Technology for products of commercial value from crustacean's seafood processing discards

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Introduction

Seafood is known as good source of easily digestible protein with balanced essential amino acids, lipids with the composition of therapeutic and essential fatty acids, mineral and other micronutrients enriched with biologically beneficial elements. The seafood industry provides both food and livelihood to the millions of people and ensures the food sovereignty of many countries across the continents. In India, 14.5 million people were directly or indirectly depends on fisheries activities. China and India together account for more than 45 % of global fish production and in Asian region alone both the countries contributed about 74% and 25% of global exports (FAO, 2018 & COMTRADE UN, 2017).

Seafood processing produces a huge quantity of waste accounts approximately 20-80% depending on the level of processing and type of fish. Global fish waste generation is estimated to be excess of 100 mMT and in Indian scenario which is estimated has less than 4mMT. As per MPEDA data in 2019, India has 285 Non-EU plants and 331 EU plants with the production capacity of 13,618.30MT (non-EU) and 17,999.72MT (EU) respectively. In the year 2017-2018, the quantity of seafood exported from India was 13,77,244 tonnes. Though this higher production can satisfy the consumer demands, it causes several negative impacts including generation of huge proportion of wastes which leads to environmental pollution, depletion of fish stocks etc. Already India has a clear road map for increasing the production and expanding its domestic as well as international markets. Hence it is obvious that as a country India is in the need to have strategies and technology for utilization of the huge quantity of waste likely to be produced in each maritime states.

Common causes of waste generation

The waste generation begins with the practice of discarding unintentional catches at sea. Traditionally, Indian seafood process follows the long marketing channel to reach the consumers. There are many avoidable and unavoidable occurrences that cause fluctuation in the cold chain which affect the quality and ultimately produce certain quantity of catch as waste. Subsequently, the waste is generated during on-board handling, transportation and processing operations. During value addition of seafood processing, only the edible parts are processed and the rest is discarded which can be used as secondary raw material for production of many pharmacologically and biologically active important compounds.

Table 1: Seafood processing plants of India (Region-wise Processing Plants as on 12-12-2019 MPEDA (2019)

S.No	Office	Non- EU/ EU plants	Capacity (MT)
1	RO Chennai	44	2,835.14
2	RO Kochi	106	3,869.22
3	RO Kolkata	44	1,604.31
4	RO Mumbai	46	3,413.80
5	RO Veraval	94	4,711.56
6	RO Vizag	14	654.50
7	SRD Ratnagiri	12	1,459.40
8	SRO BBSR	33	1,286.92
9	SRO Bhimavaram	49	2,671.17
10	SRO Goa	15	1,080.76
11	SRO Mangaluru	50	4,829.06
12	SRO Porbandar	28	1,564.68
13	SRO Quilon	16	577.20
14	SRO Tuticorin	38	1,060.30
Total		**589**	**31,618.02**

List of MPEDA approved value added products from crustaceans

- Breaded and Battered Shrimp
- IQF Marinated Shrimp
- Skewered Shrimp
- Stretched Shrimp (Nobashi)
- AFD Shrimp, AFD Powder
- Blanched/ Cooked Shrimp
- IQF Head-On/ Headless / Butterfly cooked/ blanched shrimp
- IQF Peeled Tail-on cooked shrimp
- Cooked salad shrimp
- Cooked and peeled shrimp
- Sushi
- Shrimp Pickle
- IQF tray pack shrimp
- Shrimp curry
- Pasteurized crab
- Lobster whole

Waste composition of shellfish processing

Annually, Indian shrimp industries produces more than 1 lakh tons of shrimp by products. Processing of shrimps generates large quantities of solid wastes contains head and body shell which accounts for approximately 40 – 50 % of whole shrimp weight. With approximately 60 - 70 % of the total weight of crustaceans (shrimp, crabs, prawns, lobster, and krill) ending up as by-products (Hamed et al., 2016). The tropical shrimp's head generally constitutes 34 - 45 % and body shell constitutes 10 – 15 %. In general, the exoskeletons contain about 30 - 40 % proteins, 30 - 50 % minerals (mainly calcium carbonate), and 20 – 30 % chitin along with others compounds such as pigments (e.g., astaxanthin) and lipids (Vani et al., 2013 and Hayes, 2011). The table 2 show the waste generation of crustacean seafood processing from Gujarat.

