

SALMONELLA IN MARINE PRODUCTS

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Among Gram-negative rod-shaped bacteria causing food borne gastroenteritis, the most important are members of the genus *Salmonella*. *Salmonella* is the genetic name applied to a group of bacteria, which was formerly known as paratyphoid bacteria derived by D.E. Salmon in 1885. *Salmonellas* are enteric organisms belonging to the family *Enterobacteriaceae*.

Morphology

Salmonellae are Gram-negative rod shaped bacteria mostly motile with the exception of *S. pullorum* and *S. gallinarum*. They do not form spores.

Clinically distinguishable forms

Three clinically distinguishable forms of *Salmonella* are available. They are:

A. Those producing enteric fevers, eg.

- a. Typhoid fever : *S. typhi*
- b. Para typhoid fever : *S. paratyphi* A, B and C.

B. Those producing septicaemia. This usually happens when the organism gets into the blood, for example *S. cholerae - suis*

C. Those producing gastroenteritis. All except *S. typhi* and *S. paratyphi* produce gastroenteritis. Usually this happens on ingestion of food contaminated with *Salmonella*.

Primary habitat

The primary habitat of *Salmonella* is the gut of infected man and animals especially warm blooded animals, mammals, birds, insects, lizards and snakes. From gut, it is excreted out through faeces and hence found in sewage. Some people will be carriers of *Salmonella*.

Conditions for onset of symptoms

Ingestion of *Salmonella* by man or animals does not often result in sickness. In certain cases, men or animals may become carriers without exhibiting symptoms of the disease. The number of cells required to trigger off food-borne illness depends upon the *Salmonella* serotype in question, the conditions and age of the person consuming the food and whether or not the contaminated food is ingested in an empty stomach. Infants, the elderly, undernourished and debilitated are known to be more susceptible to the disease and in such persons *Salmonellosis* is known to occur even on ingestion of a small dose such as 0.6 cells per gram.

Symptoms

Salmonella food poisoning symptoms are presumed to be due to the liberation of endotoxin from the cells by the action of the low pH in the stomach. The onset of symptoms is usually within 12-24 hours after consuming the infected food. The usual symptoms are nausea, vomiting, abdominal pain, head-ache, diarrhoea and fever accompanied by prostration, muscular pain, restlessness and drowsiness which last for two or three days.

In the case of *Salmonella* species that produce enteric fever, the symptoms are more severe. Infection is by ingestion of the organism, which passes from the small intestine to mesentericus. After a period of multiplication, they invade the blood stream and then come back to the gut. Liver, gall bladder, spleen, kidneys and bone marrow are affected. Fever, diarrhoea, restlessness, weakness, abdominal pain and severe headache are the usual symptoms. Complete recovery is possible only in about 20 days. At this stage, while these

organisms generally disappear from the intestinal tract of most of the patients, up to 5% of the victims may become carriers of the organism for about three to four months. In fact, 'carriers' are known to be the main source of Salmonella contamination in many types of food materials.

Incidence of Salmonella in seafoods

Freshly caught marine fish collected from the open sea is free from Salmonella. However, fish from polluted coastal waters are usually infected with Salmonellae.

There are several reports on the incidence of Salmonella in fresh water fishes collected from the river Nile, river Plato, Polish rivers and lakes of Central Africa. There are reports from the Western Countries on the isolation of Salmonella from eel, tuna, smoked fish, mussels, raw shrimps, cooked shrimps, picked crab meat, cat fish, fish meal and froglegs. Salmonellosis on consumption of fish cakes, raw oysters, canned salmon, smoked white fish and whale blubber has also been reported.

The Central Institute of Fisheries Technology, Cochin has made the following observations on the incidence of Salmonella in fish and fishery products (Table 1).

Table 1 Incidence of Salmonella in fish and fishery products

S.No.	Sample	Percentage sample showing incidence of <i>Salmonella</i>
1.	Frozen shrimps	10
2.	Frozen cuttle fish	14
3.	Frozen squids	0
4.	Frozen seer fish	20
5.	Frozen cat fish	25
6.	Frozen froglegs	35
7.	Raw fish-Cochin Fish Harbour	0
8.	Raw fish-Bombay market	4
9.	Fish fry and fish curry from Cochin Hotels	0
10.	Fish meal	1

Source of contamination

The major sources of contamination in marine products are :

- a Fishing from polluted waters
- b Washing the catch in the polluted coastal waters
- c Sorting the catch in the contaminated sea beaches

Salmonella has been isolated from sand collected from such beaches as shown in Table 2

Table 2 Incidence of Salmonella in sea beach sorted fish

S.No.	Beach	Incidence of <i>Salmonella</i>
1.	Vizhinjam	Present
2.	Neendakara	Present
3.	West Hill	Present
4.	Kappad	Present
5.	Mopla	Present

- d Using contaminated water for fish processing:
Of the many samples of process-water analysed at CIFT, Salmonella was detected from one shrimp processing factory situated at Cochin. Salmonella typhimurium was the serotype isolated in this case.
- e Handling of material by workers who are 'carriers' of Salmonella :
Medical examination of fish-handlers with a view to detecting 'carriers' among them has not been initiated in India. This is an area which requires high priority.
- f Improper personnel hygiene
- g. Entry of rodents and wall lizards to the processing hall:
The dropping of lizards and rodents are known to contain Salmonella. Salmonella weltevreden has often been isolated from these sources. It is, therefore, empirical that rodents and wall lizards may act as an important source of contamination of the product with Salmonella.
- h. Poor sanitary conditions of the processing units
- i. Unclean contact-surfaces
During the investigations carried out by CIFT, Salmonella has been isolated from some of the contact surfaces (Table 3).

