

An assessment of handling and processing methods used for the shrimp fishery by-catch in Kalpitiya, Sri Lanka

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Abstract

The by-catch from the shrimp trawl fishery in Kalpitiya is mainly used for the production of dried fish, which provides an additional source of income for fishermen in the area. It has been observed that current handling practices along the value addition chain are responsible for the poor quality and low price of the end product. This study was aimed at identifying the shortcomings in such handling practices by fishermen and dried fish producers and assessing the quality of shrimp fishery by-catch along the processing chain in order to recommend more efficient utilization methods that will improve the quality of the end product.

Fresh fish, dried fish and harbour water samples were tested for total coliforms, faecal coliforms, *E. coli* and *Salmonella* in order to assess their microbial quality. In addition, standard plate counts (SPC) of fish samples were also carried out. A survey was carried out from July-October 2006 at Kalpitiya, using a pre-tested questionnaire to collect information from individuals who have been engaged in dried fish processing. Average values obtained for freshly landed and dried fish respectively, were, SPC 9.88×10^5 CFU/g and 30.43×10^5 CFU/g, total coliforms 23.05 and 24.23 MPN/g and fecal coliforms 8.28 and 9.00 MPN/g. These values exceed the recommendations in the SLSI standards. A quarter of the landed fresh fish and 38% of dried fish from the producers were positive for *E. coli* and thus failed to show required end product quality. SPC of harbour water was 14.35×10^6 CFU/ml and all samples were found to be contaminated with *E. coli*. None of the fishermen and dried fish producers were satisfied with the quality of the end product. The reasons for poor quality as indicated by them were: limited availability of ice (75%), lack of infrastructure facilities (65%), uncertainty of markets (52%), lack of emphasis on quality (47%) and poor access to available technologies (41%). Respondents to the questionnaire also identified: unavailability of potable water, insulated boxes, good landing jetty, racks for drying fish, poor cold storage facilities and limitations in dried fish storage facilities, as further factors leading to the loss of quality in their products. Results demonstrate that improvements to the infrastructure facilities and conducting of proper awareness programmes on handling practices could lead to improvements in the quality of value added products prepared from the shrimp fishery by-catch at Kalpitiya.

Keywords: dried fish, shrimp fishery by-catch, infrastructure facilities, Kalpitiya, product quality

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Introduction

Sri Lanka utilizes its marine resources to earn a significant income for the people and to generate foreign exchange leading to a contribution of around 2.7% to the GNP in recent years. Over the last five decades, the fisheries sector of Sri Lanka has undergone a significant transformation, resulting in the modernization of an artisanal fishery and fishing methods leading to a fair increase in the total fish production, estimated at 130,400 MT in 2005. The Puttalam district had the 4th highest (11,940MT) marine seafood production in recent years (Sri Lanka fisheries year book 2003-2005).

This study was carried out in Kalpitiya, which is one of the Divisional Secretariats in the Puttalam district which has a major landing site in operation. Most of the people living in this area are engaged in fishing and fishery related activities such as fish processing, selling fishery accessories and repairing fishing gear. Many types of fishing methods such as gillnet fishery, longline fishery and trawling are carried out and among those, trawling was the dominant practice for shrimp fishery. Shrimp has a special significance being one of the major seafood export items of Sri Lanka.

The operation of coastal trawling with traditional fishing gears has been practiced for nearly 100 years in Sri Lanka. In later decades, the shrimp trawling fishery was restricted to small pelagic shrimp trawling (Jayawardane *et al.*, 2004). Shrimp trawling fishery has been conducted using wooden mechanized multi-day boats (3.5 tons boats operated for a minimum of four days) from Kuthiraimalai point, 20-28 km from Kalpitiya and landed in Kalpitiya harbour.

