

Adoption of hygienic practices in selected fish markets along the fish supply chain, in Sri Lanka

^{1,4,*}Edirisinghe, S.K., ²Wickramasinghe, I., ²Wansapala, M.A.J. and ³Warahena, A.S.K.

¹University of Sri Jayewardenapura, Faculty of Graduate Studies, Nugegoda, Sri Lanka

²University of Sri Jayewardenapura, Faculty of Applied Sciences, Department of Food Science and Technology, Nugegoda, Sri Lanka

³University of Vocational Technology, Faculty of Engineering Technology, Department of Manufacturing Technology, No. 100, Kandawala Rd, Ratmalana, Sri Lanka

⁴University of Vocational Technology, Faculty of Industrial Technology, Department of Agriculture and Food Technology, No.100, Kandawala Rd, Ratmalana, Sri Lanka.

Article history:

Received: 5 May 2021

Received in revised form: 8 June 2021

Accepted: 31 July 2021

Available Online: 22 April 2022

Keywords:

Fish markets,
Adoption,
Marketing personnel,
Hygienic practices,
Supply chain

DOI:

[https://doi.org/10.26656/fr.2017.6\(2\).287](https://doi.org/10.26656/fr.2017.6(2).287)

Abstract

Fish and its products are a major part of the human diet because they are rich in high-quality proteins and key nutrients for brain development. Maintaining freshness, quality and hygiene are essential in the supply chain. The purpose of this study was to assess how marketers are adopting hygienic practices in a particular fish market. A random sampling technique was applied to a sample of 100 fish marketing personnel in every five major marketplaces. Semi-structured interview schedule and observation method were used and adequacy index of infrastructure facility, the extent of adoption of hygienic measures and adoption measure for improved marketing practices were detected with descriptive statistics, ANOVA, F test, correlation, and regression by using statistical SPSS 23. Overall availability index in all five markets has shown high infrastructure availability in drainage facility (71.0±0.47%) and electricity supplies (71.0±0.50%), whereas a very less availability index in the washable floor (35.2±0.55%) and ground condition (44.0±0.54%). Among all the nine hygienic practices featured, use of fish landing platform (86.0±0.47%), use of clean polyethylene for a consumer (80.0±0.46%), and use of clean water for washing fish (70.0±0.59%) were adopted by the majority of fish marketing personnel. However, the least attention (less than 50% of the scoring index) related to the adoption practices were observed to have the proper maintenance of waste disposal (31.0±0.43%), ground conditions of approaches and surroundings (34.0±0.54%) and using adequate ice before transportation (47.0±0.46%). The R² value indicated that all the variables together served as cause for 14.4% of the variation in the adoption level. The major constraints among the marketing personnel were found as per the scoring index the improper maintenance (67.0±8.8%), lack of technical guidance (66.0±24.6%) and irregular market structure (65.0±22.4%), while handling of fish. Research showed that educational level may considerably affect maintaining hygienic practices. In order to obtain high-quality products from fish markets, there is an urgent need for continuous training in good personal hygiene for fish marketing personnel. This study recommends that appropriate mechanisms with the introduction of a grading system be adopted to implement and monitor measures of hygiene practices of fish markets.

1. Introduction

Fishery production is enormous, has exceptional economic value, and significantly increases international trade. Fish and its products are rich in high-quality protein, unsaturated fatty acids, vitamins, and minerals. Thus, it is an important source of protein, vitamins, minerals, and omega-3 fatty acids. Fatty acids are

involved in brain development (Spencer *et al.*, 1971; FAO 1998; Coletta *et al.*, 2010; Jinadasa, 2014). As per the FAO (2020) the total global capture fisheries production reached the highest level ever recorded at 96.4 million tonnes in 2018, an increase of 5.4% from the average of the previous three years (Figure 1).

*Corresponding author.

Email: sagarakamal@gmail.com

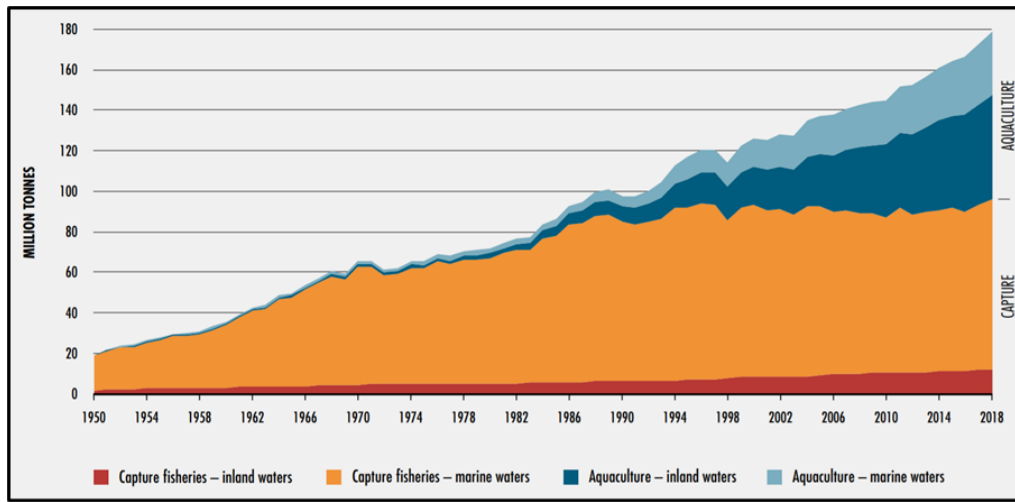


Figure 1. World capture fisheries and aquaculture production 2018. Source: FAO (2020).

