred during the post-tsunami period.

Key words : Microbial quality, Seafood, Tsunami, Vishakhapatnam

On 26th of December, 2004 the tsunami waves triggered by a massive under-sea earthquake in the Indian Ocean, measuring 8.9 on the Richter scale with its epicenter off Sumatra, Indonesia had ravaged the coastal areas of India, Sri Lanka, Thailand, Indonesia, Maldives and East Africa. In India, the states of Tamilnadu, Andhra Pradesh, Kerala, Pondicherry and the Andaman & Nicobar Islands bore the brunt of tsunami strike. As the tsunami affected regions struggled to recover from the tsunami strike, there were media reports that marine products were highly contaminated with pathogens which led to a drastic fall in demands for seafood. Apart from damaging the consumer confidence , there was a total collapse in whole chain seafood marketing resulting in huge losses to fishermen.

The present study was carried out to assess the microbiological and chemical criteria of seafood collected after tsunami and to ascertain whether the tsunami had induced any major deterioration in the quality.

Materials and Methods

A total of 40 seafood samples comprising of 34 marine fish (28 species), 5 marine shrimp (4 species) and 1 squid samples (Table 1) procured after 26th December 2004 were used in the study. All the post-tsunami seafood samples were procured directly from landing centers of Visakhapatnam Fishing Harbour. Fish were procured at regular intervals in the months of December 2004, January, February and March

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2005 and brought on ice to the laboratory within 15 minutes of procurement and analysed. Microbiological studies included total Plate Count (TPC), MPN faecal coliforms, MPN *Escherichia coli*, coagulase positive *Staphylococci*, *Salmonella*, *Vibrio cholerae*, total Vibrio count and H_2S producing bacteria employing standard methods (Speck.M.L.1978; Gram *et al.*, 1987; Anon , 1995). Total volatile base nitrogen (TVBN) content of seafood estimated by the Conway micro-diffusion method (Conway, 1950) using trichloro acetic acid extract and

Table 1. Details of Post-Tsunami Seafood used for analysis

Days post-tsunami	No.of samples	Post-Tsunami Seafood Sample	
		Scientific Name	Common Name
15	9	*Rastrelliger kanagurta*	Indian mackerel
		Pentaprion longimanus	Long fin mojarra
		Scomberomorus guttatus	Indo Pacific seer fish
		Parastromateus niger	Black pomfret
		Pampus argenteus	Silver pomfret
		Psenes indicus	Indian drift fish
		Nemipterus spp.	Threadfin bream
		Metapeneaus dobsoni	Flower tail prawn
		Parapenaeopsis spp.	Penaeid prawn
30	11	*Priacanthus hamrur*	Dusky finned bulls eye
		Lepturacanthus savala	Ribbon fish
		Tachysurus spp.	Cat fish
		Sphyraena spp.	Barracuda
		Caranx spp.	Carangid (Trevally)
		Megalaspis cordyla	Hard tail scad
		Euthynnus affinis	Little tuna
		Johnius dussumieri	Bearded croaker
		Stolephorus commersonii	Commerson's anchovy
		Penaeus monodon	Tiger prawn
		Loligo spp.	Squid
45	10	*Carcharhinus sorrah*	Sorrah
		Lutjanus spp.	Red snapper
		Scomberoides commersoni	queen fish
		Strogylura crocodilus	Full beak
		Rastrelliger kanagurta	Indian mackerel
		Scomberomorus commerson	Narrow banded seer fish
		Polynemus indicus	Indian thread fin
		Sardinella longiceps	Indian oil sardine
		Selar mate	Bulls eye
		Penaeus monodon	Tiger prawn
60	5	*Dussumieria spp.*	Rainbow sardine
		Himantura bleekeri	Whiptail sting ray
		Rastrelliger kanagurta	Indian mackerel
		Parastromateus niger	Black pomfret
		Metapenaeus spp.	Penaeid prawn
90	5	*Scomberomorus guttatus*	Indo Pacific seer fish
		Parastromateus niger	Black pomfret
		Mugil cephalus	Flat head grey mullet
		Sardinella longiceps	Indian oil sardine
		Sparius spp.	Parrot fish

Peroxide values (PV) determined iodometrically (AOAC, 1990). were chemical indices for quality.

The mean values of 25 seafood samples procured from Visakhapatnam fishing harbour during the years 2003 and 2004 was used as baseline data for pre-tsunami seafood quality

The data was subjected to statistical analysis as per standard methods (Snedecor & Cochran, (1967).

