

## Traditional Method of Fish Drying Technology in Chalanbeel, Bangladesh

<sup>1</sup>Nahid Sultana\* · <sup>2</sup>M. Nazrul Islam

Department of Zoology, Faculty of Life and Earth Science, University of Rajshahi, Rajshahi-6205, Bangladesh  
Corresponding Author: Nahid Sultana

### ABSTRACT

A study on fish drying in ChalanBeel areas was conducted between July 2011 to June 2014. Field survey was carried out in Singra, Tarash, and Bhangura Upazilas adjacent to ChalanBeel to assess the fish drying status. Twenty six fish were used for drying including five major fish species for large scale drying and remaining species were mixed with major species, mostly of damaged physically. Fishes are highly perishable food commodity due to high protein content, hence essential to sale for its immediate use or process and preserve. Fishes are processed by drying, salting, smoke-treatment, freezing and deep freezing or freeze drying. Instead of high costs of processing and preservation the fisher tribes use age old, simplest, cost effective, easy operating and environment friendly traditional methods to remove scales and sun drying. Majority (89.3%) dry fish farmers brought raw fishes from local fish markets or landing centers. Washing of raw fish was done by beel water and poor quality salts were used for salting (rate: 50-250 g / kg fish) in most cases. Majority drying were done by spreading raw fishes on bamboo rack without any protection measure from insects or dust. Finally, maximum dried products were carried to Sayadpur (Nilphamary) dry fish wholesale market by the dry fish farmers or other middlemen. The mean daily wages of male and female labours were Tk. 220 and 70 respectively seems a wide difference apparently. This study revealed that the fish processors in the studied areas mainly used the traditional methods for drying and substantial improvement was needed at different stages of handling, processing, and transportation of the fresh fish to get the high quality dried fish products. Training of the fish processors on above aspects including hygiene, sanitation, good water quality and raw materials was found very important to ensure high quality dried products for the consumers.

**Keywords:** Chalan Beel, Fish drying, Dry fish farmer, Raw fish, Marketing, Salting, Consumer.

### I. INTRODUCTION

Traditional knowledge and wisdom of the local people is very important to document our heritage and Bangladesh is a well known country for its traditional knowledge over the years (Patil et al., 2014). Fish tends to perish immediately after some time after catch, their processing and preservation is first priority of fishermen and fish shopkeepers before and after marketing of catch. Sun drying is the most ancient and cost effective method of fish processing all over the world. Due to sun drying, there are losses of nutrients like fibres, carbohydrates and essential amino acids but still it is in use as one of the cheap methods (Kamruzzaman, 1992). Recently, the mechanized drying is practiced in fishery industry but during heavy landing especially small sized fishes in fresh water capture fishery from rivers and reservoirs, fishes are preferably dried in sunlight. Based on variations in species and body size the fish are either gutted before drying or dried without gutting as a whole (Babareet al., 2013; Sugumaret al., 1995) It is necessary to remove scales from fish body called de-scaling as scales are non-edible and increase the time required for drying and also prevent moisture loss from fish body. Therefore, the scales should be removed for efficient drying of fishes (Sugumaret al., 1995). In India about 17% fish catch is sun dried (Bhat et al., 2013). Sun drying is simplest, oldest known and least expensive method of fish preservation used worldwide.

Fish and fisheries are the intrinsic part of life of Bangladeshi people from the time long past and play a vital role in generating employment, nutrition, earning foreign currency and other aspects of the economy (Alam, 2002). Bangladesh is blessed with diversified fisheries resources (Kibria and Ahmed, 2005). The Chalanbeel and several rivers are famous for producing huge amount of fish during late monsoon. During this time rivers, beels and haors remain calm and quiet and also the fishes attain marketable size grazing in these rich water bodies, as a result fishing activities are strengthened and a huge amount of fishes are harvested during this period than the other seasons. Therefore, a glut is obtained from the haor areas during winter season. As huge quantities of fresh fish are caught every day, much of them remain unsold because of shortage of buying customers, as a result big

amount of post-harvest loss occurs. Bulk catches are destroyed at that time due to unavailability of processing and preservation facilities. Therefore, the local people and also some entrepreneurs come forward to produce dried fish ('shutki' in Bengali). It is estimated that about 20% of the local artisanal fish catch are sun dried and consumed in the domestic market in Bangladesh (Mazid and Kamal, 2005).