Fish and seafood are considered fresh foods that are easily degraded by microorganisms. Their deterioration is mainly caused by bacterial activity, lipid oxidation, autolysis, and hydrolytic enzyme activity. In order to obtain the best fish yield after fishing, fish handling and storage play an important role in minimizing degradation. Therefore, maintaining and monitoring the safety and quality of fish is very important. Freshness is an important element of fish quality classification, and it is also a concern for the industry and consumers. Throughout the cold chain from harvest to consumption, good hygiene and good practices are essential to prevent loss and waste and maintain quality. It is estimated that in fisheries and aquaculture, 35% of world production is lost or wasted each year (Akande and Diei-Ouadi, 2010; FAO, 2020). Besides, the report also pointed out that due to inappropriate loading and unloading operations in domestic and export markets, the total loss and waste of fish in most parts of the world is between 30% and 35% done to the poor quality of fish and fishery products. Venugopal (2002) pointed out that finfish and shellfish are extremely perishable and susceptible to massive disparities in quality due to food and feeding habits of the fish, environmental habitats, species differences, action of autolytic enzymes, and hydrolytic enzymes of microorganisms on the fish muscle. Therefore, proper hygiene must be promoted among marketers to provide safe and high-quality fish and fishery products. Several studies have been conducted to investigate the socio-economic status of fish marketing channels and fish retailers (Sen *et al.*, 2009). Rahman *et al.* (2009) expressed that, if the marketing function cannot be performed effectively due to functional issues (such as poor road conditions, high storage loss, and improper handling), the marketing cost will be high. As per Balasubramaniam *et al.* (2009), post-harvest fishing treatment is the most important step in the production of high-quality finished products. The quality of the fish traded in the market, depends on, the cleanliness of the market, the quality and quantity of the water used the

storage and temperature of the fish, the general treatment methods implemented, and the cleanliness of the cooking utensils used by the consumer. According to Krishnaiah (2011) and Hadi (2020), the fish markets are generally dirty and unhygienic. Slippery floors, unpleasant, and foul odours, fish excrement, improper drainage, the presence of flies and dogs highlight the fish market. Ideal hygiene practices include washing hands before touching food, cleaning, and disinfecting work surfaces and equipment, and disinfection to remove or destroy spoilage and pathogenic microorganisms were recommended (Chorianopoulos *et al.*, 2008). The purpose of these sanitation procedures is to avoid fish contamination and microbial growth. Most of the intermediaries involved in the sale of fish are unaware that they are potential carriers of pathogenic microorganisms, and the poor hygiene of the staff makes fish unsafe for human consumption (Rao *et al.*, 2005). Some of the authors also revealed that technical guidance to maintain hygiene habits is an essential factor (Ali *et al.*, 2014; Shirke *et al.*, 2017; Shirke *et al.*, 2018). High levels of noise and harsh sounds are symbols of the fish market (Alam *et al.*, 2014). Personal hygiene is essential for handling fish. The bodies of fish retailers/operators are still affected by different types of pollutants and have been identified as a source of various bacteria important to public health (Balachandran, 2001; Das *et al.*, 2014). The infrastructure of wholesale and retail fish markets was not adequate regarding sales area, packaging, sanitation, water supply, drainage, cleaning, washing, and maintenance in the supply chain of Indian fish culture (Hussain, 1994; Hossain and Uddin, 1995; Singh *et al.*, 2016). When the marketing function cannot be executed effectively due to functional problems (bad road conditions, storage loss, poor handling and more), the marketing cost will be high (Rahman *et al.*, 2009). Although great efforts have been made to improve various sanitation standards and practices, train and educate food workers, and raise consumer awareness, food-borne diseases are still public health issues. Most

food-borne diseases are caused by poor-quality raw materials, but most can also be the result of improper handling by food processors and retailers (Ismail *et al.*, 2013; Upadhyay *et al.*, 2014). Other reports in many countries (FDA, 2000; FDA, 2009) consider poor personal hygiene to be one of the main risk factors for food poisoning. Strict hygiene during the manufacture of fish products may, therefore, decrease the risk from some pathogens (Huss, 1997).

