Research in
AGRICULTURE, LIVESTOCK and FISHERIES
ISSN : P-2409-0603, E-2409-9325
An Open Access Peer Reviewed Journal

Open Access **Res. Agric. Livest. Fish.**
Review Article **Vol. 5, No. 3, December 2018 : 381-390.**

A REVIEW ON DRIED FISH PROCESSING AND MARKETING IN THE COASTAL REGION OF BANGLADESH

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ARTICLE INFO

Received
25 November, 2018

Accepted
17 December, 2018

Online
27 December, 2018

Key words
SSOP
Traditional
Processing
Market
Sun-drying

ABSTRACT

Sun drying of fish is an important method of fish preservation throughout the world. Due to its availability and product specific flavor and texture, dried fish has become an important part in the diet of people living particularly in the coastal region of many Asian countries including Bangladesh. Product type is considerably wide depending on the season, availability of fish, infrastructure and technical know-how of the processors. These are mainly processed from marine fishes that are caught by the artisanal fishermen and marketed throughout the country by multistep marketing channel up to reaching to the consumer. Due to the importance of the product in terms of market volume as well as its major role in the socio-economic condition of millions of people of the country, the sector needs proper attention by appropriate authorities to ensure quality and safety of the product produced and marketed. In this paper, different methods of sun drying practiced traditionally in the coastal region of Bangladesh and associated marketing systems are reviewed. It is expected that training of processors on Sanitation Standard Operating Procedures and monitoring by appropriate government body would be necessary to improve quality and simultaneously ensure safety of sun-dried fish produced in the coastal region of Bangladesh.

To cite this article: Paul P C, M S Reza, M N Islam and M Kamal, 2018. A review on dried fish processing and marketing in the coastal region of Bangladesh. Res. Agric. Livest. Fish. 5 (3): 381-390.

INTRODUCTION

Drying is a commonly accepted method of fish preservation with sun drying being the most widely practiced method throughout the world. It is also one of the world's oldest known preservation methods (Govindan, 1985; Reza et al. 2009; Mansur et al. 2013). Sun drying alone, or in combination with salting, result in products that are highly relished by people who prefer its characteristic flavor, taste and texture (Anon, 2001). They are also regarded as a good source of protein, vitamins and minerals in the diet of people in many parts of the world including Asia and Europe. This is particularly true for the poor for whom it is the most cost-effective animal protein source. It was reported that amino acid composition in dried fish were of higher quality than that of eggs (Srivastava, 1959; Jonsson et al. 2007). Besides these, dried fish has considerably longer shelf life and requires no refrigeration facilities for storage (Immaculate et al. 2013; Reza et al. 2006). Due to these multitude of factors, global resource utilization for processing of dried fish is considerably high, estimated to be 8% of the total world catch (Patterson et al. 2018). Corresponding to this, livelihood activities of millions of fishermen, dried fish producer, wholesalers and retailers are directly connected to processing and marketing of dried fish (Nayeem et al. 2010a; Nath et al. 2013). It is particularly true for people in the marine sector engaged in the capture of fish where they are linked to traditional processing of dried fish (Reza et al. 2005). These activities in sun-dried fish processing and marketing are closely related to fisheries and aquaculture sectors and thereby play important role in employment, livelihood and economic opportunity for millions of people throughout the globe. Among the dried fish producing countries, these activities hold great importance for Bangladesh as more than 17 million people including 1.4 million women depend on fisheries and aquaculture related activities such as fishing, farming, fish handling, and processing (BFTI, 2016; DoF, 2018).