Jayakody and Costa (1986) noted that in shrimping activities, large quantities of small fish and other marine organisms are also captured as the 'by-catch'. Recently, King (2007) noted that these non-target organisms could be divided into: those species that have some commercial value (referred as by-product) and those species that are unwanted (referred to as by-catch). In this paper, however, we have used the word 'by-catch' to refer to all the fish species caught other than the shrimps (non-targeted species) in shrimp trawl fishery. Jayakody and Costa (1986) reported a shrimp to by-catch ratio of 1.3:1 in Negombo and 1:1.8 in Chilaw landing sites. Communications with fish traders in Kalpitiya, revealed that the value of the by-catch is approximately half the value of the shrimp and that the high percentage of trash fish in the catch is a major problem in the prawn fishery.

The annual by-catch in Sri Lanka has been calculated to be approximately 30,000 t (Jayakody and Costa, 1986). It shows variation in both quantity and species composition with respect to the season, geography, water current, catching time of the day, monsoon, behavioural pattern of fish and shrimp and the environmental temperature (Jayawardana *et al.*, 2004). By-catch mainly consists of *Leiognathus spp.* (pony fishes) (50%), *Arius spp.* (sea cat fishes) (15.56%), puffer fish (20%), cuttle fish (2.22%), crustaceans

(5.56%), skates, carangids, clams, mullet, *Caranx spp.* and Travelly in minor quantities (Gamaachchige *et al.*, 2006). Jayakody and Costa (1986) reported that 60-70% of total by-catch of shrimp trawl fishery consists of *Leiognathus spledens*, *Leiognathus fasciatus*, *Opisthopterus tardoore* and *Nemipterus japonicus* with a seasonal variation of the composition.

In the past, the fish by-catch which is of low value was used for the production of salted fish, dried fish or fish meal (Jayakody and Costa, 1986). In recent times, people have consumed approximately half of the total by-catch as fresh fish and the rest have been used for making dried fish, fishmeal and poultry feed. The by-catch of shrimp trawling fishery in Kalpitiya, therefore, forms a significant part of the income of fishermen (personal communication with fishermen).

The major portion of the by-catch in shrimp trawl fishery in Kalpitiya is used for the production of dried fish. After grading the fish in the by-catch, fresh fish is sold directly to the market or for the production of dried fish while the body parts of fish as well as the damaged fish are used for the production of animal feed. Larger fish of better quality including pony fishes, travelly and mullets that are well-preserved in ice are sent immediately to the market to be sold to the consumer as fresh fish. The balance fish, including species such as sea cat and skates which are pre-iced in plastic barrels, as well as the smaller sized pony fish which are pre-salted in barrels, are generally used for dried fish production. Evisceration is not practiced for smaller varieties. It was noted that the use of harbour water for washing, adversely affects the quality of the dried fish that is produced. After noting these current practices, it was decided to carry out a systematic study to identify the drawbacks in handling of shrimp by-catch that have led to the problems faced by the dried fish producers. This would form the basis for the recommendations to improve the handling and processing practices and to overcome the problems of microbiological, physical and chemical quality losses.

Materials and Methods

A pre-tested questionnaire was used to gather information from the population which has been involved in handling and processing of prawn fishery by-catch at the Kalpitiya landing site in the North Western Province. The sample comprised of seventeen operators who have been involved in shrimp trawling in Kalpitiya. Those surveyed included the total population in the district, namely: the boat owners of trawl fishery, the dry fish producers, the skippers and the buyers of landed fish. In most instances, the same person was involved in all of the different operations. The survey was conducted during a period of four months from July to October 2006. Information gathered through the questionnaire included: by-catch composition, post-harvest processing methods of by-catch, existing facilities for handling and processing of the by-catch, drawbacks indicated by respondents and suggestions for improvements made by respondents.

Personal information in relation to experience in fishery, income level and educational level were also collected from the respondents.

Microbial analysis

Microbiological analysis was carried out to check the quality of the landed fresh fish, dried fish, and the harbour water which is used to wash the fish during the dried fish production. Fish and dried fish were analyzed for the microbiological quality by the Standard Plate Count (SPC), coliforms, faecal coliforms, *E. coli* and *Salmonella* using SLSI microbiological test methods (SLS standards, Standard microbial analysis). Harbour water which is used for washing the fish holds of the boats and fish, was also subjected to the microbial analysis using SPC and *E. coli* test method.

