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Status of Fisheries Postharvest Industry in the Sultanate of Oman: Part 2-Quantification of Fresh Fish Losses

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Abstract: Global demand for fish has continued to increase, particularly as urban populations and incomes rise in developing countries. Fresh fish is highly susceptible to rapid deterioration after harvest, particularly under arid tropical conditions which are commonly prevalent in Oman. Losses in product quality (due to downgrading) and quantity (unfit for utilization) represent economic losses to the fishermen, traders and end-users. Efforts to reduce the incidence of postharvest losses must include the quantification of the magnitude of losses and identification of critical control points along the supply chain. In this study, we used a combination of structured interviews, questionnaires and field observations to assess the incidence of postharvest losses among fishermen and fresh fish traders in Oman. Our study showed that considerable losses in value occur at key stages in the supply chain, including landing sites, retail and wholesale. The actual quantity of loss as perceived by respondents depended on fish type, time between catching and landing and market forces. Overall, losses in value per day due to downgrading can range from 11 to 33% of the price of top quality product. Most respondents identified the availability of sufficient quantity of ice for cold storage as a major factor in their ability to reduce the incidence of losses. Processing into *maleh*-a traditional dried spicy fish product, is the most common strategy adopted to reduce wastage in large pelagics (such as tuna). Small pelagic fishes such as sardines are usually stored in ice for up to two days before discarding as waste if there is no market and up to 400 pieces per fisherman per day can be discarded as waste.

Key words: Postharvest losses, fresh fish, value-addition, market forces, sultanate of oman

INTRODUCTION

Fish is an important component of the human nutrition and diet. Marine fish provides high quality, easily absorbable protein and a wide range of minerals, including magnesium, selenium and phosphorous[1]. The FAO[2] calculated that fish provides over 26% in Asia, 22% of animal protein in low-income food deficit countries (including China), 17% in Africa, more than 9% in Europe and over 7% in North Africa and Central Asia.

Worldwide production of aquatic food products has more than doubled since 1970, with a total of approoximately 93.2 million metric tonnes (mmt) in 1997[3]. Similarly, global consumption of fish as food has doubled since 1973 and the developing countries have accounted for more than 90% of this increase. Fish are important source of protein in the human diet, especially in developing countries. They account for over 20% of animal derived protein in low-income food deficit countries, in comparison with 13% in the industrialised countries. Recent FAO[4] estimate showed that the global amount of fish consumed as food increased from 45 mmt to over 90 mmt between 1973 and 1997. During the same period, world per capita consumption of fish as food also grew from 12 kg.year^{-1} to 16 kg.year^{-1}. In 1998, approximately 40% of the value of global fish landing (about 33% by weight) was traded in the international market[5], in comparison with less than 10% for meat[6]. The value of global fish trade in the mid-1990s (including fish meal) amounted to over US$50 billion[7], which represents more than three times the corresponding value a decade earlier, while the whole food and agricultural trade (including fish) only doubled in nominal value terms over the same period[3,4]. Recent projections on global fish

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production and consumption by Delgado *et al.*[3] showed that per capita consumption will rise and fish prices are also expcted to rise between 4-6%, depending on the type. As global fish supply struggles to meet demand over the next 20 years, postharvest technologies which result in waste reduction and value-addition will play essential role in stabilising production and determining the prices of food fish to the consumer.

The Sultanate of Oman is endowed with a long coastline with abundant marine fisheries resources. Historically, the fisheries sector has been a vital source of food and economic activities for a large number of Omanis particularly those living in the coastal areas. Besides direct involvement in fishing operations, the support services related to the fisheries sector such as transportation, preparation and marketing are sources of employment and income to many citizens. Despite the overriding importance of the oil and gas sectors in the national economy, the marine and fisheries sector contributed an average of 0.82% of the GDP during the past Fifth Five-Year (1996-2000) Development Plan[8]. During the same period, the average share of fisheries in non-oil export was 10.18%, with average annual growth of-10.4% during the period. The industry is highly dominated by traditional small-scale fishermen and traders, who account for more than 86% of the total fish landing.