Therefore, this study aimed to investigate the awareness and adoptions of hygienic fish handling practices by the fish marketing personnel and identify constraints and problems encountered by fish marketing personnel in the adoption of hygienic fish handling practices. It was also anticipated to determine correlation and regression of socio-economic status and adoption level of hygienic practices by fish marketing personnel. A scientific hypothesis is the education level of fish marketers may not affect the maintenance of hygienic practices of the marketplace

2. Materials and methods

Negombo fishery harbour is located on 7°09' N and 79°51'E and it is one of the main fishery harbour and food fish supply locations in the Western province of Sri Lanka (Figure 2), which is placed as the third-highest fish production landing site. The average annual fish supply from Negombo is around 41,000 mt. which is around 20% of the shared total marine fish production. It is a famous fish landing site in the western province of Sri Lanka for both offshore (multiday vessels) and coastal (one-day crafts) fishery operations. Therefore, Negombo based marine fishery supply chain was selected for this study.



Figure 2. Map of the country with Indian Ocean

100 fish marketing persons each were randomly selected from the five sampling areas as shown in Figure 3, which included Negombo fish market, Peliyagoda

wholesale market (Central market), Ragama area of fish market, Kegalle area of the fish market, and Kandy fish market (mid of the country), along the supply chain from Negombo fish landing centre to consumer at the mid of the country. A pre-tested semi-structured interview schedule and observation methods were used for gathering information from the marketing personnel. Along with that, discussions were carried out with wholesalers, middlemen and other stakeholders for more information to support the study. The data was collected from March 2018 to February 2019. The status of the socio-economic factors was observed by using seven criteria *viz.*, age, education, experience, working days per week, quantity handled per day, number of species handled per day, and monthly income. The acceptability index of the infrastructure facility was measured by evaluating ten criteria *viz.*, washable floor, clean water, drainage channel, water disposal facility, clean ground condition, transportation facility, icing facility, hygienic washroom, electricity, and proper shed. It was calculated on a three-point rating scale *viz.*, not adequate, partially adequate, and adequate with the scoring pattern of 1, 2 and 3 respectively. The extent of adoption of hygienic measures was appraised by assessing nine hygienic practices *viz.* use of fish keeping platform, use of clean water for washing fish, sorting of the catch done hygienically in a clean place, Prompt system for waste disposal, using adequate ice before transportation, using clean containers for fish handling, use of clean polyethylene for a consumer, ground conditions of approaches and surroundings environment and maintenance of personal cleanliness. The adoption measure for improving marketing practices by marketing personnel was computed on a three-point rating scale *viz.*, not adequate, partially adequate, and adequate, with the scoring pattern of 1, 2, and 3 respectively.



Figure 3. Selected locations along the fish supply chain from Negombo fishery harbour
Selected locations 1.Negombo (7.2103° N, 79.8313° E), 2. Peliyagoda (6.9682° N, 79.8881° E), 3. Ragama (7.0300° N, 79.9214° E), 4. Kegalle (7.2537° N, 80.3505° E), 5. Kandy (7.2932° N, 80.6348° E)

2.1 Statistical analysis

Statistical analysis for basic characteristics was performed by using descriptive statistics. A one-way ANOVA test was used to evaluate the relationship between hygienic practices and the education level of fish marketers. In addition to that further analyses were interpreted with the test of correlation and regression by using SPSS 23 package.

3. Results and discussion

Potential factors related to the socio-economic status of fish marketing personnel of selected marketplaces are given in Table 1. The overall average age and experience in fish marketing of marketers were found to be 38.1±6.6 and 25.3±6.6 years respectively. Based on that age and experience, indicated that the majority of marketing personnel were of the middle age group and engaged in fish marketing from a very young age. The Negombo fish market is found to have higher average age and experience of fish marketing (47.5±7.1 and 32.5±7.2 years) than the other four marketing places Peliyagoda central market (37.0±4.7 and 19.0±7.2 years), Ragama (32.0±6.2 and 19.5±6.9 years), Kegalle (40.0±9.2 and 24.0±5.1 years) and Kandy (34.0±6.0 and 31.5±6.7 years). The status of education among the marketing personnel was indicated (based on the five-point scale) with an average education level up to Ordinary Level (1.4), which is very poor. The fish market belonging to the Ragama area is observed to be having a considerably high average education (1.6) followed by Peliyagoda central fish market (1.5). The results showed that the lowest education level was reported from Negombo (1.15). The average monthly income among the marketers was recorded as LKR 412,332.00 (US\$ 2,290). The highest income was perceived from Negombo and Peliyagoda as LKR 428,472.00 (US\$ 2,380) and LKR

412,280.00 (US\$ 2,290) respectively, whereas the lowest income LKR 386,712.00 (US\$ 2,148) was observed from the Kegalle fish market. The fish market belonging to the Kegalle area was noticed to be having the lowest average monthly income as LKR 386,712.00 (US\$ 2,148). The average number of working days for all marketing personnel per week was 6.0±0.32 days. The details regarding the species handled in the markets revealed a very lesser number (eleven) of species from Kegalle and the highest number (twenty-two) from Peliyagoda central market. The frequency of fish collection was found to be six times on a weekly average whereas the average quantity handled by fish marketing personnel is 46.34 kg in a day.