Landed fish, dried fish from the Kalpitiya area and harbour water samples were collected weekly for the analysis. Fresh fish samples and dried fish samples were aseptically collected in sterile bags and placed in well iced regifoam boxes and the water samples were collected using sterile bottles and placed in ice boxes. The collected samples were transported to the Microbiological Laboratory, within 5-6 hours. In the laboratory, the samples (fish and water) were kept in a refrigerator until the analysis was carried out. Microbial analysis was performed within 24 hours from the time of sample collection. All samples were analyzed according the methods described in the SLS standards.

Results and Discussion

Shrimp trawl fishery in Kalpitiya has been in operation for more than three decades and contributes significantly to the Sri Lankan economy by earning considerable amounts of foreign exchange. The by-catch of the shrimp trawl fishery makes a significant contribution to the local economy, being consumed as fresh fish or converted to dry fish or animal feed.

Fig. 1 illustrates the composition of the by-catch from shrimp trawl fishery during the period of July to October 2006. The average percentage was calculated on a weight basis from different boats. The predominant species in the by-catch were Pony fishes (*Leiognathus* spp.) (57%) followed by Sea cat (*Arius* spp.) (27%). Gamachchige *et al.*, (2006) also found Pony fish as the predominant species in shrimp by catch (54%).

The quality of fish landed in Kalpitiya is poor, with a high percentage of quantitative and qualitative losses. A high post-harvest loss of around 30-40 % of the catch can be seen especially in multi-day boat operations. This may be attributed to very limited facilities for chilling or refrigeration with poor insulation of fish holds leading to rapid melting of the ice. This substandard quality fish in the catch, as a result of inappropriate temperature and poor handling, is supplied to dried fish processors at a lower price. The main reasons for the poor fish quality are: firstly, lack or limitation of facilities for fish handling and storage in boats and secondly, a poor or limited awareness of improved fish handling

methods leading to poor post harvest practices. The result of the qualitative loss of fish has serious implications, since in the export trade quality of raw materials is of prime importance. It is also apparent that a large proportion of valuable fish which may be otherwise available for human consumption is instead used for animal feed production due to shortcomings in the quality. These problems may be easily rectified by providing proper facilities and by building up awareness in the industry.

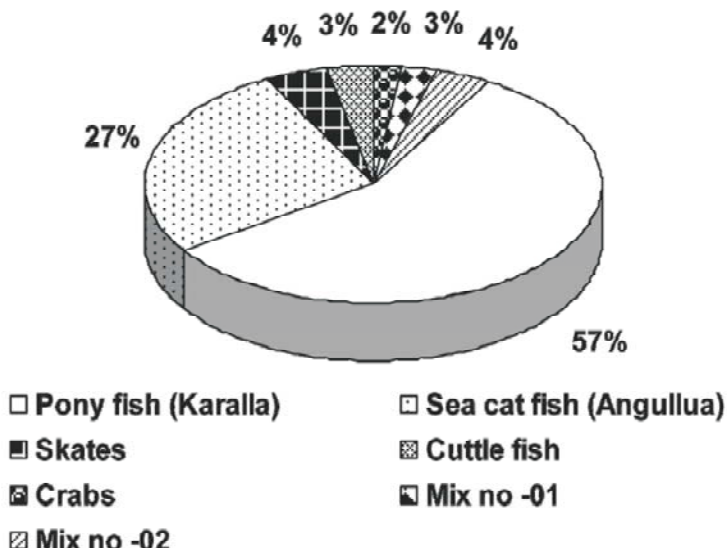


Fig. 1. By-catch composition of shrimp trawl fishery in Kalpitiya from July to October 2006 (Mix No.01 & Mix No.02: mixture of different fish species)

The responses to the questionnaire relating to the condition of infrastructure facilities available at the Kalpitiya harbour in relation to quality maintenance of fresh fish are summarized in Fig. 2. It was evident that 82% of the people involved in the industry are not satisfied with the available facilities. The highest percentage of respondents (47%) stated that potable water (fresh water, according to the SLS standard) is not available at the required quality standards. Harbour water which is not suitable for washing fish is also commonly used to wash the containers that hold the fish (with or without ice) thereby resulting in contamination and problems of quality and safety.