In 2003, a total of 138,485 metric tonnes (mt) of fish was landed by the traditional and industrial fishers, with a total value of 62.86 RO million[9], while 69,009 mt of fish was exported at total value of 52.39 RO million. Figs. 1 and 2 show the relative contributions of the major fish groups to total amount of landings and value in Oman. Clearly, the pelagic groups dominate the Omani fisheries sector in terms of total landing and revenue. The data also shows that while the total landing and value of other group of fish have generally increased during the past decade, both the total quantity landed and value of large pelagics (mainly tuna) have steadily declined. Although preharvest management factors play a crucial role in terms of stock availability and amount of landing, it is apparent that improvements in postharvest handling and marketing will be required to reverse the continuing decline in value of economically important group of fish.

During the past 18 years, there has been a steady increase in the proportion of total fish landing that is exported, although the actual growth rate has fluctuated considerably from-35% in 1996 to 70% in 1988. During the same period, the percentage of total fish landing that is exported increased steadily from 19% in 1986 to 50% in

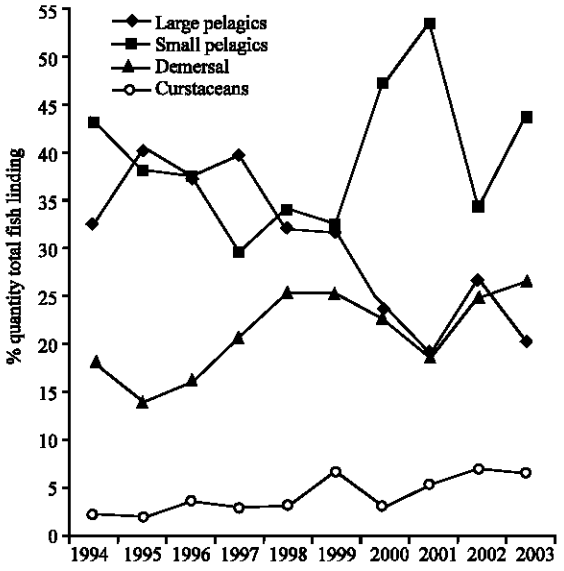

Fig. 1: Contribution of major fish groups to total quantity of traditional fishery landings, 1992-2003

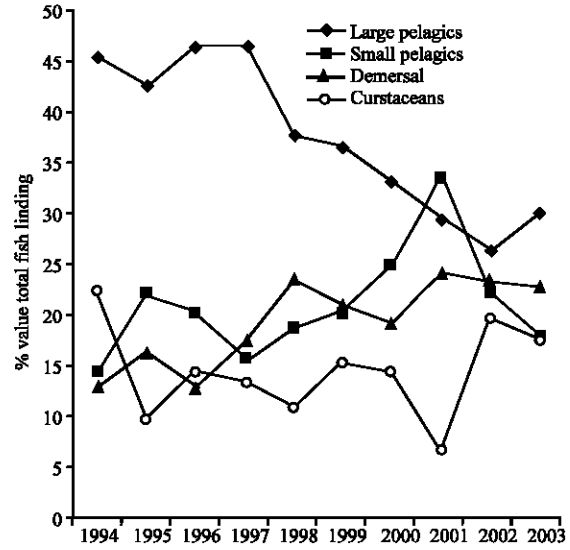

Fig. 2: Contribution of major fish groups to the value of total traditional fishery landings, 1992-2003

2003. The continuing increase in fish export income corroborates the government's growth strategy for the sector as articulated in Vision 2020 to raise its share of the GDP from 1.1% in 1995 to about 2% in 2020[8]. Realisation of this vision for the fisheries sector is dependent on the harvesting, landing and delivery of consistent good quality fish to both the domestic and export market. With continuing growth in population, income and urbanisation in Oman, the Gulf region and globally, consumer theory assures a future demand for good quality fish and other animal products[6,10].