The 'F' value shows a significant difference among the marketing personnel of the five selected markets for the variable studied *viz.* age, education, experience, working days, quantity handled, species handled, and monthly income. The analyses of infrastructure facilities for the market studied are contained in Table 2. The highest availability index (range 0-100%) was found in Peliyagoda Central fish market (75.0±0.48%) followed by Ragama (64.50±14.85%), Negombo (50.0±0.51%), Kandy (45.0±0.48%) and Kegalle (35.0±0.48%) with the overall availability index for all the five market areas being 54.0±0.51%.

The observed value shows that there was a lack of infrastructure facilities in all five market areas. The availability index showed the need for the establishment or improvement of the infrastructure facilities available in all the five markets studied. Overall availability index in all five markets showed high infrastructure availability in the drainage system and electricity supply (71.0±0.47% and 71.0±0.50%), but moderate availability index in proper shed (68.0±0.55%), waste disposal system (67.0±0.48%), transportation facility

Table 1. Socio-economic status of fish marketing personnel of along the marine fish supply chain (from Negombo to Kandy) (n = 100)

Variable	Negombo (N = 20)	Peliyagoda (N = 20)	Ragama (N = 20)	Kegalle (N = 20)	Kandy (N = 20)	Overall mean ±std	F value P value
Age (years)	47.5±7.1	37.0±4.7	32.0±6.2	40.0±9.2	34.0±6.0	38.1±6.6	19.878** 0.000
Education	1.15±0.36	1.50±0.51	1.60±0.68	1.40±0.50	1.35±0.59	1.4±0.53	21.882** 0.000
Experience (years)	32.5±7.2	19.0±7.2	19.5±6.9	24.0±5.1	31.5±6.7	25.3±6.6	9.344** 0.003
Working days/week	5.90±0.45	6.10±0.31	6.10±0.64	6.06±0.22	6.00±0.00	6.0±0.32	6.03* 0.002
Quantity handle/day	54.10±5.95	53.75±5.87	45.30±4.71	39.30±2.94	39.25±4.24	46.34±4.74	41.549* 0.000
No. of species handle	19.0±2.4	21.9±2.4	16.1±1.6	11.5±2.6	13.0±1.9	16.3±2.18	7.587** 0.007
Monthly income (SLR)	428,472.00 ±47,164.35	428,280.00 ±46,810.33	413,136.00 ±42,990.96	386,712.00 ±28,927.10	405,060.00 ±43,768.05	412,332.00 ±41,932.15	12.034** 0.001

*Significant at 0.01 level, **Significant at 0.05 level.

Table 2. Availability index of infrastructure facility in different fish markets (Percentage)

Variable	Negombo (N = 20)	Peliyagoda (N = 20)	Ragama (N = 20)	Kegalle (N = 20)	Kandy (N = 20)	Overall Index mean \pm std	F value P value
Washable floor	40.0 \pm 0.50	75.0 \pm 0.44	15.0 \pm 0.64	35.0 \pm 0.49	11.0 \pm 0.67	35.2 \pm 0.55	0.955 0.331 83.538
Clean water facility	55.0 \pm 0.51	75.0 \pm 0.44	50.0 \pm 0.68	25.0 \pm 0.44	65.0 \pm 0.73	54.0 \pm 0.56	0.000 35.283
Drainage facility	85.0 \pm 0.51	95.0 \pm 0.36	75.0 \pm 0.44	35.0 \pm 0.48	65.0 \pm 0.57	71.0 \pm 0.47	0.000 48.358
Waste disposal system	65.0 \pm 0.48	90.0 \pm 0.44	45.0 \pm 0.51	55.0 \pm 0.51	80.0 \pm 0.48	67.0 \pm 0.48	0.000 4.377
Ground condition	20.0 \pm 0.41	65.0 \pm 0.75	55.0 \pm 0.60	25.0 \pm 0.44	55.0 \pm 0.51	44.0 \pm 0.54	0.039 6.804
Transport facility	65.0 \pm 0.48	95.0 \pm 0.50	75.0 \pm 0.48	55.0 \pm 0.64	40.0 \pm 0.50	66.0 \pm 0.52	0.011 14.293
Icing facility	95.0 \pm 0.51	95.0 \pm 0.48	40.0 \pm 0.50	20.0 \pm 0.41	15.0 \pm 0.22	53.0 \pm 0.42	0.000 10.567
Hygienic toilet facility	70.0 \pm 0.52	85.0 \pm 0.41	35.0 \pm 0.48	25.0 \pm 0.44	85.0 \pm 0.52	60.0 \pm 0.47	0.002 41.175
Electricity facility	85.0 \pm 0.47	95.0 \pm 0.30	65.0 \pm 0.50	55.0 \pm 0.51	55.0 \pm 0.71	71.0 \pm 0.50	0.000 0.087
Proper shed	70.0 \pm 0.36	95.0 \pm 0.36	65.0 \pm 0.48	55.0 \pm 0.85	55.0 \pm 0.71	68.0 \pm 0.55	0.769 0.107
Overall facility index	50.0 \pm 0.51	75.0 \pm 0.48	65.0 \pm 0.60	35.0 \pm 0.48	45.0 \pm 0.48	54.0 \pm 0.51	0.744