Bangladesh possesses vast aquatic resources in the form of inland waters, rivers, brackish and marine waters and ranks among the top five fish producing countries in the world (FAO, 2016). As per the FAO's latest report in 2018, Bangladesh now holds the 3rd position among freshwater fish producing countries in the world after China and India. Beside the freshwater aquaculture activities, Bangladesh has huge potential in the marine fisheries sector where production is dominated by artisanal fishermen. Over the last couple of years, fish production from marine sector is increasing in Bangladesh, showing a steady growth of above 5% (DoF, 2018). So it is expected that additional workforce in fish catching, handling, transportation, processing and marketing will be involvement in near future. We previously reported that drying of fish using traditional methods is the major fisheries activity in the coastal region, and the overall quality of these products is sometimes not satisfactory (Reza et al. 2005; Paul et al. 2018). It is well known that processing, transportation and marketing stages of these products are essential complementary functions, and women in Bangladesh traditionally have played a major role. In addition, processing and marketing activities have a great potential for employment within the fisheries and aquaculture industry and thereby information on these aspects have been gathered for formulating strategies for improvement. Several studies have previously reported the marketing channel and value chain of marine fishery products of the country (Sabur et al. 1977; Islam et al. 2001; Islam et al. 2006; Nayeem et al. 2010b; Haque et al. 2015; Ahsan, 2016). In this review we summarized the methods employed for dried fish processing and marketing generally practiced in the coastal region of Bangladesh.

Importance of sun-drying of fish in Bangladesh

Traditional sun-drying of fish is an important method of fish preservation in Bangladesh. Generally, the process takes place when fish is exposed to the sun and wind by placing it in trays, on racks, or even on the ground (Bala and Mondol, 2001; Reza et al. 2009). The advantage of drying products directly in open-air is that almost no costs for fuel and appliances have to be spent by the processor. However, the dried products are often of lower quality due to varying temperature levels and contamination of the products with dust, vermin's and leafs (Häuser and Ankila1997; Reza et al. 2006). In many cases good hygiene is not practiced. Still the method of sun-drying is important for Bangladesh because most species of fish can be sun dried, and except for monsoon months, huge sunshine and air flow are available throughout the year that enables sun-

drying everywhere, from the deck of the fishing boat to the roof of the house. The product obtained through the process contains higher nutrition levels compared to fresh fish on unit weight basis and has a special flavour that is highly relished by different ethnic people. Another important feature of dried fish is that if properly stored, the product can maintain quality for up to 3-6 months depending on the packaging and storage conditions (Immaculate et al. 2013; Uddin et al. 2014).

Processing methods of traditionally dried marine fish

Drying of processing of marine fishes has been performed since the time immemorial. Through our previous studies we collected information on the production, marketing and quality loss of traditionally dried marine fish products in the coastal region of Bangladesh. It was revealed that a total of 48 species of fish and shrimp were used to produce sun-dried fish that were mainly used for domestic consumption (Table 1). Among these species *Stromateus chinensis*, *S. cinereus*, *Riksha* sp., *Johinus argentatus*, *Trichiurus haumela*, *Harpodon neherus*, *Lutianus johnii* and *Penaeus* sp. were most common as we reported previously (Paul et al. 2018). Other species included gobies, scads, threadfins, breams, mackerels, soles, herrings and various penaeid, metapenaeid and *Ascetes*-like shrimps (Table 1). This is a substantial number of species used for sun drying as it constitutes approximately 10% of species amongst the 475 fish and shrimp species available in the Bay of Bengal (DoF, 2016). It was previously thought all species of fish and shrimp available in the Bay of Bengal were sun-dried. This is probably an over-estimate as we observed that the sun-dried fish were prepared from the species listed in Table 1 according to our observation and discussion with fishermen, processors and traders during the study. Set-bag nets were mainly used to harvest these pelagic and demersal fishes used as raw material for traditional drying in the coastal areas of Bangladesh (Walker and Greeley, 1991). In addition to this, we observed fish caught using mechanized and non-mechanized boats that were usually a part of artisanal fisheries supplied large share of raw materials for sun-drying.