Drying is a traditional method which has been used for centuries for preserving fish (Cole and Greenwood-Barton, 1965; Waterman, 1976). Drying method is considered as the least expensive method of fish preservation (Balachandran, 2001). Dried fish is a very popular and delicious food item in Bangladesh especially, in the coastal, central and north-eastern districts (Nowsad, 2007). It is also a most reliable source of protein to the people in rural areas of least developed countries (Graikoski, 1973). This traditional method is followed for the preservation of fish especially in rural areas (Chakrabarti and Varma, 1999). Edible fishes are preserved through removal of moisture. The basic principle of fish drying is that the activity of the muscle enzyme and microorganism is reduced to a minimum through the revocation of the water content of the fish by sun drying in a traditional way (Banglapedia, 2014). Fish drying is carried out in some selected parts of Bangladesh where modern preservation facilities and good infrastructure for transportation are absent. The methods employed for handling and processing of fish in study area are still traditional and need lot of improvement. The information pertaining to various aspects of post-harvest handling, processing, distribution and socio-economic condition of dried fish processors are important as it acts as an implement for fisheries development and acts as a forward linkage for value addition and quality control with consequent economic and employment benefits. Although, few scientific articles on drying methodologies, household socio-economics, resource use of dried fish processors (Ahmed et al., 1993; DFID, 2001) and entrepreneurs has been conducted in Bangladesh but no such research work was found especially on fish drying activities, socio-economic condition dried fish processors and entrepreneurs in Chalanbeel area of the country. The present study was conducted to evaluate the fish drying activities and socio-economic condition of dried fish processors and entrepreneurs in three upazilas of three districts through field investigation.

Sun drying of fish is though most ancient method but it takes long time therefore method of salt curing is employed in many parts of India (Govindan, 1985) to remove moisture from fish body, therefore fishes are either brined or wrapped in salt powder before sun drying (Sugphapalaet al., 2012). Apart from these most common known facts of fish processing, traditional and unhygienic ways of handling and processing fishes to remove the scales and sun-drying without using salt is highlighted in the present study. It is different from all known methods. The fisher tribes from the selected study area were of opinion that the application of salt before drying is responsible for early decay of fish (Shanthini and Patterson, 2002).

Sun drying of fishes is a simple and the oldest known method of fish preservation where fishes are dried under the sun. Drying method is considered as the least expensive method of fish preservation (Balachandran, 2001). Being the largest beel of the country, ChalanBeel produce huge amount of fish every year. A large number of fish is being used in sun drying in ChalanBeel region. Dried fishes do not lack in importance regarding fish utilization since they are consumed by a substantial number of people. They are the predominant food bringing vital protein to people in rural areas of least developed countries (Graikoski, 1973). Drying is traditional method, which has been used for centuries for preserving fish (Cole and Greenwood-Barton, 1965; Waterman, 1976). Traditional drying is often rudimentary and good hygiene is rarely practiced. During the rainy season, when humidity levels are high, sufficient drying cannot be achieved using traditional methods. In such conditions, stored dried fish will re-absorb moisture and become susceptible to bacteria, fungal or insect attack (Azam, 2002). Though few works were done on fish drying different regions of Bangladesh by Nowsad (2002, 2003, and 2005), Reza et al. (2005) and some other authors but study on fish drying of ChalanBeel region is scant. The present study is focused on the fish drying activities by the dry fish farmers of ChalanBeel areas through field investigation.

## **II. MATERIALS AND METHODS**

### **Location and description of the ChalanBeel**

The ChalanBeel is an important water resource in the northwest region of Bangladesh and it is the biggest beel of the country. The total area of this beel in monsoon season is about 300-320 square kilometers whereas in winter and summer the area decreases down to about 50-75 square kilometers. Most of the areas of the ChalanBeel has water depth of about 2-2.5 meters. The ChalanBeel covers an area of Atrai Upazila of Nowgaon district, Singra, Gurudaspur, Boraigram Upazilas of Natore district, Chatmohor, Bhangura Upazilas of Pabna district, and Tarash, Ullapara, Raygonj Upazilas of Sirajgonj district.

