Enzyme Assisted Peeling of Shrimp: A promising pre-processing intervention to minimize drudgery and maximize productivity in shrimp processing units

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Frozen shrimp is the major item of fisheries export from India in 2022-23, both in terms of quantity (7,11,099 MT; 41%) and value (Rs. 43,136 crores; 67%) (mpeda.gov.in). Peeled shrimp products namely peeled-deveined (PD), peeled-undeveined (PUD), peeled-deveined tail on (PDTO), Butterfly cut-PDTO, cooked-peeled shrimp, etc. (Fig. 1) are common shrimp products exported from India.

Peeling of shrimp is a pre-processing step wherein exoskeleton (shell) is separated from abdominal meat portion. Structurally, three layers viz., shell, epidermis and muscle are tightly interwoven. The shrimp shell and the epidermis are strongly connected by intra-cuticular fibers and on the other hand the epidermis and shrimp muscle are firmly attached by extensive interdigitation (Talbot et al., 1972). The shell is removed from the meat portion by exerting significant amount of manual force.

Peeled-shrimp (Butterfly Cut-PDTO)

Peeled-shrimp (Cooked)

Fig. 1. Peeled-shrimp products

Females form 63% of the total personnel in shrimp processing units and peeling activity is the major activity performed by the women work force (Rao *et al.*, 2022). The peeling activity is laborious and time-consuming activity wherein the women continuously peel the shrimp for 4-6 hours during a shift. Generally, each person can peel about 40 kg of shrimp per shift. Pre-treatment process can assist in easy peeling which would help in reducing the physical effort during the peeling step.

A pre-treatment process called 'maturation' aids in the loosening of the crosslinks between the muscle and shell prior to peeling. The common maturation practices employed in the pre-processing of shrimp are the use of ice or brine solution (sodium chloride, with or without phosphates) for several days (Dang *et al.*, 2018a, 2018b) but such long maturation times adversely affect shrimp meat quality. After the harvest of shrimp, the post-mortem changes due to the shrimp's intrinsic enzymes and microbial enzymes are responsible for shell-loosening. However, external addition of enzymes derived from microorganisms, plants or animals to augment maturation is a promising approach to accelerate the loosening of shell. Pre-treatment process that assists in loosening of shrimp shell while maintaining the organoleptic quality is needed for the shrimp processing industry. In this context, the present study aims to introduce a pre-processing intervention that minimizes the effort involved in peeling (easy peeling) by using proteolytic enzymes.

Headless shrimp (*Penaeus vannamei*) procured from a shrimp processing unit, Visakhapatnam, Andhra Pradesh was used for enzymatic maturation study. Endo-protease (from *Bacillus licheniformis*) and exo-protease (from *Aspergillus oryzae*) sourced from Sigma-Aldrich Chemicals Private Limited, were tested for their efficiency to augment shell-loosening of the headless shrimp. The endo-protease and exo-protease enzymes were used at 0.5% concentration (v/v) at three ratio of enzymes; endo-protease: exoprotease [1:1 (T1), 2:1 (T2) and 1:2 (T3)]. The headless shrimps were dip treated in enzymes solution at 1:1 ratio (w/v). All the enzyme treatments were performed at 5°C for 1 h with continuous stirring at 150 rpm. Control shrimp were not exposed to enzymes but other conditions of temperature, time and stirring were maintained. The control (C) and treated shrimp (T1, T2 and T3) were analysed at 15 min interval for peelability, texture and, organoleptic changes and the results are presented in Table 1.

Table 1. Effect of Endo- and Exo-protease enzyme treatment on peelability of shrimps

Time (min)	Control (C)	Treatments		
		T1 (1:1)	T2 (2:1)	T3 (1:2)
0	• Very difficult to peel	• Very difficult to peel	• Very difficult to peel	• Very difficult to peel
15	• Difficult to peel • Last abdominal segment and telson difficult to peel off. • Shell and muscle are connected with connecting tissues	• Easy to peel, • Last abdominal segment and telson easy to peel off.	• Easy to peel, • Last abdominal segment and telson easy to peel off.	• Easy to peel, • Last abdominal segment and telson easy to peel off.
30	• Difficult to peel • Last abdominal segment and telson difficult to peel off. • Shell and muscle are connected with connecting tissues	• Easy to peel, • Last abdominal segment and telson easy to peel off. • Soft shell	• Easy to peel, • Last abdominal segment and telson easy to peel off. • Softer shell than T1	• Easy to peel, • Last abdominal segment and telson easy to peel off. • Softer shell than T1
45	• Easy to peel, • Last abdominal segment and telson easy to peel off.	• Easy to peel, • Last abdominal segment and telson easy to peel off. • Abdominal shell, telson and pleopods separated from muscle. • Very soft shell	• Easy to peel, • Last abdominal segment and telson easy to peel off • Abdominal shell, telson and pleopods separated from muscle • Softer shell than T1 • Soft meat	• Easy to peel, • Last abdominal segment and telson easy to peel off • Abdominal shell, telson and pleopods separated from muscle • Softer shell than T1 • Soft meat
60	• Easy to peel, • Last abdominal segment and telson easy to peel off.	• Easy to peel, • Last abdominal segment and telson become easy to peel off • Abdominal shell, telson and pleopods are separated from muscle • Very soft shell • Soft meat	• Easy to peel, • Last abdominal segment and telson become easy to peel off • Abdominal shell, telson and pleopods are separated from muscle • Softer shell than T1 • Soft meat	• Easy to peel, • Last abdominal segment and telson become easy to peel off • Abdominal shell, telson and pleopods are separated from muscle • Softer shell than T1 • Soft meat

**T1: Shrimp treated with endo- protease and exo-protease at the ratio of 1:1; T2: Shrimp treated with endo-and exo-protease at the ratio of 2:1 and T3: Shrimp treated with endo- and exo-protease at the ratio of 1:2*

The results indicate that that the proteolytic enzyme [0.5% concentration (v/w)] treatment effectively improved the peelability of the shrimp. A combination of endo- and exo-protease at 1:1 ratio resulted in the best peeling of shrimp followed by endo- and exo-protease at 1:2 ratio after 30 min of enzyme maturation. However, shell became very soft after 45 min of enzyme maturation in all the enzyme treated shrimp. It was pertinent to note that the enzymatic maturation did not affect the texture, colour and taste of the shrimp as compared to the control.

Ease-of-peeling would benefit the female predominant workforce in shrimp pre-processing areas by way of reducing their unit effort required for peeling. Easy peeling would also enable the workers to peel relatively higher quantities of shrimp. Easy peeling also helps in progressing towards mechanical peeling. Further studies are needed to optimize the enzyme concentration, enzyme combinations, maturation times for easy peeling of different grades and species of shrimp.

References

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