During the survey, three categories of processing methods were observed to be practiced in the coastal region: sun-drying of large fish, sun-drying of elongated fish and sun-drying of small fish and shrimp (Figure 1). Generally, the large sized fish like threadfins, mackerel and sharks are first gutted, and cut into long strips using a sharp knife in such a way that it keeps connected at the head and the tail. A small piece of bamboo ring was then placed in between the strips and fish was hung from poles. This enables quick drying as surface area was increased. In many cases, the fishes were covered with mosquito nets to keep flies away from the fish. Two widely popular dried fish, viz., ribbon fish and Bombay duck having long, compressed and slender bodies was dried in an interesting fashion. The ribbon fish is tied up at the caudal end in pairs (for larger sized ones) or number ranging from 3-5 (for smaller sized ones) and hung over bamboo bars. In the case of Bombay duck, two fishes are joined together with their lower extended jaws that interlock and hung similarly over bamboo poles. In case of medium to small-sized fishes, they are dried in lots in whole on bamboo-made elevated racks. These include small jewfish, anchovy, shads, sardines, etc.

For all three types of processing, many of the pre-processing activities may or may not be performed. These include grading, dressing, descaling, washing, salt pre-treatment etc. Large-sized fishes are graded, dressed, descaled and sometimes salt pre-treated while small fish and shrimps are sun-dried whole without any pre-treatment. Drying took about 3-5 days depending on weather and surface area of fish to be dried. After completion of drying process, the products are collected from drying yards and taken to the storage room or piled in the drying field for few days. The products were then allowed to cool for a day or two at room temperature and packed either 12 to 20 kg or 25 to 50 kg according to buyer's demand in jute made bags. During the survey, it was observed that the processors used some chemicals in dried products to prevent insect infestation. But they did not want to disclose the type of chemicals used. It was suspected that such chemicals were harmful to human health and could create health hazards. No measures were taken to prevent reabsorption of moisture during storage, transportation and marketing. The packaged products were found to be stored in the rooms of earthen floor at room temperature until marketing.

Table 1. Fish species used for dried fish processing

SL. No.	Local name	English name	Scientific name
1	Rupchanda	Chinese Pomfret	*Stromateus chinensis*
2	Folichanda	Silver Pomfret	*S. cinereus*
3	Lalpoa	Silver jewfish	Johnius argentatus
4	Rupalipoa	Belanger's croaker	*J. belangerii*
5	Kala poa/ bolpoa	Blackspotted croaker	*Protonibea diacanthus*
6	Loijjapoa	Panna croaker	*Panna microdon*
7	Churi	Ribbon fish	*Trichiurus haumela*
8	Riksha fish	Riksha fish	*Riksha sp.*
9	Loittya	Bombay duck	*Harpodon nehereus*
10	Lalchoukya	Red snapper	*Lutianus johnii*
11	NunaBaila	Celebes goby	*Glossogobius celebius*
12	Murguilla	Bartail flathead	*Platycephalus indicus*
13	Gutimurbaila/Gutimach	Rough flathead	*Grammoplites scaber*
14	Futkichapa	Talang queenfish	*Scomberoides commersonianus*
15	Kawyamach	Torpedo scad	*Megalaspis cordyla*
16	Malabar mouri	Malabar trevally	*Carangoides malabaricus*
17	Nilambori	Japanese scad	*Decapterus maruadsi*
18	Pekhom Mouri	Indian threadfish	*Alectis indica*
19	Dhommach	Whipfin silver-biddy	*Gerres filamentosus*
20	Samudrik koi	Tripletail	*Lobotes surinamensis*
21	Rangga koi	John's snapper	*Lutjanus johnii*
22	Lalpansa	Malabar blood snapper	*L. malabaricus*
23	Lowkka	Indian threadfin	*Leptomelanosoma indicum*
24	Topshi	Paradise threadfin	*Polynemus paradiseus*
25	Tailla	Fourfinger threadfin	*Eleutheronema tetradactylum*
26	Datina	Goldlined seabream	*Rhabdosargus sarba*
27	Sadadatina	Silver grunt	*Pomadasys argenteus*
28	Gutidatina/nakkoro	Saddle grunt	*P. maculatus*
29	Surma / Maitta	Indo-Pacific king mackerel	*Scomberomorus guttatus*
30	Bommaitta	Kawakawa	*Euthynnus affinis*
31	Chomppa	Indian mackerel	*Rastrelliger kanagurta*
32	Chapa	Doublespotted queenfish	*Scomberoides lysan*
33	Tulardanddi	Flathead sillago	*Sillaginopsis panijus*
34	Korati chela	Tenpounder	*Elops machnata*
35	Kukurjib/ bashpata	Long tongue sole	*Cynoglossus lingua*
36	Kukurjib / assh sole	Indian tongue sole	*Cynoglossus macrolepidotus*
37	Chowkka / Faissha	Bigeye ilisha	*Ilisha megaloptera*
38	Dati Fasha	Longjaw thryssa	*Thryssa setirostris*
39	Pati Fasha	Dussumier's thryssa	*Thryssa dussumieri*
40	Oluya	Goldspotted grenadier anchovy	*Coilia dussumieri*
41	Ram Chowkka	Elongate ilisha	*I. elongata*
42	Gurtailish / fuittailish	Kelee shad	*Hilsa kelee*
43	Bagda chingri	Giant tiger shrimp	*Penaeus monodon*
44	Chaga / chaka chingri	White shrimp	*P. indicus*
45	Motka chingri	Crystal shrimp	*Farfantepenaeus brevirostris*
46	Chali chingri	Yellow shrimp	*Metapenaeus brevicornis*
47	Bara chaka	Jinga shrimp	*M. affinis*
48	Buna chingri	Shrimp	*Penaeus sp.*