(66.0 \pm 0.52%), hygienic toilet facility (60.0 \pm 0.47%). A very less availability index was reported in the washable floor of the sales area (35.2 \pm 0.55%), the ground condition of the market area (44.0 \pm 0.54%). Among all five markets, the Peliyagoda central fish markets are positioned to be having developed infrastructure facilities followed by Negombo and Kandy fish market. Ground condition of the Negombo fish market was indicated as the poorest place (20.0 \pm 0.41%) among other areas including damaged floors with stagnant muddy water, damaged shed covers, corrosive structures of sheading areas, and improper unsafe wiring walls. Kandy and Kegalle market areas were observed to be providing very poor icing facilities featured as (15.0 \pm 0.22%) and (20.0 \pm 0.41%) respectively.

The 'F' value displays a significant difference among the five selected market areas for the variable studied *viz.* clean water facility, drainage facility, waste disposal system, ground condition, transport facility, icing facility, hygienic toilet facility, and electricity facility.

The extent of the adoption of hygienic practices among all the marketing personnel of the selected fish markets is featured in Table 3. The overall awareness index related to hygienic practices was calculated as (47.0 \pm 0.46%) for all the live fish markets.

Among those practices such as the use of a fish landing platform (86.0 \pm 0.47%), the use of clean polyethylene for a consumer (80.0 \pm 0.46%), and the use of clean water for washing fish (70.0 \pm 0.59%) was found adopted by the majority of fish marketing personnel. The

practices such as following appropriate guidance for waste disposal (31.0 \pm 0.43%), suitable ground conditions of approaches and surroundings environment (34.0 \pm 0.54%), and using adequate ice before transportation (47.0 \pm 0.46%) was expressed to have very little adoption. Among all the five markets, the extent of adoption was found high in the Ragama fish market area (65.0 \pm 0.48%) followed by Peliyagoda central fish market (60.0 \pm 0.50%). The extent of adoption was observed lowest in the Kegalle fish market area (35.0 \pm 0.45%). The 'F' value indicates the significant difference in the adoption of hygienic practices *viz.*, washing of fish with clean water, sorting of the catch done hygienically in a clean place, following measure for waste disposal, use of adequate ice before transportation, use of clean containers for fish handling, use of clean polyethylene for a consumer, ground conditions of approaches and surroundings environment, and maintenance of personal cleanliness. Kegalle fish market area. Ground conditions of approaches and surroundings environment in all five market areas were observed that poor adoption hygienic conditions. It may potential to possibilities contamination, quality deterioration, and health risk.

The establishment of the proper waste disposal mechanism, the cold storage facility is essential. Among the marketing personnel, a variable such as age, experience, quantity handled per day, number of species handled and monthly income were found to have a negative correlation with adoption scores. However, the education level of marketing personnel and working day per week in the fish markets was found to have a positive

Table 3. Extent of adoption of hygienic practices among different fish marketing personnel (Percentage)