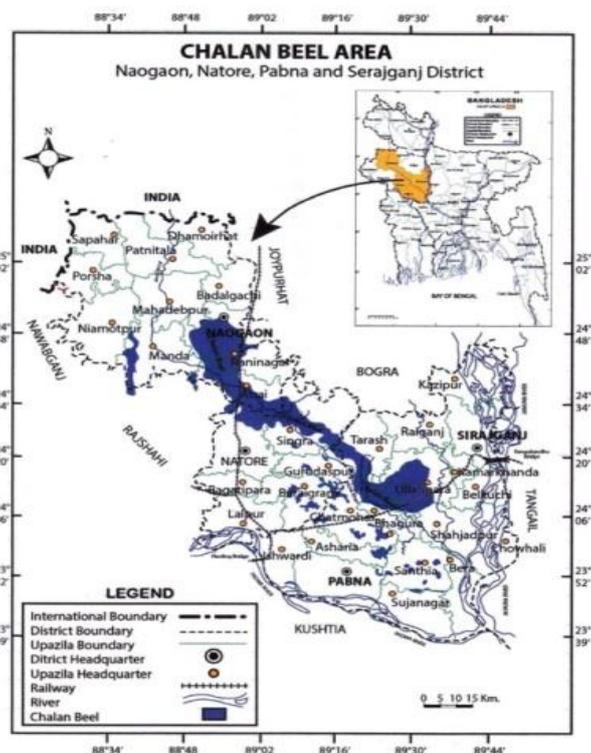


Figure 1: The location map of Chalanbeel.

**Study time and spots**

This study was conducted for a period of July 2011 to June 2014. To carry out the present study different spots in Chalan Beel areas were selected. Different fish drying spots in Atrai (Nawgaon); Singra, (Natore); Bhangura (Pabna); and Tarash (Sirajganj) Upazilas were visited for the present study.

**Study methods**

Frequent field visits and interviews of the dry fish farmers (n=50) were made to collect necessary data on fish drying. Fish drying process was observed in the drying spots of the study areas.

**III. RESULTS AND DISCUSSION**

**Fish drying activities**

**Fish drying yard:** People of Chalan Beel areas carry out sun drying for two purposes viz. business and household consumption. Sun drying for business purpose is generally carried out on rack made of bamboo splits and poles, sometimes on fishing net directly on earth whereas sun drying for household consumption is performed in small scale by using bamboo baskets and small earthen pots (locally called sara) by hanging. Species used in sun drying: Variety of fishes is being used in sun drying in the study areas. A total of twenty six (26) species of fishes were identified used for drying. Among them, eighteen (18) species from Singra, twenty (20) species from Tarash, and twenty three (23) species from Bhangura areas (Table I). Drying of cultured an exotic fish silver carp (*Hypophthalmichthys molitrix*) was also observed. Fish species that are used in sun drying can be divided into two main categories (i) major fish species (95% of total dried fish) and (ii) minor fish species (5% of total dried fish) (Figure 01). Major categories include those fish, which are targeted by the dry fish farmers to be dried and minor species included different fish species that remain mixed with major fish species in small quantity

**Table I.** Species recorded in the fishes used for sun drying in different upazilas

Sl. No.	Scientific name	Bangla name	Name of the upazilas			Availability
			Singra (Natore)	Tarash (Sirajganj)	Bhangura (Pabna)	
1	Puntius sopher	Punti	✓	✓	✓	Common
2	Puntius conchonus	Punti	✓	✓	✓	Few
3	Puntius ticto	Tit-punti	✓	✓	✓	- do -
4	Chandanama	Namachanda	✓	✓	✓	Common