Table 2: Data collected from seafood processing plants of Veraval, Gujarat

Type of product before process	Type of product After processing	Waste generated (%)	Yield of edible meat (%)	Present utilization	Price (Rs/ kg)
Head on *Penaeus vannamei*	Headless *vannamie*	32	68	Chitosan production	2-3/-
Head on white *Penaeus indicus*	Headless white	35	65	Chitosan production	2-3/-
Head on green tiger prawn *Penaeus semisulcatus*	Headless green tiger prawn	35	65	Chitosan production	2-3/-
Head on pink shrimp *Matapenaeus monoceros*	Headless pink shrimp	38	62	Chitosan production	2-3/-
Head on kiddi shrimp *Parapenaeopsis sytlifera*	Headless kiddi shrimp	45	55	Chitosan production	2-3/-
Head on white *Penaeus indicus*	PUD white	50	50	Chitosan production	2-3/-
Head on green tiger prawn *Penaeus semisulcatus*	PUD green tiger prawn	52	48	Chitosan production	2-3/-
Head on pink shrimp *Metapenaeus monoceros*	PUD pink shrimp	54	46	Chitosan production	2-3/-

Head on kiddi shrimp *Parapenaeopsis sytlifera*	PUD kiddi shrimp	60	40	Chitosan production	2-3/-
Head on coastal mud prawn *Solenocera crassicornis*	PUD coastal mud prawn	70-68	30-32	Chitosan production	2-3/-
Headless white *Penaeus indicus*	PUD white	25-20	75-80	Chitosan production	2-3/-
Headless green tiger prawn *Penaeus semisulcatus*	PUD green tiger prawn	25-20	75-80	Chitosan production	2-3/-
Headless pink shrimp *Metapenaeus monoceros*	PUD pink shrimp	22-25	75-78	Chitosan production	2-3/-

a) Carbohydrate

Chitin is the second most important natural polymer in the world. Chitin and its derivatives are the major commercial products produced from crustacean processing waste. The main sources exploited are two marine crustaceans, shrimp and crabs. The percentage of chitin content is varies with different crustacean waste. The shrimp and crab waste contains 14 - 42 % & 13 - 26 % (Ashford et al.,1977), krill 39 - 49 % (Naczk et al.,1981) and lobster 60 - 75 % (Synowiecki et al.,2003) of chitin on a dry basis exoskeleton. The deacetylated form of chitin is known as Chitosan.

Chitosan is the most important derivative of chitin.Chitin and chitosan offer a wide range of application from the agriculture to pharmacy industry due to its specific properties like bioactivity, biodegradability, chelation ability, absorption and film forming ability. Although the chitin and chitosan are known to have very interesting physicochemical, functional and biological properties in many areas, their molecular weight and their solubility property restrict their usage. Chitosan, which is soluble in acidic aqueous media, is used in many applications (food, cosmetics, biomedical and pharmaceutical applications).

Unfortunately, all chitin and chitosan are not applicable in all sectors owing to its high molecular mass, high viscosity and, thus, low absorption for in vivo applications. The effectiveness of chitosan in various applications appears to be dependent on the degrees of acetylation. Recent studies on chitosan derivatives particularly water soluble derivatives have drawn considerable attention, since the products obtained possess versatile bio-functional properties. The different types of chitosan derivatives and its application are mentioned below.

Chitooligosaccharides

The depolymerised form of chitosans is called as chitosan oligomers or chitooligomers, or chitooligosaccharide (COS). COS has been paid great interest in pharmaceutical and medicinal applications due to their high solubility and non-toxicity.

Carboxy methyl Chitosan

Carboxy methyl chitosan (CM-chitosan) is the most fully explored derivative of chitosan. This derivative is water soluble in a wide range of pH, only if prepared from a fully acetylated chitin.

Hydroxy propyl Chitosan

Hydroxypropyl chitosan (HPCS), a kind of water-soluble functional derivative of chitosan, is obtained by means of etherification through propylene oxide at the C6/C3 position under alkali conditions. Application of HPCS includes drug delivery, tissue engineering and wound healing.