Results and Discussion

Microbiological and chemical analysis of post-tsunami seafood procured from Visakhapatnam fishing harbour was carried out. The results of analysis were grouped based on time interval series as 15, 30 , 45, 60 and 90days post-tsunami.

Table 2. Quality of Post-Tsunami Seafood vis-à-vis Spoilage

Days Post-tsunami	Total Plate Count (log cfu/g)	H_2S producing bacteria (log cfu/g)	TVBN (mg/100g)	PV (meq of O_2/kg of fat
15	5.14 ± 0.36*	1.60 ± 0.82	17.9 ± 4.41	3.20 ± 0.67
30	4.32 ± 0.70	1.61 ± 0.40	14.78 ± 2.35	2.00 ± 1.78
45	4.21 ± 0.57	1.85 ± 0.45	15.08 ± 3.32	1.63 ± 2.14
60	5.08 ± 0.40	1.31 ± 0.77	12.91 ± 4.64	3.66 ± 3.39
90	4.25 ± 0.16	1.61 ± 0.94	17.17 ± 2.06	5.05 ± 3.52
Coefficient of Variation, (range)	7% - 16%	24% - 58%	12% - 36%	21% -130%

* mean ± standard deviation

The total plate count and count of H_2S producing bacteria together with TVBN and PV were taken as indicators of seafood quality with regard to spoilage and the result is given in Table 2. The mean TPC values of post-tsunami seafood procured at different post-tsunami periods ranged between log 4.21 and log 5.14 cfu/g. The mean TPC values were similar through out the study period with not even one log difference between them. All the mean TPC values were less than log 5.698 cfu/g which corresponds to 10^5 cfu/g the maximum permissible limit for TPC (Government of India, 1995). Out of the 40 samples only one fish (*Scomberomorus guttatus*, 15days post-tsunami) had a higher TPC value of 6.9 x 10^5 cfu/g . Sulphide producing bacteria are some of the most predominant bacteria associated with spoilage of fish products. The mean counts of H_2S producing bacteria ranged between log 1.31 and log 1.84 cfu/g. Maximum H_2S producing bacteria were detected in *Polynemus indicus*, 740 cfu/g. (45days post-tsunami) .The mean TVBN values ranged between 12 - 17 mg / 100g which was less than the acceptable limit of TVBN for frozen fish (Connell, 1975). Maximum TVBN value was obtained with *Penaeus indicus* 23.51mg/100g (15days post-tsunami) while the lowest TVBN values were observed in *Parastromateus niger*, 7.81mg% and *Himantura bleekeri*,7.94 (60days post-tsunami). The mean peroxide values (PV) ranged between 1.6 and 5.05 meq of O_2/kg of fat and all values were less than the acceptable level of 10 meq of O_2/ kg of fat (Connell, 1975), indicating that minimal loss of fat quality occurred in the post-tsunami seafood. PV value of 0 meq of O_2/kg of fat was observed in *Penaeus monodon, Megalaspis cordyla,, Loligo spp, Johnius dussumieri* (30days post-tsunami); *Carcharhinus sorrah, Lutjanus spp, Strogylura crocodilus, P.monodon, Scomberomorus commerson* (45days post-tsunami); *Himantura bleekeri, Parastromateus niger* (60days post-tsunami) and *Parastromateus niger* (90days post-tsunami). Maximum PV value was detected in *Mugil cephalus*, (8.57 meq of O_2/kg of fat; 90days post-tsunami), followed by *Sardinella longiceps* (7.14 meq of O_2/kg of fat; 90days post-tsunami) and *Dussumieria spp.* (7 meq of O_2/kg of fat; 60 days post-tsunami). The total plate counts, H_2S producing bacteria, TVBN and PV obtained over different post-tsunami periods were found to be very similar The results of post-tsunami quality of seafood *vis-à-vis* spoilage indicate that the post-tsunami seafood was of good quality.

The results of post-tsunami quality of seafood *vis-à-vis* faecal indicator and pathogenic bacteria is given in Table 3.The mean MPN *E.coli* levels were similar during the first 30 days post-tsunami (41-47 MPN/g) and after 60days post-tsunami (40.6 to 57.2 MPN/g) but the seafood samples procured between 30 to 45 days post-tsunami had a higher mean *E.coli* level (120 MPN/g). The higher mean *E.coli* level in 45days post-tsunami period ccould be attributed to the very high *E.coli* level in *Polynemus indicus* (1100MPN/g) procured during that period. The mean *E.coli* levels were higher than the permissible level of 20/g for raw fresh or frozen fish and shrimp (Government of India, 1995). This result indicates that poor hygiene practices were followed while handling the seafood. The pre-tsunami seafood also had mean *E.coli* (Fig. 3) levels (38 MPN/g) that were higher than the permissible level. Therefore it can be inferred that the high levels of faecal indicator bacteria seen in seafood might be a general lack of hygiene in this area and not a specific influence of tsunami.