5	Parambassisranga	Chanda	✓	✓	✓	- do -
6	Parambassislala	Chanda	✓	✓	✓	Few
7	Colisafasciata	Colisa	✓	✓	✓	- do -
8	Colisalalia	Colisa	✓	✓	✓	- do -
9	Hypophthalmichthys molitrix	Silver carp	✓	-	✓	- do -
10	Amblypharyngodon mola	Moa, Mola	-	✓	✓	- do -
11	Esomus danricus	Darkina	✓	✓	✓	Rear
12	Botialohachata	Bou, Rani	✓	-	-	- do -
13	Gudusia chapra	Chapila, Khoira	✓	-	✓	- do -
14	Tetraodoncutcutia	Potka, Tepa	✓	✓	✓	Common
15	Channa punctata	Taki, Saitan	-	-	✓	- do -
16	Lepidocephalus guntea	Gutum, Gorkun	✓	✓	✓	- do -
17	Acanthocobitis botia	Balichata	✓	-	-	- do -
18	Xenentodon cancila	Kakila	-	✓	✓	- do -
19	Mystus vittatus	Kakila	-	✓	✓	- do -
20	Heteropneustes fossilis	Sing, Jiol	-	✓	✓	rare
21	Badis badis	Sing, Jiol	-	✓	✓	Very rare
22	Mastacembelus pancalus	Guchi	✓	✓	✓	Few
23	Macrornathus aculeatus	Tara baim	✓	✓	✓	- do -
24	Glossogobius giuris	Bele, Baila	✓	✓	✓	- do -
25	Wallago attu	Boal	-	-	✓	Common
26	Pseudeutropius antherinoides	Boal	-	✓	✓	Few

✓ = Yes; - = No

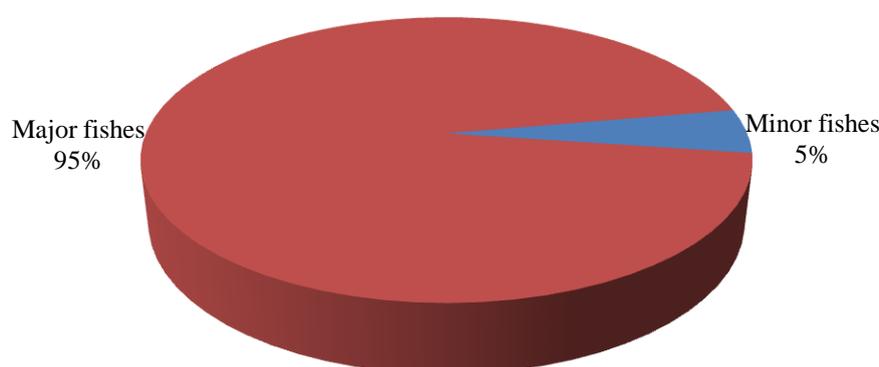


Figure 2: Fish species used for drying in Chalan Beel regions.

**Season and seasonal income of fish drying activities** Fish drying generally started in mid-October and ended in mid-March. Sufficient sunlight was available during that time and wind moisture content was less which enabled proper drying of fish. Fish drying activities also depended on the raw materials availability and market demand of fresh fish. Flowra et al. (2012) also found most of the fish drying points were operated seasonally (from July to March) where the peak period of drying was September- October. The seasonal income of drying enterprise might vary from area to area. This variation was due to the raw material availability, processing cost and demand of the consumers. The average seasonal income of fish drier enterprise in three study areas is given in Figure 3. It showed that 26.31%, 28.94% and 44.73% fish drier enterprises were found in the income range of Tk. 10000-75000, Tk. 100000-500000 and Tk. 600000-1000000 respectively. The data revealed that only nearly

half of the fish drier entrepreneurs had the handsome earnings from the business. Flowra et al. (2012) reported the average monthly income of dried fish processors of ChalanBeel area that, 30.71%, 50.00% and 14.28% seasonal dried fish processors were grouped into the TK. 2000- 5999, Tk. 6000-10999 and Tk. 11000 -15000 income range. The earnings of the processors in the present study were higher than Flowra et al. (2012). The difference in income range might be due to the scale of drying activities, raw materials availability and the consumer preference about dried fish in certain area. Therefore, it was very much profitable and suitable businesses in this area as the seasonal fishes were available during glut catch.

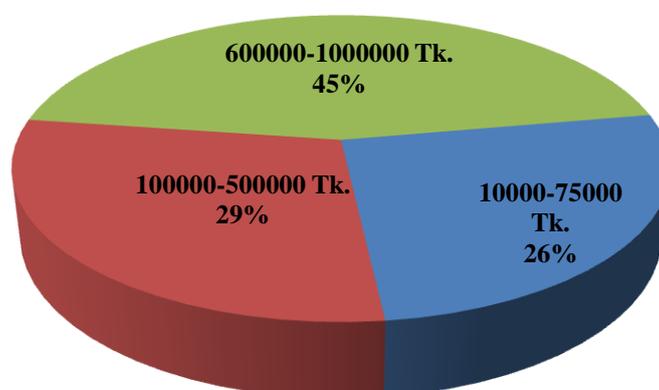


Figure. 3. Percentage of seasonal fish drier enterprise in different income groups.