The problem of high incidence of losses has been recognised as a major impediment to the realisation of the government's goal of increasing the contribution of the sector to the overall national economy. The annual loss due to downgrading of fish in Oman has been estimated to be nearly 24 million RO (1 Rial Omani = US$ 2.58)[8]. Although these estimates highlight the potential problem facing the fisheries postharvest sector, there is a dearth of information on the exact magnitude of losses and the steps where they occur in the postharvest system. Such data would be valuable in developing appropriate interventions to mitigate the problem.

In an earlier study, we described the postharvest handling and marketing systems adopted by Omani traditional fishermen and traders[11]. Our studies at fish markets and landing sites also indicated that postharvest losses of fresh fish is prevalent at all steps in the supply chain, thereby reducing the profitability and competitiveness of the Omani fisheries. A recent report by the Ministry of National Economy[8] estimated that the loss in quantity (thrown from commercial fishing ships) ranges between 40-70% for the demersal fishes, 5% for the pelagics and 10% for the traditional sector. The objectives of the present article are to:

- quantify the magnitude of fresh fish postharvest losses in Oman
- identify the major factors contributing to the incidence of losses. Recommendations are also made on appropriate technological and institutional interventions to reduce losses in the fisheries handling and marketing system.

Causes of fresh fish postharvest losses: A mini review: Freshly harvested fish and other marine food products are susceptible to rapid deterioration and quality loss due to a myriad of biophysical, chemical and microbiological factors[12]. Factors contributing to the incidence of postharvest fresh fish spoilage and physical loss include presence of mechanical damage, exposure to high temperatures and action of microbiological agents such as bateria and digestive enzymes inside the fish. The degradative effects of these factors on quality manifest in loss of freshness and eventual spoilage. Affected fish may exhibit several undesirable physico-chemical and microbiological changes including odour and colour. For instance, while good quality fresh fish have clear eyes and red gilt, these features change to sunken eyes and brown gilt, respectively, in bad quality fish. Apart from physical loss (wastage) due to product that is considered unfit for consumption, large amounts of harvested fish are also lost at fishing grounds when fishermen and commercial fishing boats through away all or part of their catch due to several reasons including limited onboard storage or processing capacity and ghost fishing.

MATERIALS AND METHODS

We used a combination of semi-structured interviews, questionnaires and field observations to assess the incidence of postharvest losses among fishermen and fresh fish traders in Oman. Several visits were made to major fish markets and landing sites in Mutrah and Seeb in Muscat Governorate and Barka in Al-Batinah Region, while single visit were made to Sur in Al-Shaqiyah Region and Salalah in Dhofar Governorate to observe the postharvest handling and marketing systems adopted by fishermen and traders.

A questionnaire (Appendix 1) was developed and administered to fishermen and traders in Muttrah and Seeb fish markets and landing sites in Muscat Governorate to assess their perception on the incidence of postharvest fresh fish losses. Completion of each questionnaire was followed by a semi-structured interview to enable the fishermen and traders to explain further their responses in the questionnaire and to provide further insights on the factors contributing to the losses.

A total of over 60 fishermen and traders were interviewed, while 13 fishermen and traders completed the questionnaire on incidence of loss. In practice, over 50 fishermen and traders participated in the completing the questionnaire since each questionnaire was often completed based on the responses provided in by a group of two or more interviewees who worked together or closely associated. Mean data on percentage incidence of fish losses in quantity (physical loss/wastage) and quality (price reduction due to downgrading) as perceived by the fishermen and traders were calculated.

Appendix 1: Questionnaire for estimated fish quantities, prices and losses

No			
1	Marketing system (%)	Wholesale	
		Retail	
2	Average quantity caught/sold (tonnes or kg per week)		
3	Average price per kg		
4	Average period between catch/supply and selling (h or days)		
5	Do you use ice-storage?		☐ Yes ☐ No
6	If No, pls give your reason(s)		
7	Estimated Total Incidence of Wastage (0-100%) (i.e., not utilised)		_____%
8	Perceived main reasons for the incidence of wastage		
9	Estimated Percentage of fish sold at reduced price due to loss in quality (0-100%)		_____%
10	Name the fish species that are most susceptible to postharvest handling losses and wastage	Fish name	Average loss (%)
11	Name the fish species that are least susceptible to postharvest handling losses and wastage	Fish name	Average loss (%)
12	Have you received formal training on techniques and procedures for postharvest handling of fresh fish?		☐ Yes ☐ No
13	List the most important postharvest technologies affecting the quality and losses of your fresh fish (e.g., packaging, availability of ice, chillers, refrigerated transport, availability of market, etc)		
14	Indicate your willingness to attend a training on postharvest handling of fresh fish		☐ Very willing ☐ Moderately willing ☐ Moderately willing
15	Any other comments:		