Quality loss of traditionally dried marine fish

Quality loss is a term that describes deviation or variation of a product characteristic from the desired quality. These are generally caused by physical, biochemical and microbiological factors such as insect attack, enzymatic, oxidative and microbiological spoilage. Previous studies had estimated loss of quality through spoilage and insect attack on dried fish amounted 10-35% in the coastal region of Bangladesh (Doe et al. 1977; Reza et al. 2005). In the present study, it was observed that a number of factors resulted in quality loss of the final product that were either related to lack of infrastructure, method of processing or negligence and/or lack of awareness about proper handling and transportation methods of raw material as well as the final product. It was found that the fishermen did not gut the fishes in most cases. Moreover, the processors did not wash the fish except for large-sized ones. When washing was done, processors used to take the fish to nearby channel, dipped into the water and washed several times prior to sun drying. Alam (2007) also reported similar incidence of washing technique followed by the processors in Kutubdiapara, Cox's Bazar. In many cases, products were not properly dried and moisture levels were much higher than the recommended value for dried fish. This resulted in deteriorative changes caused by chemical and biological factors including attack by microbial population such as bacteria, fungi and viruses (Azam, 2002). It was reported that sun dried fish showed visible fungal growth within a month of storage and it was particularly true during monsoon months. This resulted in absorption of moisture from the atmosphere which ultimately resulted in the increase of microbial load. The processors used jute bags for packaging, which were unable to prevent moisture reabsorption or insect infestation during storage. Another reason of quality loss in dried products were due to loss of freshness of raw material before being dried (Reza et al. 2005). This is particularly true during glut period, e.g., winter season when the catch is considerably higher compared to other seasons of the year. During the investigation, it was revealed that some of the processors used many types of undisclosed chemicals including insecticides and fungicides for preventing damage by fly and insects. It was not unlikely that such chemicals may create severe health hazard (BFRI, 1998; Chowdhury et al. 2010; Musa et al. 2010). Insects are reported to cause greater damage to dried fishes than bacteria, fungi or mites in tropical countries (Daniel and Etoh, 1983). It was also reported that such type of products was stored in a damp warehouses either at the site or nearby coastal cities where weather was humid particularly during the monsoon period (Ahmed et al. 2013; Uddin et al. 2014). During early storage period we observed that the dried fishes were susceptible to attack by house flies. The flies laid eggs which hatched within few hours. The larvae then fed on fish flesh. Similarly, dried fish in the store room were attacked by various types of beetles and inflicted heavy qualitative and quantitative damage to the product. Based on these, it is concluded that the poor quality of sun dried fishes were mainly due to unhygienic processing, inadequate salting, improper drying, use of spoiled fish for processing and lack of air tight packing of the dried fishes. More or less similar results were also reported by Immaculate et al. (2013) where they studied quality and shelf life status of salted and sun-dried fishes during different seasons in a coastal village in India.