Variable	Negombo (N = 20)	Peliyagoda (N = 20)	Ragama (N = 20)	Kegalle (N = 20)	Kandy (N = 20)	Overall Index mean \pm std	F value P value
Use of fish keeping platform	80.0 \pm 0.41	95.0 \pm 0.44	80.0 \pm 0.44	85.0 \pm 0.32	90.0 \pm 0.72	86.0 \pm 0.47	3.256 0.074
Use of clean water for washing fish	55.0 \pm 0.58	75.0 \pm 0.44	65.0 \pm 0.60	70.0 \pm 0.62	85.0 \pm 0.72	70.0 \pm 0.59	10.131 0.002
Sorting of the catch done hygienically in a clean place	70.0 \pm 0.62	65.0 \pm 0.51	80.0 \pm 0.45	70.0 \pm 0.62	35.0 \pm 0.44	64.0 \pm 0.52	26.271 0.00
Follow appropriate for waste disposal	40.0 \pm 0.51	40.0 \pm 0.31	35.0 \pm 0.50	15.0 \pm 0.37	25.0 \pm 0.44	31.0 \pm 0.43	37.756 0.000
Using adequate ice before transportation	70.0 \pm 0.47	90.0 \pm 0.68	25.0 \pm 0.44	15.0 \pm 0.22	35.0 \pm 0.49	47.0 \pm 0.46	86.629 0.000
Using clean containers for fish handling	60.0 \pm 0.77	90.0 \pm 0.62	55.0 \pm 0.62	55.0 \pm 0.51	70.0 \pm 0.47	66.0 \pm 0.60	41.571 0.000
use of clean polyethene for a consumer	85.0 \pm 0.67	85.0 \pm 0.36	80.0 \pm 0.41	70.0 \pm 0.48	80.0 \pm 0.41	80.0 \pm 0.46	11.597 0.001
Ground conditions of approaches and surroundings environment	25.0 \pm 0.44	40.0 \pm 0.50	45.0 \pm 0.51	30.0 \pm 0.47	30.0 \pm 0.80	34.0 \pm 0.54	41.683 0.000
maintenance of personnel cleanliness	65.0 \pm 0.81	85.0 \pm 0.37	70.0 \pm 0.52	50.0 \pm 0.71	45.0 \pm 0.45	63.0 \pm 0.57	24.611 0.000
Overall awareness index	30.0 \pm 0.47	60.0 \pm 0.50	65.0 \pm 0.48	35.0 \pm 0.45	45.0 \pm 0.40	47.0 \pm 0.46	12.273 0.001

Table 4. Correlation and Regression Analysis between the socio economic variables and adoption scores among the marketing personnel (n = 100)

Variable	Correlation coefficient "r"	Regression coefficient "b"	SE of "b"	t
Age (years)	-0.270**	-0.238	0.103	-2.307
Education	0.230**	0.144	0.114	1.267
Experience (years)	-0.123**	0.166	0.112	1.482
Working days/week	0.070	0.122	0.125	0.977
Quantity handle/day	-0.139	-0.015	0.017	-0.859
No.of species handle	-0.093	0.010	0.018	0.572
Monthly income (SLR)	-0.055	Negligible	0.000	0.814

**Significant at the 0.01 level (2-tailed). *Significant at the 0.05 level (2-tailed). $R^2 = 0.144$

relationship which indicated that when the score improves, the adoption scores also increase. The R^2 value indicates that all the variables together served as cause for 14.4% of the variation in the adoption level (in Table 4). The constraints and problems encountered by the fish marketing personnel are in the adoption of hygienic fish handling practices are described in Table 5. The major constraints responded by the marketing personnel are improper maintenance (67.0%) followed by the lack of technical guidance (66.0%), irregular market structure (65.0%), and lack of cold storage facility (59.0). Overall average major constraints and problems were solved up to now 52.5% of all five marketplaces. The areas of the Kandy and Kegalle marketplaces have expressed more constraints, such as lack of storage facility, lack of technical guidance, unavailability to purchase ice adequate amount, and improper maintenance than the other places. Concerning the total values of constraints, most of the factors were recorded higher than 50% except the constrain of lack of fish handling facilities (43.0 \pm 23.0) at the market.

Table 6 shows the evaluation between identified factors related to hygienic practices and the education level of fish marketers. As per the ANOVA results the education level was significantly affected with five factors such as usage of fish keeping platform ($p = 0.006$), sorting of catch done hygienically in a clean place ($p = 0.015$), use of clean polyethylene for a consumer ($p = 0.000$), maintaining good approaches of the surrounding environment of fish stall ($p = 0.000$), and maintenance of personal cleanliness ($p = 0.019$). Compared with the mean values of educational level for the overall index, the Ordinary level (2.02 \pm 0.38) is higher than the primary level of education (1.80 \pm 0.53). The overall index of the hygienic practices may greatly affect ($p = 0.021$) the educational level of the fish marketers. Based on the summary results of Table 6, the null hypothesis like "educational level of fish marketers may not affect the maintenance of hygienic practices of the marketplace" was rejected.

4. Conclusion

Table 5. Constraints/problems apparent by the fish marketing personnel in adoption of hygienic fish handling

Constraints/problem	Negombo (%)	Peliyagoda (%)	Ragama (%)	Kegalle (%)	Kandy (%)	Total (%)
Lack of cold storage facility	25.0	10.0	85.0	90.0	85.0	59.0±32.7
Lack of technical guidance	40.0	30.0	80.0	90.0	90.0	66.0±24.6
Insufficient space in marketplace	65.0	20.0	45.0	70.0	55.0	51.0±16.9
Lack of fish handling facilities at market	15.0	15.0	45.0	65.0	75.0	43.0±23.7
Irregular market structure	65.0	20.0	80.0	75.0	85.0	65.0±22.4
Unavailability to purchase ice adequately	15.0	10.0	60.0	85.0	90.0	52.0±32.3
Improper maintenance	55.0	60.0	65.0	75.0	80.0	67.0±8.8
Average value	40.0±19.8	23.6±15.6	65.7±14.9	78.5±8.8	80.0±11.0	57.5±13.1