### Traditional Sun Drying Methods of Fish

#### Raw material collection system

Raw fishes were harvested by fishermen from rivers, haors and beels of Sylhet District. Then the fishes were brought to the nearest markets by rickshaw, van, pickup van, truck etc. Directly fishermen also sold their catches into the drying yards. Generally, semi-spoiled fishes were used as raw materials for drying. Reza et al. (2005) conducted a study on traditional drying activities of commercially important marine fishes of Bangladesh and found poor quality raw materials were used for drying which coincides with the findings of the present study. Latif et al. (1983) studied on the status of the dried fish processing industry in the East Coast states of Kelantan and Terengganu where most processors agreed that freshness of fish before processing was a very important factor in producing good quality dried fish which agreed with the present finding. Transportation of raw fishes from fish markets to drying point was mainly carried out by non-mechanized van, rickshaw, boat, and bicycle or by head load or shoulder load.

#### Washing

In most cases, dry fish farmers washed their raw fish with beel water as there was no good water supply sources in drying areas and few dry fish farmers used tubewell water for this purpose. It was also found that, many dry fish farmers did not wash their raw fish.

#### Salting

It was found that, dry fish farmers in the studied areas used salt for mixing with raw fishes before drying but they did not maintain any fixed ratio of salt and fish. They generally mixed 50-250 g commercial salt for 1 kg of fishes (Table II). All the dry fish farmers (100%) used non-brand commercial salt for salting.

Table II. Dry fish farmers and amount and type of salt used by them

Sl. No.	Upazila	District	No. of Dry fish farmer (n=56)	Amount of salt used (g /kg raw fish)	Type of salt used
1	Singra	Natore	23 (41.07%)	100-150	Non-brand commercial
2	Tarash	Sirajganj	09 (16.07%)	50-100	Non-brand commercial
3	Bhangura	Pabna	08 (14.29%)	200-250	Non-brand commercial

#### Dressing and splitting of raw fish

Only for large fish like, boal (Wallago attu), silver carp (H. molitrix) and taki (Channapunctata) gutting and splitting were practiced. First the fishes were deheaded and then alimentary canal was removed from the body. In case of taki (C. punctata) only beheading and gutting were done before drying. In case of boal (W. attu) and silver

carp (*H. molitrix*) after beheading and gutting, splitting were done for uniform drying of all parts of muscle. Other small fish species were directly dried under the sun without any dressing.

### **Drying under the sun**

For comparatively large scale fish drying, bamboo made rack of 0.6-1.2 meter high from earth is used in most cases. A bamboo splits made mat is used on the rack over which raw fishes were spread for drying. It was observed that, in some places like Kaliganj (in Singra Upazila) fishes were spread on fishing seine nets directly on earth without using any bamboo rack (Plate 01). Sometimes large fishes like taki (*C. punctata*) and silver carp (*H. molitrix*) were hung from a rope tied horizontally to the two poles placed vertically for drying instead of using any rack.

During drying on the bamboo made racks, dry fish farmer turned over spread fishes at regular interval for better drying. Only 16.07% dry fish farmers used fishing nets over the rack to prevent fish from insect infestation. Drying duration extremely varied with weather conditions like available sunlight, temperature, relative humidity, wind flow, raining status etc. In the surveyed areas, at normal weather condition (enough sunlight, temperature, humidity, and no rain) drying duration recorded to be varied from 2-6 days depending on the size of the raw fishes.



**Plate 1:** Drying under the sun

### **Sorting of dried fish**

Smaller fishes were remained in mixed condition and were sorted out after drying. Generally women workers sorted out the mixed dried fishes and separated the fish according to the species, size and quality of the dried fish. However, sorting of fish could be varies from area to area. Flowra et al. (2012) reported that sorting of dried fish was not common in ChalanBeel areas of Bangladesh but it was only performed after collection of raw fishes for drying. This difference might be due to the variation in traditional processing activities of three study areas.