RESULTS AND DISCUSSION

At both the Muttrah and Seeb markets, fish is sold at the landing site (beach line) and in purpose-built fish markets very close to the landing site. Fishermen may also be wholesalers and/or retailers depending on the quantity of catch. Similarly, fish traders at the landing site and inside the fish markets may be wholesalers or retailers. The other group of wholesalers, often referred to as truckers, sell their products at multiple outlets and across regions while some engage in exports. The present study on incidence of fish losses was based on responses by fishermen and retail traders who sell their products at the landing site or inside the purpose-built fish markets.

Quantity handled and handling interval: The average quantity of large pelagic fish caught and sold by a fisherman or bought by a retailer from the fishermen ranged from 10-190 (average 90) per day in Muttrah and 7-182 (average 60) per day in Seeb. Fish is commonly sold on a per piece basis or visual estimation of the bulk for wholesale and therefore it was difficult to estimate the quantity of small pelagics handled at the landing site and retail market. Fish landing and selling occurs between the end of the early morning prayers *Fagr* (~5:30 am) and mid-day prayers *Dhuhur*. Thus fresh fish may be subjected to a handling period of about 7 h between landing and sale. During this period, some fish may be exposed to direct air temperatures which may range between 25-40°C

depending on the season. The handling interval for small pelagic fish (mainly sardines) at the landing site is about 50% less because these are usually sold direct to retailers and wholesalers immediately after removal from the net.

Cool-chain management: The use of ice is the common method for maintaining a cold-chain during fresh fish handling and marketing in Oman. All the respondents reported that they practice ice-storage to maintain the freshness and extend the storage life of their products. Most traders use ice-flakes instead of ice-blocks for both storage and retail-display. The spray of cold water on fish during retail-display is also commonly practised to maintain product freshness. The preference for ice-flake over ice-block was attributed to its relative ease of handling and optimisation of storage space. Most respondents expressed the strong view that consumers considered frozen fish to lack freshness ('old') and sold at lower price. One fisherman reported that on some occasions, he has thrown away up to 400 pieces of sardines per day because they were not sold.

Incidence of postharvest losses

Physical loss (wastage): Both fishermen and traders reported small incidence of physical loss (wastage) of fresh fish at the landing sites and retail markets. Some fishermen acknowledged throwing away some fish at the fishing ground due to physical injury (from fishing gear or other aquatic species) or spoilage due to extended period between catch and removal from the fishing gear onto the boat. Thus, most losses occur due to downgrading of fresh fish, resulting in loss in value.

For the small pelagic (mainly sardines), the average quantity of fresh fish that is thrown away (not utilized) ranges from 145-1000 pieces (average 515) per day. Based on the prevailing price of sardines (100-200 pieces per Rial Omani) during the study period, the loss in value per fisherman can reach 10.300 RO per day. With a total number of 31,587 traditional fishermen in Oman in 2003 (DG PIP 2003), annual loss in revenue could potentially exceed a quarter million Rials Omani. Small pelagic fishermen reported average sale revenues ranging from 40-50 RO per day. At the sale price range of 100-200 pieces per RO and loss in value of 5.150-10.300- RO per day, this can result in revenue losses ranging from 12.5-20.0%.

Both fishermen and traders reported lower incidence of wastage of the large pelagic compared to the small pelagic. However, some fishermen recalled instances during the peak season when large quantities can be found dumped at the landing sites, presumably due to lack of market. Based on average daily catch or supply of 60 (Seeb) and 90 (Muttrah) pieces of fish (mainly tuna) per day, the reported incidence of physical loss ranged from 0.32-0.63% and 0.48-0.95% at each site, respectively. Such wastage occurs when fish is badly spoilt that it cannot be processed into maleh and this decision is made when salt does not stick on fish.