Table 2. Causes of quantitative loss of traditional dried marine fishery products

Causes of quantitative loss	% of loss
Loss due to infestation (fly/larvae)	40
Loss due to spoilage of raw materials	25
Loss due to spoilage during storage	12
Loss due to meteorological effect	05
Loss due to handling and transportation of sun-dried fish	18

Based on the interview of fishermen, commission agent (fresh fish), processors, wholesaler, commission agent (dried fish) and retailers

The sun-dried fishes incurred quantitative loss due to different causes and they were listed in Table 2. Data were collected from fishermen, processors, commission agents, wholesalers and retailers through questionnaire interview. It was revealed that the main causes of quantitative loss were due to insect infestation followed by

chemical spoilage of raw materials, handling and transportation of the product and some loss for meteorological reasons. This was quite expected because traditional sun drying was done in open spaces or sometimes in direct contact with soil without any measure to protect them from insects. Apart from optional salt-pretreatment no other pre- or post-processing treatments were found to be practiced to kill or deter the fly or insect larvae or to protect them from further infestation during storage. It was observed that the highest qualitative loss of 40% incurred due to infestation by fly and larvae during processing while approximately 25% loss occurred due to quality of the raw materials. It was well documented that the quality of raw material used for traditional drying were of poor quality primarily due to insufficient icing during harvest (Alam, 2007). Lack of institutional training of processor was identified to substantially influence the quality of the product. Generally, the manpower involved in processing was considered to be skilled due to their generation to generations' experience. However, they did not receive any institutional training and lack knowledge on Sanitation Standard Operating Procedures (SSOP) and personnel hygiene. The meteorological factors including foggy weather during winter and rain during monsoon were also was identified as another reason of quality loss that accounted for approximately 5% (Table 2). It was revealed that products drying in open air or placing them on elevated bamboo racks without any coverings resulted in contamination and subsequent loss of product quality.

Marketing of traditionally dried marine fish

Marketing includes various activities involved in the flow of goods and services from its producer to the consumer while marketing system is defined as a series of organized effective methods to carry out marketing related activities for a specific product. Marketing system of sun-dried fish holds an important activity in the coastal area of Bangladesh. Figure 2 shows the flow chart for marketing of sun-dried fish in the coastal region of Bangladesh. Ahmed et al. (2007) conducted elaborated study on the marketing system and reported that producers had little influence over marketing and supply chain management, rather they were strongly managed and monopolized by giant traders, brokers that resulted in price distortion in domestic market. Several other studies have also reported marketing system is very complex and un-friendly to the consumer. The sun-dried marine fishery products were almost entirely consumed locally while only a small quantity was exported to other countries. All these products were marketed by private sector. It was observed during the period of investigation that processors were not directly involved with the retailing of their products. Raw fishes were collected at a comparatively low price mainly from the private fish landing centres located near the processing zones of Kutubdiapara, Moheshkhali, Dhalghata and St. Martin's Island. The processors collected raw materials directly from the fishermen or sometimes from purchase commission agents of fresh fish. Then they sold their products to the wholesalers and the wholesaler distributed to the retailer and finally the products came to the hand of consumers. We previously reported that a total of six intermediaries were involved in marketing of sun-dried fish in coastal region of Bangladesh (Reza et al. 2005). More or less similar results were also reported for dried fish marketed in the coastal areas of other developing countries like India, Sri Lanka and Nigeria (Murray and Little, 2000; Ismail et al. 2014; Payra et al. 2016). It was observed that the wholesalers as well as processors of dried fish used agents to buy fish/dried products from landing centers and dried fish processing sites. Each buying station had two or three agents who acted as intermediaries between fisher folks and wholesalers. Agents usually had long term credit relationship with fishers in return for guaranteed supply. Their commission was deducted from the payments of both to buyer and fish seller. Depending on the season and lunar cycle, fishermen had three possible outlets for selling their catches such as hawkers, wholesalers or agents. Sometimes raw materials were sold directly from the boat. Priority sale went to market intermediaries who have credit relationship with the fishers. It was common in some areas for agents that they arrived to the fishing vessels and bought the whole catch, dividing it and distributing among processors, wholesalers and occasionally hawkers. A sort of monopolistic marketing strategy was observed during the study. Similar incident of non-competitiveness of dried fish market was reported in Borno State, Nigeria (Ismail et al. 2014). The empirical findings also revealed that wholesalers purchased the sun-dried products from small-scale processors or through other intermediate commission agents and distributed to the retailers. Finally, the product reached to the consumer through retailers resulting in substantial increase in price, often resulting in up to 200% increase in marketing margin and profit on the traded products (Reza et al. 2005).