Phosphorylated Chitosan

Through phosphorylation chitosan is converted to the form of Phosphorylated Chitosan. This derivative is important due to its interesting biological and chemical properties and it also exhibits bactericidal and osteoinductive properties.

Application of chitosan derivatives

Specific properties	Main applications
Bioactivity	Antimicrobial additive to fibers and textile products, food packaging, wound healing and anticholesterolemic agent
Biodegradability	Controlled release of drugs, agro-chemical, food packaging and toiletries production
Chelation ability	Reduction of surface water and waste water pollutions by chelating of heavy metal ions and radionuclide
Absorption capacity	Efficient electrostatic painting, clarification of juices and beverages.
Film forming ability	Production of dialysis membranes and dental fluids, separation membranes for medicine and food processing.

Glucosamine hydrochloride

Glucosamine in the form of glucosamine sulphate, glucosamine hydrochloride, or N-acetyl-glucosamine is extensively used as a dietary supplement for the treatment for osteoarthritis, knee pain, and back pain, and glucosamine is safe and does not affect the glucose metabolism.

Glucosaminoglycans

Glycosaminoglycans(GAGs) are heteropolysaccharides consist of a repeating disaccharide unit without branched chains in which one of the two monosaccharides is always an amino sugar (N-acetylgalactosamine or N-acetylglucosamine) and the other one is a uronic acid. It possesses significant antioxidant and antihypertensive properties and could be utilized as natural preservative ingredient in functional foods and pharmaceutical industry.