### **Packaging**

After sorting, the dried fishes were bagged into a plastic and hessian bag for easy handling. Sometimes bamboo baskets were also used for this purpose.

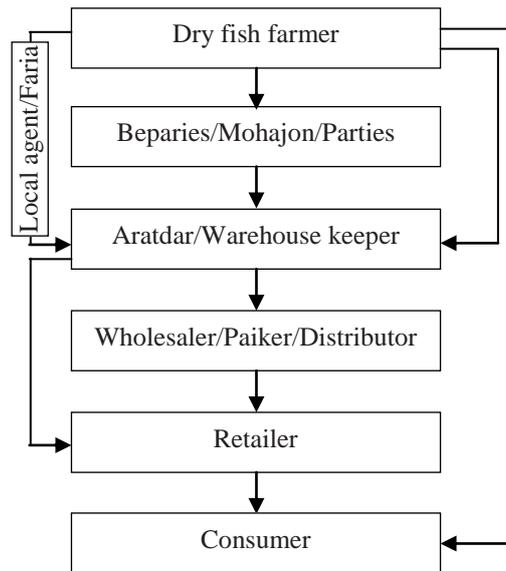
### **Storage**

Storage of dried fish was found to be performed in a tent generally made of thin plastic sheet and bamboo splits. This tent is usually made in the place of fish drying. Bagged dried fishes were kept into these tents for temporary storage until marketing or selling to the local vendors.

### **Transportation and Marketing**

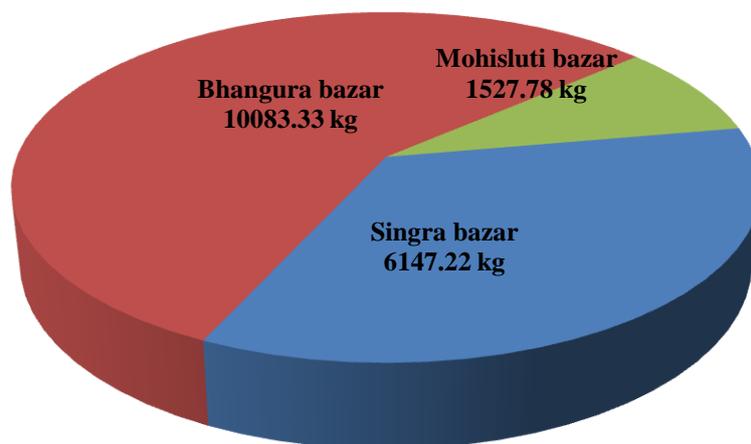
In the studied areas, dried fishes were marketed by the dry fish farmers at every 7-15 days interval. There is little information about the quality aspects of fresh fish and the dried products in different stages of marketing chains since no detailed survey was conducted in Bangladesh (Nurullah et al., 2005). It was found that almost all the dried fish product (98-99.5%), dried in Chalanbeel areas, carried to the Sayadpur dry fish wholesale market in Nilphamary district. Very small amount of dried products (0.5-2%) were consumed locally. Marketing channel of dried fish in the study areas consisted of dry fish farmers, several middleman (local vendor, Bepari, Aratdar,

distributor, and retailer), and consumer. However, five (5) types of dried fish marketing channels were observed during the investigation period (Figure 5).



**Figure 5.** Marketing channel of dried fish of the Chalanbeel.

In Bangladesh, there is a lack of marketing infrastructure for both wholesale and retail markets. Transportation and storage facilities are poor in most part of the country. The involvement of large number of middlemen and commission agents reduce benefit to the fish producers (Ahmed et al., 1993; Mazid, 1994). Production of dried fish The production of dried fish might be varied from area to area and drying points to drying points. Chalanbeel region of Bangladesh supports huge water resources and a part of huge catch were used for processing of dried fish because of its consumer demand and public preference. Total dried fish production from Singra bazar, Bhangura bazar and Mohisluti bazar of study area were 73766.64 kg, 201666.6 kg and 9166.68 kg respectively which is shown in Figure 6. The dried fish production was always higher at the Chalanbeel area followed by Shingra bazar and Mohisluti bazar area. In October and March, the average production was lower than other months which were due to the scarcity of raw materials for dry fish production.