Most of the standard facilities required such as a good landing jetty, ice boxes and cold rooms are not adequate at the site. Among the respondents, 41% indicated that the landing jetty is not in a good condition and unclean cement floors are used for landing the by-catch, while 53% stated that trolleys are not in a good condition. Moreover, 35% and 53% respectively are in the view that ice boxes and cold rooms in boats are not satisfactory. As a result, instead of cold rooms, plastic barrels and regifoam boxes commonly with insufficient ice, are used to preserve fish.

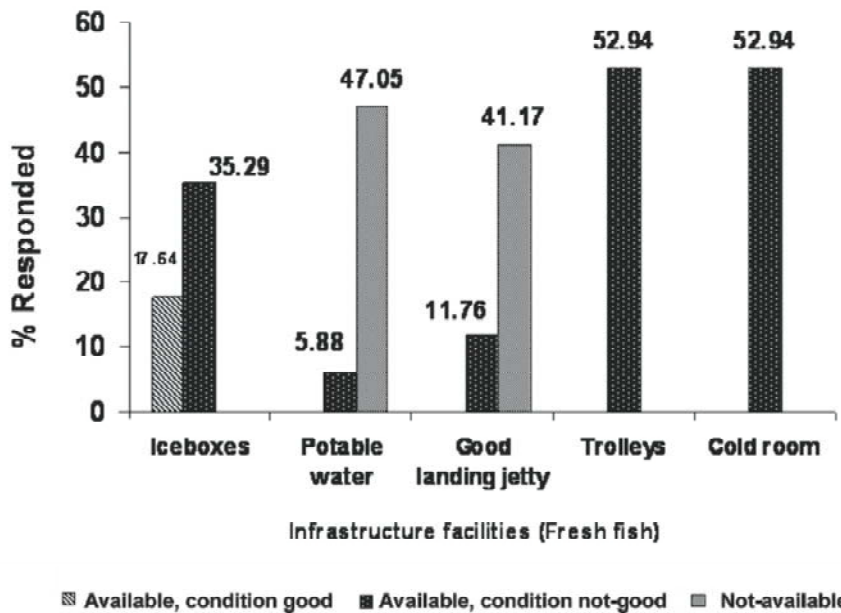


Fig. 2. Infrastructure facilities available to maintain quality of fresh fish in the Kalpitiya landing site (Percentage indicates the responses of the target population)

The result of all these shortcomings is that the fishermen are compelled to sell the low quality, partially spoilt and damaged fish to the dry fish processors at a reduced price. Moreover, many of the basic requirements that needed to be followed in the production of quality-dried fish (listed below) are rarely observed in the dried fish producing centers in Kalpitiya.

At dry fish processing centers, the following steps are generally important to get a good quality dried fish product:

- Fish should be sorted out according to the species and size
- Washed using potable water to remove contaminants
- After removing the gut, gills and head (optional), fish should be immersed in salt water for a few hours depending on the size of the fish. The salt water should be prepared with potable water (fresh water, SLS standard).
- Salted fish spread on the racks or shelves should be sun-dried for 3-4 days before they are sent to the retail markets.

The responses of the target group on the situation with regard to infrastructure facilities for dried fish production of trawl by-catches are illustrated in Fig. 3. Of those surveyed, only 23.5% and 17.6%, respectively, stated that good quality salt and covering nets in good condition are available and the majority mentioned that they do not have such

facilities. Nearly 30% of the respondents stated that ice boxes for holding fish and potable water for washing and racks/shelves for drying were not available. Only 17.6% believed that the storage facilities are not available, while 23.5% respondents were not satisfied with the condition of the plastic barrels and tanks used for fish storage.