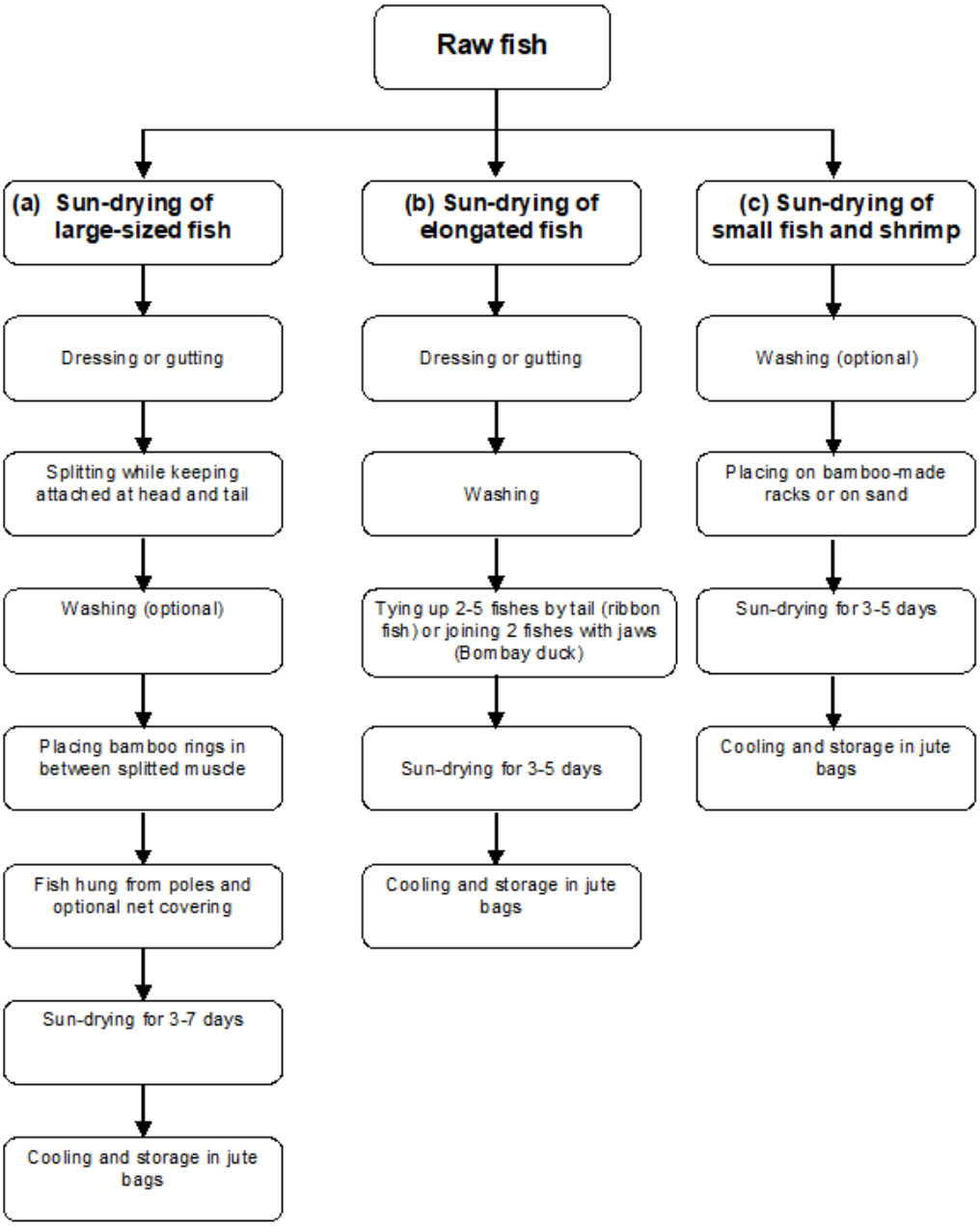

Figure 1. Flow chart for the three categories of traditional drying process for marine fishes in the coastal region of Bangladesh. (a) sun-drying of large-sized fish, (b) sun-drying of elongated fish and (c) sun-drying of small fish and shrimp.

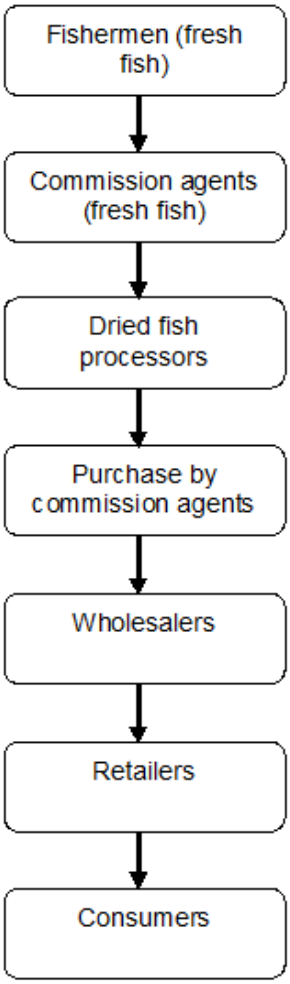

Figure 2. Flow chart for marketing of sun-dried fish in the coastal region of Bangladesh

We previously conducted a study on marketing margin and marketing profit of traditional dried fish in this region (Reza et al. 2005). It was revealed that marketing margin and profit almost doubled irrespective of species, and the processors in primary market received higher marketing profit followed by retailers and wholesalers in consumer market and secondary market, respectively. More or less similar observations were reported by Ahsan et al. (2016) which showed 35% and 19% marketing margin respectively for dried products of Bombay duck and ribbon fish in Cox's Bazar. In this part of the world, prices generally increased due to the intermediaries involved in marketing chain who provided services and marketing facilities but simultaneously established sorts of exploitation of different actors in the line by setting up artificial pricing at different levels (Kleih et al. 2003). Particularly in dried fish marketing, commission agents (locally known as *beparies* and *aratdars*) are key players who raises the market price of the products. Islam et al. (2006) suggested that formulation of policy through rationalizing or eliminating these commission agents would help reduce the market price of dried fish and would benefit the consumers.

CONCLUSION

Sun-dried fish processing is an important economic activity in the coastal region of Bangladesh that provides livelihood of millions of fishers, processors and traders. While the product quality may be rated as poor to moderately acceptable, price of the final product was found to be relatively higher due to the presence of multiple intermediaries in the marketing channel. Recent interventions taken by government and non-government organizations have slightly improved the marketing and distribution system of sun-dried products. However, lack of monitoring by appropriate authority has resulted in unsustainability of any measures taken. It is, therefore, suggested that Bangladesh Food Safety Authority should work in co-operation with local processors and traders that will ensure both quality and safety of these important food products.

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