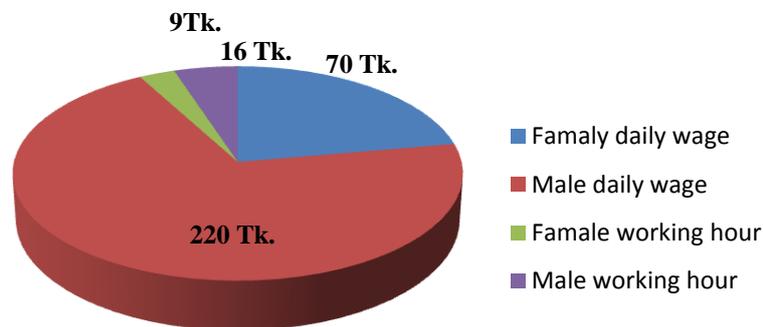


**Figure 6.** Mean monthly production of dried fish in three drying points in Sylhet.

#### **Labour Cost Of Fish Drying Activities**

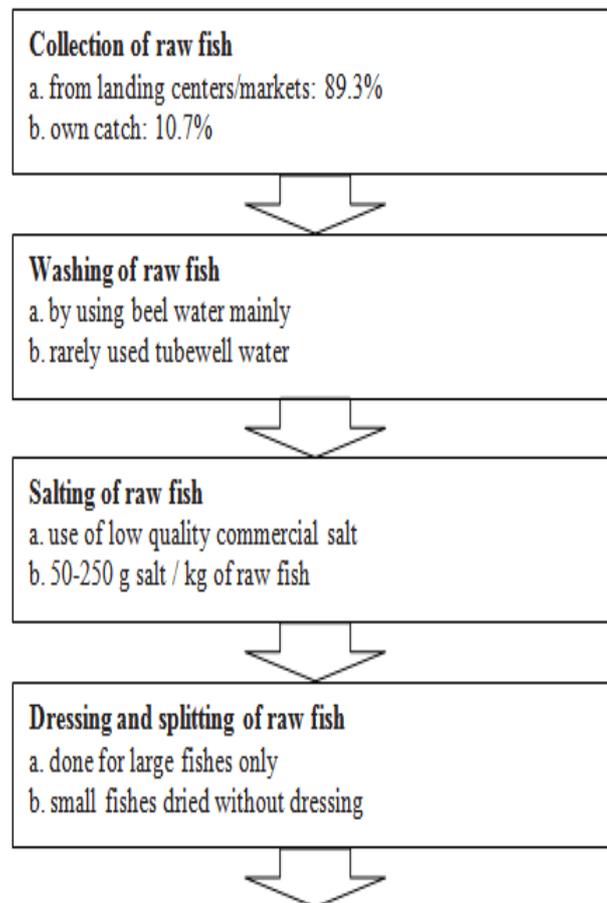
The male labours got their wages on monthly basis whereas females worked only daily basis. Their wages varied from drying points to drying points. Male workers worked 7.00 a.m. to 11 p.m. while female workers worked 7.00 a.m. to 4.00 p.m. Females were mainly involved in dressing and sorting activities whereas male

workers handled the whole drying process other than dressing and sorting of fish. Rabbanee et al. (2012) studied about women involvement in dry fish value chain approaches towards sustainable livelihood where they found women workers were involved in different income generating activities like drying, sorting and grading, cleaning and salting etc. that supports the finding of the present study.



**Figure7.**Labour wages and working hours in study areas.

The average daily wages of male and female labor was recorded Tk. 220 and Tk. 70, respectively (Figure 7). The average monthly wages of male labor was Tk. 4080. There was a distinct difference in the daily wages between male and female labor. Male labor got daily 13.75 Tk. per hour but the female labor got only 7.78 Tk. per hour which indicated prevalence of gender discrimination in fish drying labors.