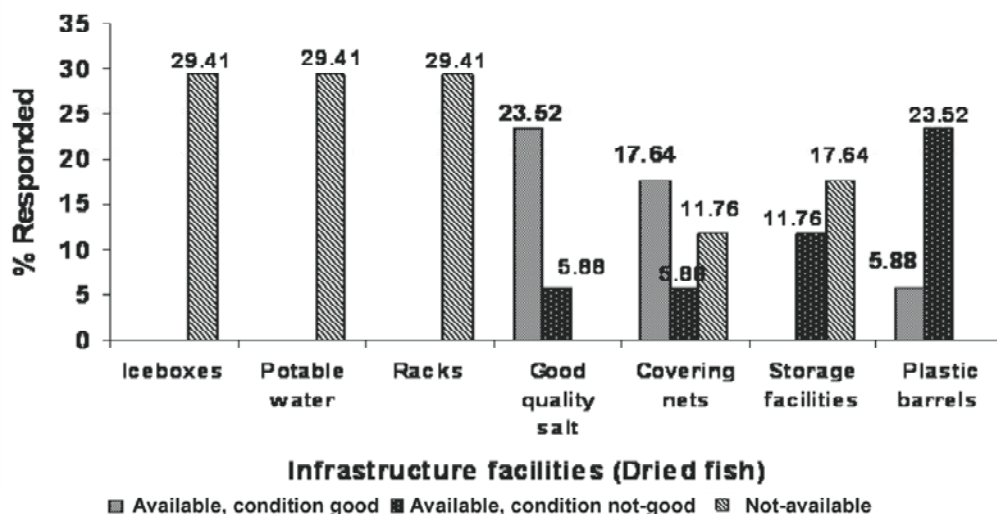


Fig. 3. Responses of dried fish producers on the adequacy of infrastructure facilities for dried fish production (Percentage indicates the responses of the target population)

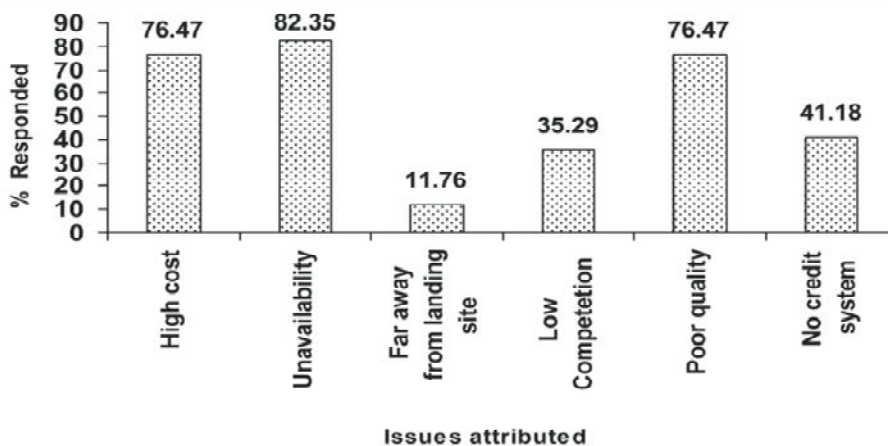
In dried fish production, most of the required infrastructure facilities to obtain the wholesome end product, such as potable water for washing, ice boxes for holding fish in the boat until landing and shelves for drying, are not available at the dry fish processing centers in the Kalpitiya area. Harbour water is used for washing fish used for dried fish production, and this water is not suitable due to high levels of *E. coli* contamination (Table 1). Non-availability of drying racks/shelves could reduce the efficiency of the drying process and the high moisture content in dried fish would lead to quality reduction in the final product. Contaminated water used in the production invariably has a negative impact on the quality of the end product. The net effect of all the limitations prevailing in the area, adversely affect the quality, marketability, shelf-life and the wholesomeness of the product.

Table 1. Standard Plate Counts of both fresh and dried fish of the shrimp trawl fishery by-catch in Kalpitiya

Sampling Day	Fresh Fish	Dried fish	Dried fish	Dried fish
	SPC (1×10^5 CFU/ g)	SPC (1×10^5 CFU/ g)	Coliform MPN/g	Faecal Coliform MPN/g
1	8.73	62.85	8.60	5.50
2	9.29	19.66	46.60	9.50
3	8.91	16.83	8.70	9.00
4	9.25	19.51	24.60	12.00
5	12.17	45.63	10.30	9.30
6	10.90	18.12	16.60	6.50

Note: Fresh fish- International commission on Microbial safety of Food (ICMSF) has noted that fresh fish Standard Plate Count (SPC) should be less than 5×10^5 CFU/g. Sri Lanka Standard Institute (SLSI) states that dried fish Standard Plate Count (SPC) should be less than 1×10^5 CFU /g.