Table 6. Factors related to hygienic practices against the level of education in fish vendors

No.	Variable	Edu level Mean value		ANOVA	
		Primary	OL	F	Sig. at the 0.05 level
01	Use of fish keeping platform	1.61±0.64	1.92±0.45	7.916	0.006
02	Use of clean water for washing fish	1.98±0.47	2.02±0.48	0.179	0.674
03	Sorting of the catch is done hygienically in a clean place	1.76±0.47	1.96±0.29	6.136	0.015
04	Follow appropriate for waste disposal	1.41±0.61	1.20±0.46	3.731	0.056
05	Using adequate ice before transportation	1.98±0.65	1.78±0.62	2.602	0.110
06	Using clean containers for fish handling	2.06±0.61	2.20±0.41	1.929	0.168
07	use of clean polyethylene for a consumer	2.31±0.90	3.00±0.00	28.146	0.000
08	Ground conditions of approaches and surroundings environment	1.55±0.50	1.88±0.33	14.773	0.000
09	Maintenance of personnel cleanliness	1.53±0.50	1.76±0.43	5.731	0.019
10	Overall awareness index	1.80±0.53	2.02±0.38	5.461	0.021

The quality of seafood depends on various factors. Maintaining good hygiene and specific environmental hygiene is very important for high-quality and safe seafood. The education level of the marketing personnel was found to have an essential component to the adoption of good hygienic practices, not only that adequate infrastructure facilities have to be provided among the fish markets. This study revealed that the fish market, which has been established in the suburb areas and mid-country were fulfilled the waste disposal mechanism, adequate supply of ice, cold storage facility and space allocation. Furthermore, the marketing personnel were not adhering to following good hygienic practices in most of the places. Therefore, the establishment and continuation of a proper monitoring mechanism are essential for evaluating the hygienic practices of the retail fish market. Hence, local government bodies such as the Municipal council, and District secretariat, (*pradesiya saba*) need to be concerned about environmental conditions, location, construction when establishing or issuing licenses for fish outlets. Extension agencies can provide innovations and technologies through short-term training programs, technical guidance, and awareness campaigns for the marketing personnel. Introducing a proper mechanism such as a grading system with the scoring index may help to motivate the marketing personnel for the adoption of hygienic practices.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

This research work was supported by the grant, UoVT/EST/1/4/02 University of Vocational Technology, Ratmalana, Sri Lanka.

References

- Akande, B. and Diei-Ouadi, Y. (2010). Post-harvest losses in small-scale fisheries. Food and Agriculture Organization of the United Nations. Retrieved from <https://epub.sub.uni-hamburg.de/epub/volltexte/2011/7069/pdf/i1798e.pdf>
- Alam, M.M., Haque, M.M. and Shikha, F.H. (2014). Studies on public health and hygiene condition of retailers at fish markets in south-central Bangladesh. *Journal of the Bangladesh Agricultural University*, 12(2), 411-418. <https://doi.org/10.3329/jbau.v12i2.28702>
- Ali, M.M., Rahman, M.M., Hossain, M.Y., Rahman, M.Z., Hossen, M.A., Naser, S.A., Islam, R., Subba, B.R., Masood, Z. and Hoque, M.A. (2014). Fish marketing system in southern Bangladesh: Recommendations for efficient marketing. *Our Nature*, 12(1), 28-36. <https://doi.org/10.3126/on.v12i1.12254>