Downgrading and loss in value: With regard to large pelagic fish, downgrading: through price reduction is limited to 2-3 days when the product is sold fresh. Most fishermen and retailer considered this period to be maximum they could store fresh fish in ice before the onset of deterioration which may be observed externally. Based on the information provided by fishermen and traders during the questionnaire interview, price reductions of 200-500 Baisa per piece per day are quite common when freshly landed fish could not be sold on the same day. This represents a reduction in value of 10-25% and 19-43.75% after one and two days of landing, respectively.

Fish that are not sold within this period are commonly processed into *Maleh* (traditional fish product that is gutted, bled, cleaned and mixed with large quantity of sea-salt for long-term preservation). Depending on the market conditions, each fish may be sold between RO 0.600-2.000, while the price of an equivalent freshly landed fish would sell for RO 1.800-2.000 per piece. Thus, converting unsold (poor quality) fish into *maleh* does not appear to represent an economical loss. This is possibly explained by the small quantity of fish converted into maleh in comparison with the total fish landing in Oman. Based on data provided by one experienced fish trader, we estimated only 2.7-4.4% of his total fresh fish supply may be processed into *maleh* due to lack of market. For many fish traders, preservation fish in salt is one method of reducing losses but the amount of fish preserved appears also to be dependent on the potential market for such products.

CONCLUSION

The marine fisheries sector is important in the national economy of Oman through employment and income generations as well as providing a valuable source of nutrition. Government's effort to diversify the economy relies partly on a five-fold growth in the contribution of the fisheries sector to the national GDP by 2020. To realisation this strategic vision for the fisheries sector, the application of innovative postharvest technology to reduce losses and add-value to fish products is essential.

In this study, we used a combination of structured interviews and questionnaires to assess the incidence of postharvest losses at two landing sites and fish markets in Muscat Governorate. Cool-chain management practices adopted by fishermen and retailers were also examined. Based on our finding, the following conclusions were made:

- The average number of large pelagic fish handled by a small-scale traditional fisherman or retailer was 60-90 pieces per day.
- Ice-flake storage was the common techniques adopted in the industry. Ice-flake was preferred over ice-blocks because of its ease of handling ice-flakes and optimisation of fish storage space. There was strong view in the industry that fish stored in ice-blocks are less preferred by consumers as reflected by a lower price.
- Overall cool-chain management was considered inadequate given that freshly landed fish may be exposed to high air temperatures up 5 hours duration during retail display in unshaded areas. Furthermore, storing fresh fish in ice-flakes during long distance transport requires frequent temperature monitoring and addition of fresh ice flakes.
- The incidence of physical loss (wastage) at the landing sites and retail markets can amount up to 12.5-20.0% of the total revenue of the fisherman or trader for small pelagics. However, physical loss of large pelagics at these sites is negligible, but can range from 0.32-0.95% of the daily catch or supply.
- For large pelagics, downgrading through price reduction is limited to 2-3 days after which the product is discarded or processed into a secondary fish product. Reduction in fish value due to loss of freshness can reach up to 10-25% after the first day of landing 19-43.75% after the second days of landing.
- Large pelagic fish that are not sold within 2-3 days are commonly processed into *Maleh* (traditional fish product that is gutted, bled, cleaned and mixed with large quantity of sea-salt for longterm preservation). The price of *maleh* is comparable to that of freshly landed fish and given the relatively very small quantity of fish that is processed into maleh (2.7-4.4%) in comparison to the total annual landing, this product does not represent a viable economic alternative to fresh fish handling and marketing.

Overall, this study has shown that postharvest handling and marketing losses is a problem in the Omani marine fisheries sector. Further studies are required to quantity the magnitute of losses occuring at other steps in the supply chain from sea to market. Research is also warranted to characterise the effectiveness of the existing marketing centres, including assessment of their postharvest handling infrastructure so that appropriate interventions can be developed and implemented to reduce the high incidence of losses in value occuring in the industry.

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