Fig. 4 illustrates the problems relating to the usage of ice in order to maintain the quality of the fish. The major factors identified are: unavailability (82.35%), poor quality (76.47%) and high cost (76.47%) of ice. Lack of a system of credit for purchasing ice was also a problem for a large section of the population (41.18%). These factors limit the usage of ice for holding and utilizing the by-catch when compared to shrimp. Limited usage of ice will no doubt accelerate the deterioration and spoilage rate. The Monopoly in ice production and thus the unavailability of competitors to meet the demand is another major reason for this situation.

**Fig. 4.** Attributed problems during usage of ice as the view of target population (Percentage indicates the responses of the target population)

Reasons for the quality reduction of fish and fishery products, which were stated by the target population, are shown in Fig. 5. The proportion of respondents identifying the different factors which significantly influence the quality were, limitation of ice availability (76.47%), poor infrastructure facilities (64.71 %), uncertainty in marketing (52.94%), shortage of labour and the low consideration given for the quality of products (47.06%).

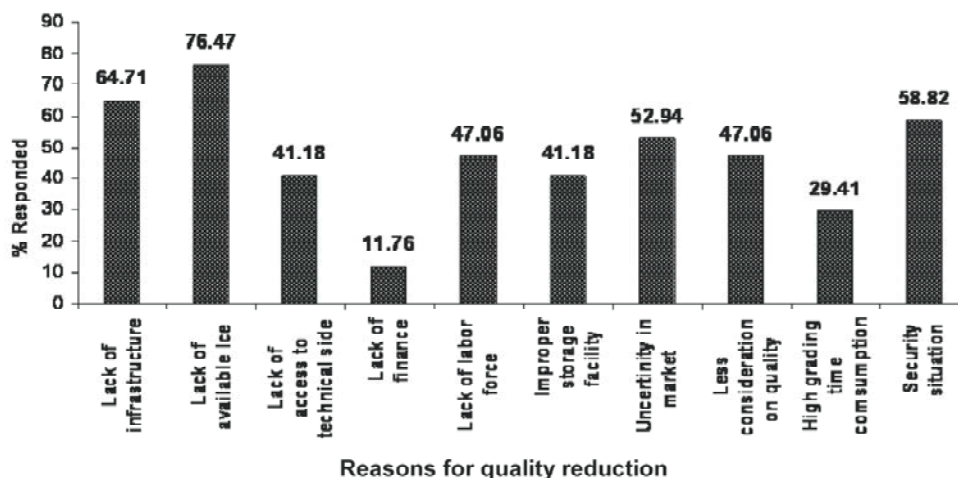


Fig. 5. Major reasons for the quality loss of shrimp trawl fishery by-catch (Percentage indicates the responses of the target population)

Improper marketing channels cause unstable prices, leading in turn to less consideration of quality. The chain effect of market uncertainty causes incapability of using high labour force for the grading purpose leading to delays in processing which has a negative impact on the quality. Due to security situations, harvesting is limited to daytime only. In order to obtain a higher catch and to expedite the process, improper handling methods are commonly practiced. This also has an impact on the loss of quality.

The largest number of respondents (88.24%) suggested that the introduction of new marketing channels would eliminate the quality loss. Apart from that, the improvement of price stability (76.47%), proper awareness programmes (70.59%), reconstruction of boats & cold rooms (64.71 %) and increased access to new technology (58.82%), were recommended by them to overcome the ongoing problems related to handling and processing of shrimp trawl by-catch (Fig. 6).