Post-tsunami quality of seafood with respect to pathogenic bacteria such as *Salmonella* and *Vibrio cholerae* was good, as these human pathogens were not detected in any of the 40 post-tsunami seafood samples (Table 3). Coagulase positive *Staphylococci* should be less than 100/g in raw fresh or frozen shrimp and fish (Government of India, 1995). The mean coagulase positive staphylococci value of samples were near the border line of acceptability. *Staphylococcus aureus* is one of the most resistant non-spore forming pathogen

Table 3. Quality of Post-Tsunami Seafood vis-à-vis Faecal Indicators and pathogenic bacteria

Days Post tsunami	Faecal Coliforms (MPN/g)	*E.coli* (MPN/g)	Coagulase positive *Staphylococcus* aureus (cfu/g)	*Salmonella* 25g	*Vibrio cholerae* 25g
15	105 ±126*	41.5 ± 89	92.9 ± 100	0	0
30	69.9 ± 147	47.8 ± 95	64.5 ± 63	0	0
45	130.2 ± 341	120 ± 345	166 ± 261	0	0
60	57.2 ± 103	57.2 ± 103	88 ± 154	0	0
90	48.8 ± 37	40.6 ± 37	100 ± 100	0	0
Coefficient of Variation, (range)	76 ± 262	91 ± 288	98 ± 175	-	-

* mean ± standard deviation

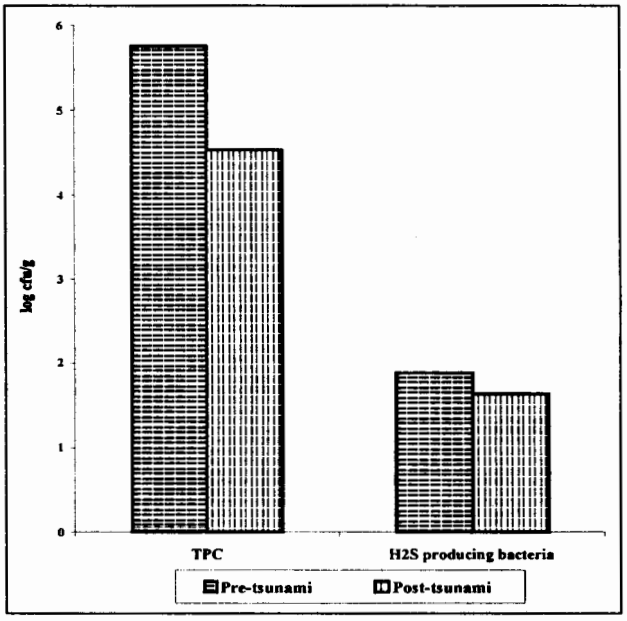

Fig 1. Comparison of Microbial Quality vis-a-vis spoilage of Pre-Tsunami and Post-Tsunami Seafood.

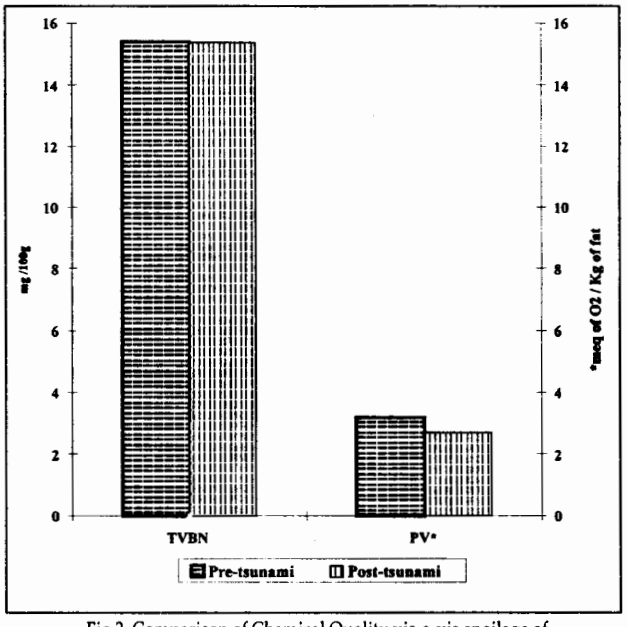

Fig 2. Comparison of Chemical Quality vis-a-vis spoilage of Pre-Tsunami and Post-Tsunami Seafood.