b) Protein hydrolysate

Protein hydrolysates are the mixture of amino acids

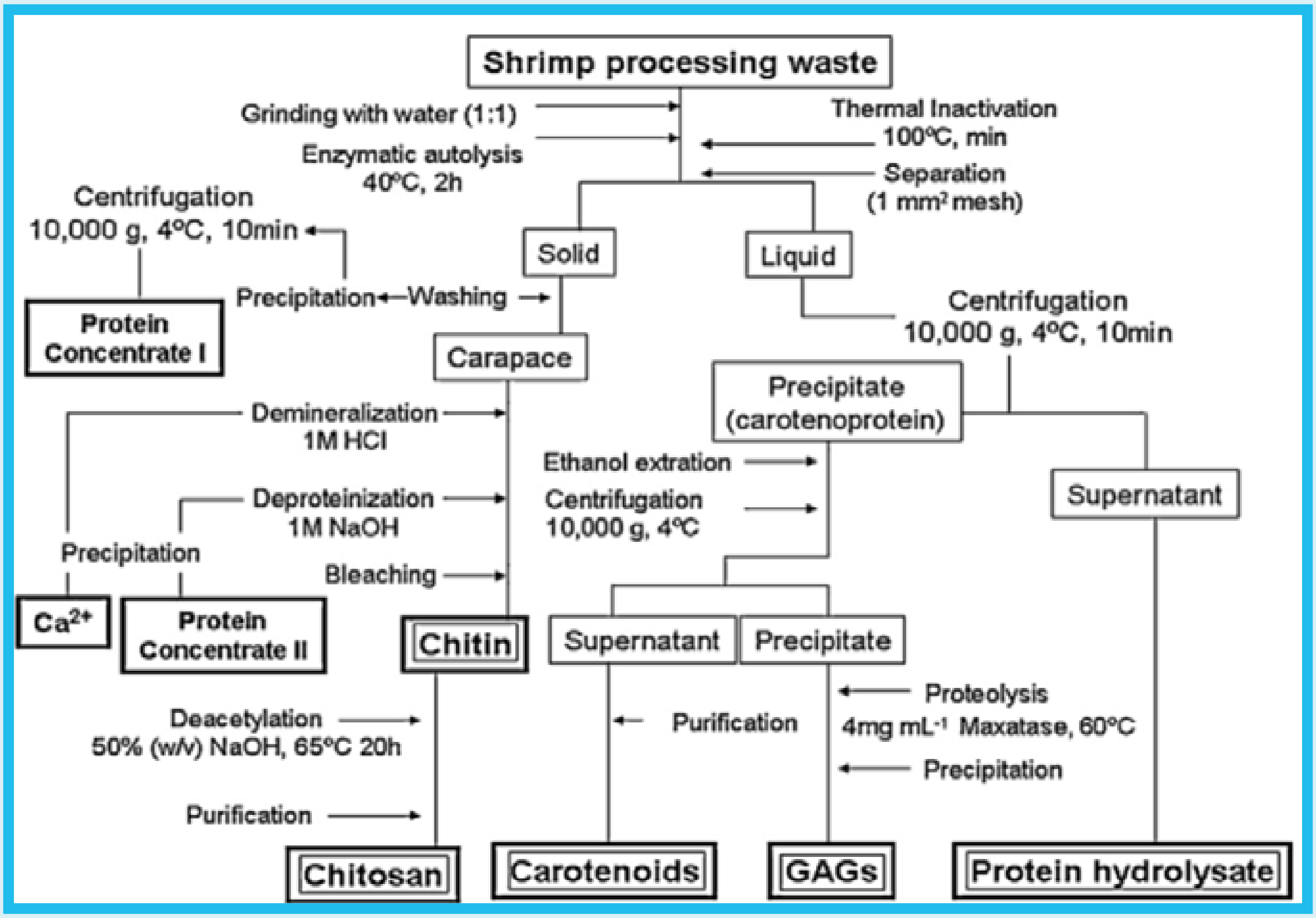

Figure1: Valuable compounds from shrimp processing waste and their process flow (adopted from cahu et al.,2012)

and peptides obtained by digesting proteins from crustaceans processing waste using proteases. The enzymatic hydrolysis is the promising bio-technique currently employed to recover the nutritionally and physiologically important peptides from the protein rich secondary raw material of crustacean processing. Bioactive peptides present in the mixture of protein hydrolysates have been found to possess many physiological functions, including antioxidant, antihypertensive, anticoagulant, antimicrobial, anticancer, antiproliferative, antiobesity and antidiabetic activities.

c) Carotenoids

Shrimp waste is one of the most important natural sources of carotenoids (Shahidi and Brown, 1998). Shrimp waste, such as head and body carapace, are used for carotenoids extraction using organic solvents. Astaxanthin is a red carotenoid with high scavenging activity and has proven excellent biological activities including anticancer and anti-aging, repairing central nervous system, improvement cardiovascular function and protecting eyesight, hence become more essential ingredient in formulations of in pharmaceutical, food industries and cosmetics.

Conclusion

In conclusion, fish waste represents a diverse array of biomolecules having numerous potential. Abundant studies have emphasized the scope to develop new products from crustaceans processing discards. Nevertheless, the major problem to industrialize these developments is the freshness of the processing discards. Processing discard must be better considered as secondary raw materials than wastes both on-board as well as at the processing plants. The quality of the secondary raw material should be maintained as like the edible products and due care should be taken for minimizing the rate of enzymatic degradation and microbial spoilage. The major challenges like poor cold chain during processing, lack of clear legislation, highly scattered nature of seafood processing units, and uncertainty of marketing needs to be addressed for better conversion of these resources into high value commercially important commodities.

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SEAFOOD TRADE IN THE MIDST OF COVID-19 - A REPORT

The COVID-19 pandemic has disrupted industries all over the world thereby affecting the global economy. Seafood industry also had to face both demand and supply challenges. The shutdown of restaurants and retail outlets has reduced the demand for seafood items and panic-buying has been replaced with a very less and unpredictable demand.

India has a growing aquaculture sector contributing to the seafood export. Due to the lockdown, there was disruption in the production side, which has affected the supply chain.

Hatcheries were not able to operate to produce seed stock due to shortage of labour and logistics during the initial phase of lockdown. This in turn has increased the seed price. Due to the unpredictable conditions in the international market, farmers were panic stricken and resorted to early harvests.

There was a fall in export prices and cancellation of large orders from regular buyers. In the present scenario, tapping a new market or switching to a new buyer became very difficult due to lesser demand, travel and other logistic issues. The purchasing power of consumers as the pandemic has affected the job of many people. Seafood exporters are facing difficulty due to cancellation of regular orders, logistic issues and decreased price.

Due to the decline in orders, there is a possibility of stock piling of seafood. Seafood orders from EU countries have stopped. While China used to import large quantities of shrimp for both domestic