- Balachandran, K.K. (2001) Post-harvest Technology of Fish and Fish Products. New Delhi, India: Daya publishing house,
- Balasubramaniam, S., Jeeva, J.C. and Sreenath, K. (2009). Adoption of hygienic practices in fish landing centres and markets. Retrieved from http://krishi.icar.gov.in/PDF/ICAR_Data_Use_Licence.pdf
- Coletta, J.M., Bell, S.J. and Roman, A.S. (2010). Omega-3 fatty acids and pregnancy. *Reviews in Obstetrics and Gynecology*, 3(4), 163-171.
- Das, A., Kumar, N.R., Debnath, B., Choudhury, T.G. and Mugaonkar, P.H. (2013). Adoption of hygienic practices in fish markets of Tripura. *Fishery Technology*, 50(3), 272-276.
- FAO. (1998). Food quality and safety system – a training manual on food hygiene and hazard analysis and critical control point (HACCP system). Rome: FAO.
- FAO. (2020). World capture fisheries and aquaculture production. Retrieved from [http://www.fao.org/state-of-fisheries-aquaculture#:~:text=In%202018%2C%20total%20global%20capture,three%20years%20\(Figure%201\).](http://www.fao.org/state-of-fisheries-aquaculture#:~:text=In%202018%2C%20total%20global%20capture,three%20years%20(Figure%201).)
- FDA. (2000). Report of the FDA retail food program database of foodborne illness risk factors. US: FDA Retail Food Program Steering Committee
- FDA. (2009). FDA report on the occurrence of foodborne illness risk factors in selected institutional foodservice, restaurant, and retail food store facility types. US: FDA National Retail Food Team Fisheries in Andaman and Nicobar Islands. Retrieved from www.and.nic.in/fisheries/fishweb.htm.
- Hadi, S. (2020). (Peer review + Similarity) Model of Marketing Integration Strategy of Sea Fish through Application of Hygienic. *International Journal on Emerging Technologies*, 11(2), 618-626. <http://repository.unmuhjember.ac.id/id/eprint/5718>
- Hossain, M.M. and Uddin, M.H. (1995). Quality control and marketing of fish and fish product needs for infrastructure and legal support. Paper presented in the National workshop of Fisheries Research Development and Management, 29 October - 10 November. Dacca. Bangladesh.
- Huss, H.H. (1997). Control of indigenous pathogenic bacteria in seafood. *Food Control*, 8(2), 91-98. [https://doi.org/10.1016/S0956-7135\(96\)00079-5](https://doi.org/10.1016/S0956-7135(96)00079-5)
- Hussain, M.S. (1994). Status of backyard pond utilization in some selected areas of Bangladesh. *Bangladesh Journal of Fisheries*, 22(1), 113-118.
- Chorianopoulos, N.G., Giaouris, E.D., Skandamis, P.N., Haroutounian, S.A. and Nychas, G.J. (2008). Disinfectant test against monoculture and mixed-culture biofilms composed of technological, spoilage and pathogenic bacteria: bactericidal effect of essential oil and hydrosol of *Satureja thymbra* and comparison with standard acid-base sanitizers. *Journal of Applied Microbiology*, 104(6), 1586-1596. <https://doi.org/10.1111/j.1365-2672.2007.03694.x>
- Ismail, R., Aviat, F., Michel, V., Le Bayon, I., Gay-Perret, P., Kutnik, M. and Fédérighi, M. (2013). Methods for recovering microorganisms from solid surfaces used in the food industry: a review of the literature. *International Journal of Environmental Research and Public Health*, 10(11), 6169-6183. <https://doi.org/10.3390/ijerph10116169>
- Jinadasa, B.K.K.K. (2014). Determination of quality of marine fishes based on total volatile base nitrogen test (TVB-N). *Nature and Science*, 5(12), 106-111.
- Krishnaiah, P. (2011). Management and Maintenance of Hygienic Fish Market. Government of India, India: Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture.
- Rahman, M.M., Hossain, M.M., Rahman, S.M. and Alam, M.H. (2009). Fish marketing system in Khulna, Bangladesh. *Journal of Innovation and Development Strategy*, 3(5), 27-31.
- Rao, B.M., Jeeva, J.C. and Khasim, D.I. (2005). Palm Impression Technique: a simple tool to popularize good hygiene and sanitation practices among fish handlers. Cochin, India: Society of Fisheries Technologists.
- Sen, A.K., Hasan, M.M., Rahman, M.L., Ahsan, M.E., Islam, S. and Haque, M.R. (2009). Marketing system of fishes and socioeconomic condition of fish retailers in Madaripur town. *Journal of Agroforestry and Environment*, 3(1), 69-72.
- Shirke, S.S., Sukham, M.D., Nashad, M. and Pradeep, H.D. (2017). Assessing the Adoption of Hygienic Fish Handling Practices by Fishermen of South Andaman District of A&N Islands. *Indian Research Journal of Extension Education*, 17(2), 52-56.
- Shirke, S.S., Sukham, M.D., Nashad, M., Pradeep, H.D. and Rahman, M.R. (2018). An overview of adoption of hygienic practices by fish marketing personnel in selected fish markets of Port Blair city, Andaman and Nicobar Islands. *Indian Journal of Economics and Development*, 6, 1-6.
- Singh, Y.J., Santhakumar, R., Pandey, D.K., Bharati, H. and DebRoy, P. (2016). Adoption of hygienic fish handling practices by fishermen. *Indian Research journal of Extension Education*, 12(1), 36-38.
- Spencer, H., Samachson, J., Fowler, J. and Kulka, M.J. (1971). Availability in man of protein and minerals

- from fish protein concentrate. *American Journal of Clinical Nutrition*, 24(3), 311-317. <https://doi.org/10.1093/ajcn/24.3.311>
- Upadhyay, A.D., Pandey, D.K. and Singh, Y.J. (2014). Socio-Economic Determinants of Consumption Pattern of Fish in Urban Area of Tripura. *Economic Affairs*, 59(3), 355. <https://doi.org/10.5958/0976-4666.2014.00004.7>
- Venugopal, V. (2002). Biosensors in fish production and quality control. *Biosensors and Bioelectronics*, 17 (3), 147-157. [https://doi.org/10.1016/S0956-5663\(01\)00180-4](https://doi.org/10.1016/S0956-5663(01)00180-4)