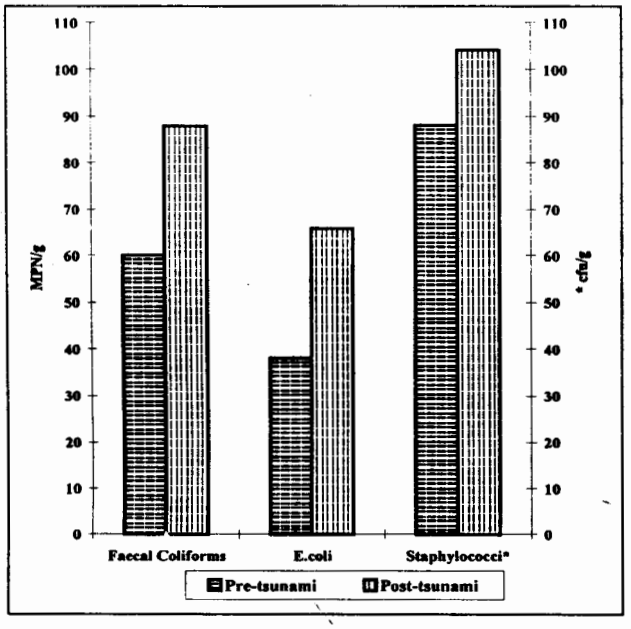

Fig 3. Comparison of Chemical Quality of Pre-Tsunami and Post-Tsunami Seafood.

(Doyle *et al.*, 1997). Food handlers with poor personal hygiene are reported to be the main sources/means of contamination of food with *Staphylococccus aureus* (Forsythe, 2000; Bacon & Sofos, 2003).

The coefficient of variation (CV) values (Table 2 & 3) were higher for coagulase positive *S.aureus*, faecal coliforms and *E.coli* compared to that for TPC and TVBN values. The low CV levels for spoilage indices compared to CV values of faecal indicators suggested that the adoption of sanitation or hygienic practices by fishermen was insufficient and has to be given more attention.

The quality of post tsunami fish vis-à-vis acceptable limits is given in Table 4. Only 2.5% of post-tsunami seafood samples had TPC levels above the permissible limit and all post-tsunami seafood samples had acceptable levels of TVBN and PV. Human pathogens namely *Salmonella* and *Vibrio cholerae* were absent in post-tsunami seafood samples. 45% and 30% of post-tsunami seafood samples had higher than permissible levels of *E.coli* and coagulase positive *S.aureus*, respectively.

The results of comparison of post-tsunami and pre-tsunamis seafood quality is given in Fig 1-3. It is evident from the figures that there is no significant difference in TPC and H_2S producing bacteria (Fig. 1); TVBN and PV levels (Fig. 2) between post-tsunami and pre-tsunami seafood. The results suggest no major deviation in the seafood quality during the post-tsunami period but a gradual deterioration in the sanitation and hygiene quality of seafood is being taking place. *Vibrio* levels tend to fluctuate with changes in water parameters such as water temperature, dissolved oxygen, turbidity, receding tides (Kelly and Stroh, 1988; Pfeffer *et al.*, 2003; Nordstram *et al.*, 2004).The vibrio count was almost steady and low ranging from 22cfu/ to 200cfu/g indicating very low fluctuaton in water parameters with regard to natural microbial flora.

The results of the study on the quality of post-tsunami seafood suggest that there was no major deviation in the seafood quality during the post-tsunami period. Both category of seafood did not reveal spoilage and were not contaminated with *Salmonella* and *Vibrio cholerae*. However it is of utmost priority to initiate steps to inculcate good sanitation and hygiene

Table 4. Quality of Post-Tsunami Seafood vis-à-vis Acceptable levels

Days Post-tsunami	Total Plate[1] Count (%)	*E.coli*[2] (%)	*Coagulase*[3] *positive Staphylococci* (%)	*Vibrio cholerae*[4] (%)	TVBN[5] (%)	PV[6] (%)	*Salmonella*[4] (%)
15	11	22	22	0	0	0	0
30	0	36	27	0	0	0	0
45	0	50	40	0	0	0	0
60	0	60	20	0	0	0	0
90	0	80	40	0	0	0	0
Mean	2.5	45	30	0	0	0	0

[1] percentage of samples with values above 5,00,00cfu/g

[2] percentage of samples with values above 20/g

[3] percentage of samples with values above 100cfu/g

[4] percentage of samples in which the pathogen was detected in 25g

[5] percentage of samples with values above 30mg/100g

[6] percentage of samples with values above 10 meq of O_2 /kg of fat

practices among fish handlers.

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