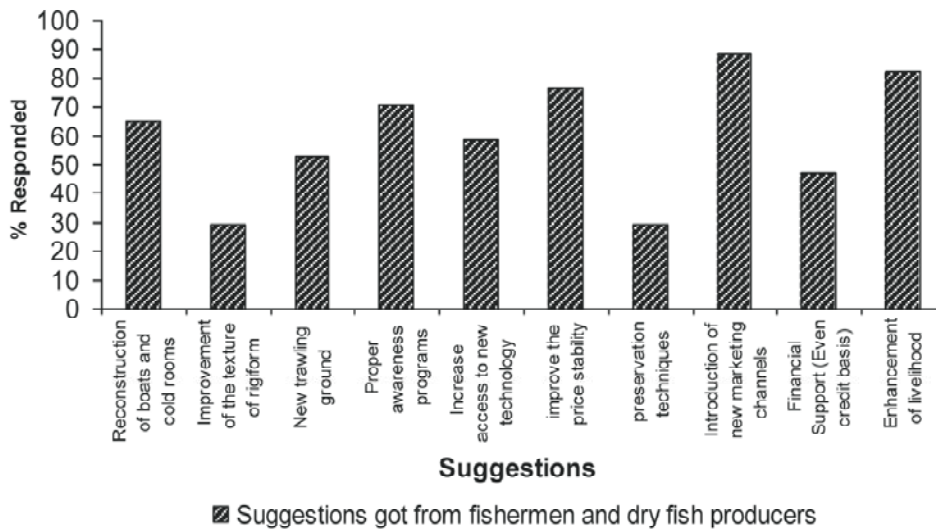


Fig. 6. Suggestions obtained from the target population to overcome the problems of trawl fishery by-catch handling and processing in Kalpitiya (percentages indicate the response of the target population)

They further suggested that the by-catch processing industry could be improved by reconstructing boats and cold rooms, increasing access to new technology, conducting awareness programmes for efficient and correct handling and processing techniques, providing access to credit, and discovery of new trawling grounds. At present, the trawl by-catch industry is not carried out in a sustainable manner. Therefore, it is necessary to educate the people involved in the by-catch handling and processing industry on the quality aspects and factors causing reduction of the by-catch quality.

Average Standard Plate Counts (SPC) of landed fresh fish and dried fish from the production centers were 9.88×10^5 & 30.43×10^5 CFU/g, respectively (Table 1). Bacterial load of both landed fresh fish and dried fish are higher when compared to SLS standards. Microbial quality of fish with respect to SPC, total coliform, faecal coliform and *E. coli* is poor, reflecting the unsatisfactory post harvest handling practices observed. The weaknesses of handling and processing practices of by-catch should be eliminated to obtain good quality end products.

Table 2 shows the SPC and distribution of *E. coli* in harbour water samples. Unavailability of potable water is a major issue, which highly affects the quality of fish. Harbour water is the only source available for washing of fish holds, ice boxes and fish used for dried fish production after the de-gutting process, leading to cross contamination and quality reduction. Availability of potable water should be ensured to obtain safe fish and fishery products from the by-catch of shrimp trawl fishery in Kalpitiya.

Table 2. Microbial parameters of water samples collected from Kalpitiya harbour

Samples	W1	W2	W3	W4	W5	W6
SPC (1×10^6 CFU/ml)	17.81	15.80	16.27	16.10	14.80	15.20
<i>E. coli</i>	+	+	+	+	+	+

Note: • Presence of *E. coli* - (+)
• Absence of *E. coli* - (-)
• Week - (W)

Conclusions

Major shortcomings identified through the survey were lack of availability of ice, lack of infrastructure facilities and potable water, lack of a good landing jetty and racks for drying purposes, uncertainty of market with unstable prices and poor access to improved technologies such as drying techniques and preservation methods. Addressing these identified shortcomings would facilitate the improvement of shrimp trawl by-catch processing industry to a satisfactory level. Following recommendations could be made: (1) conduct awareness programmes based on proper post harvest handling practices of fish (2) improvement of infrastructure facilities mainly potable water and cold rooms in boats (3) implementation of alternative marketing channels such as supermarkets (4) introducing the production of diversified products using by-catch.

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