Table 3 Serotypes of *Salmonella* isolated from contact surfaces

S.No.	Surface	Serotype of <i>Salmonella</i> isolated
1.	Floor	<i>S. typhimurium</i>
2.	Floor	<i>S. weltevreden</i>
3.	Floor	<i>S. bareilly</i>
4.	Basin	<i>S. weltevreden</i>
5.	Wooden surface	Rough strain of <i>Salmonella</i>

Before starting and after finishing each day's work in processing all the contact surfaces may have to be scrubbed with a suitable detergent followed by disinfection using chlorine of appropriate strength as recommended by CIFT.

Salmonella serotypes

More than 2000 serotype of Salmonella are known to exist. But, all the serotypes need not be present in one country. According to the Joint FAO/WHO Expert Committee on Microbiological aspects of Food Hygiene (1968), only 100 serotypes are observed regularly. Different serotypes dominate in different parts of the world but it seems that *S. typhimurium* is the serotype most frequently encountered. The pattern can change drastically in any country within a short period. Thus in 1971, the U.S. and several other countries experienced a sudden increase in the frequency of isolation of *S. agona* whereas *S. wien* increased in France. In all these cases, the probable cause of increase of certain specific serotypes was due to the international movement of people, food and feed.

Some Salmonella serotypes are known to have certain host specificity, such as *S. gallinarum* in chicken, *S. cholerae-suis* in pigs, *S. weltevreden* in wall lizards and *S. enteritidis* in rodents, cows, sheep and goat.

In India, 161 serotypes have so far been isolated from various sources including man, animals, clinical specimens, water and food products. Till recently, no detailed study has been carried out on the Salmonella pattern in fishery products. Detailed investigations carried out at CIFT have resulted in the isolation of about 35 different serotypes of Salmonella, which constitute about 22% of the total serotypes isolated on a national level from various sources. The dominating serotype in various fishery products are given in Table 4.

Table 4 Dominating serotypes in fishery products

S.No	Sample	Dominating serotype
	Frozen froglegs	<i>S. typhimurium</i>
	Frozen shrimps	<i>S. waltevreden</i>
	Frozen fish	<i>S. waltevreden</i>
	Frozen fish	<i>S. waltevreden</i>

The Central Institute of Fisheries Technology, Cochin isolated the following serotypes of *Salmonella* for the first time in India as given in Table 5. The studies also resulted in the isolation of certain rare serotypes of *Salmonella* (Table 6)

Table 5 Serotypes of *Salmonella* isolated at CIFT

S.No.	Serotype	Date of isolation	Source
1.	<i>S. roan</i>	19 Oct. 1977	Frozen froglegs
2.	<i>S. larochelle</i>	27 Nov. 1979	Frozen froglegs
3.	<i>S. wentworth</i>	25 Feb. 1986	Frozen and lobsters

Table 6 Serotypes and sources of isolation

S.No.	Serotype	Date of isolation	Source of isolation
1.	<i>S. heidelberg</i>	12 Jul. 1976	Fish shrimps Cochin
2.	<i>S. matopeni</i>	7 Nov. 1977	Frozen froglegs Cochin
3.	<i>S. waycross</i>	7 Nov. 1977	Frozen froglegs Cochin
4.	<i>S. chingola</i>	13 Oct. 1977	Frozen froglegs Cochin
5.	<i>S. orion</i>	5 Jun. 1979	Frozen red snapper Bombay
6.	<i>S. eastbourne</i>	2 Feb. 1982	Fresh tuna fillet Bombay
7.	<i>S. braenderup</i>	25 Mar. 1986	Fresh mussel meat Calicut

Standards pertaining to the presence of *Salmonella*:

The organism should be totally absent in seafood. It is generally accepted that presence of any serotype of *Salmonella* at any level in a food material has to be regarded as potential hazard.

Viability during freezing and frozen storage

The following observations have been made in the studies carried out at CIFT:-

- a. All serotypes of *Salmonella* can survive freezing at -40°C.
- b. During frozen storage (-20°C), *Salmonella* can survive up to 9 months depending upon the serotype and the initial bacterial load (Table 7).

Table 7 Survival of serotypes during frozen storage

No.	Serotype	Before Free zing	After Free zing	Viability after months										
				1	2	3	4	5	6	7	8	9	10	
1.	<i>S. typhimurium</i>	+	+	+	+	+	+	+	+	+	+	+	-	-
2.	<i>S. paratyphi B</i>	+	+	+	+	+	+	+	+	+	+	+	+	-
3.	<i>S. newport</i>	+	+	+	+	+	+	+	+	+	+	-	-	-
4.	<i>S. weltevreden</i>	+	+	+	+	+	+	+	+	+	-	-	-	-
5.	<i>S. roan</i>	+	+	+	+	+	+	+	+	+	+	+	-	-
6.	<i>S. poona</i>	+	+	+	+	+	+	+	+	+	+	+	-	-
7.	<i>S. saintpaul</i>	+	+	+	+	+	+	+	+	+	-	-	-	-
8.	<i>S. salford</i>	+	+	+	+	+	+	+	+	+	+	+	-	-

+ = Viable = Not viable

Prevention of contamination

- a. Avoid fishing from polluted waters
 - b. Avoid washing with near-shore waters
 - c. Avoid sorting the catch in sea beaches
 - d. Use only chlorinated water (10 ppm) for processing and for ice manufacture
 - e. Workers may be periodically examined to detect carriers.
 - f. Those who are suffering from vomiting or diarrhoea shall not be engaged for fish processing
 - g. Before starting work, all fish handlers may wash and disinfect their hands
 - h. Entry of rodents, wall lizards and flies to the processing hall may be avoided
- Before starting and after finishing each day's work, all the utensils used for processing may be cleaned and disinfected.