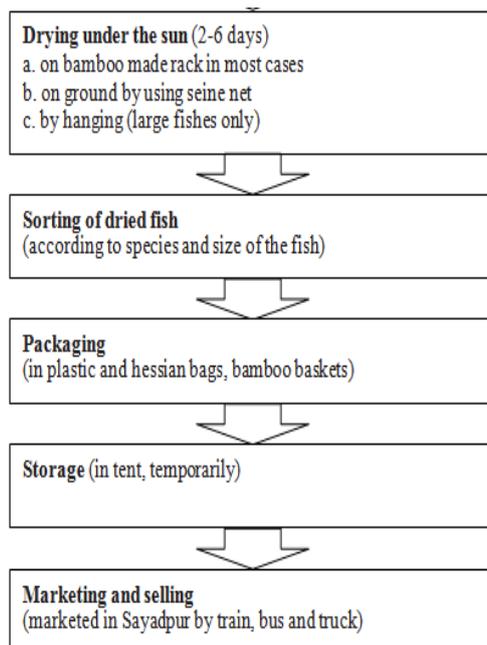


Figure 8. Flowchart of overall fish drying activities in the study areas.

#### IV. CONCLUSION

From the study it was clear that the fish drying in three drying areas of study area was traditional. Poor quality raw materials were used for drying to fetch higher price than usual. As it was relished by many people of the country, there was ample opportunity to improve the quality of the fish drying process in the study areas. For the improvement of quality of dried fish, it was not necessary to use any sophisticated equipment based technology. Maintaining proper sanitation and hygienic practice in all stages of fish drying in processing area, and introducing adequate packaging and storage methods would increase the shelf life of dried fish to larger extent. A satisfactory dried product is highly desirable at all consumer levels and for that reason drying process should be practiced following scientific ways. Extension work is needed to increase the awareness among dry fish farmers on proper handling procedures and quality standards to ensure reduction in losses and improving the quality of products. The microbial stability of dried fish products during processing and storage is depended upon their moisture content (Scott, 1957; Waterman, 1976; Chirife and Iglesias, 1978; Troller and Christian, 1978). Sometimes dry fish farmers used insecticides for protecting raw fish from insect attack. This practice greatly affects the quality of final product which is very harmful for human health too. Storage in unhygienic condition was also found which usually took place in the tent having no platform. Sometimes it was also observed that, raw and final dried fishes were kept in the same tent which badly affects the quality of dried final product. The requirement of a satisfactory dried product is highly desirable and to achieve this, scientific drying methods should be practiced in all the drying process. Extension work needs to be done so that there is awareness from dry fish farmers to consumers on handling procedures and quality regulations to ensure reduction in losses and quality of product to market. In these instances, low cost solar dryer can be constructed by using locally available materials that will ensure high quality dried products, safe for consumption and will fetch higher economic benefits for the dried fish processors and consumers.

#### REFERENCES

- [1]. Ahmed M., Rab A. and Bimbao M. P. (1993) Household socioeconomic, resource use and fish marketing in two thanas in Bangladesh. ICLARM Tech. Rep. 40:82p.
- [2]. Alam MF (2002). Socioeconomic aspects of carp production and consumption in Bangladesh. pp 83-93. In: Penman, DJ, Hussain MG, McAndrew BJ, Mazid MA (eds.). Proceedings of a workshop on Genetic Management and Improvement Strategies for Exotic Carps in Asia. Dhaka, Bangladesh. Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh. p 83.
- [3]. Azam K. (2002) Fishermen Community of Kuakata, Bangladesh: Fisheries Activities and Quality of Dried Fish.
- [4]. Babare RS, Chavan SP and Kannevad PM, 2013. Gut content analysis of Wallago attu and Mystus senegalensis the common catfishes from Godavari river system in Maharashtra State. Advances in BioResearch, 4(2):123-128.
- [5]. Balachandran K. K. (2001) Post-harvest Technology of Fish and Fish Products, Daya Publishing House, Delhi-110035, pp. 77.
- [6]. Balachandran KK (2001). Post-harvest technology of fish and products, Daya Publishing House, Delhi-110035, p 77.
- [7]. Banglapedia. (2014). Banglapedia, the National Encyclopedia of Bangladesh. Retrieved 13 August, 2014, from [http://www.banglapedia.org/HT/D\\_0337.htm](http://www.banglapedia.org/HT/D_0337.htm)
- [8]. Bhat TH, Rizwan, Balkhi MH and Bilal Ahmed Bhat, 2013. An investigation on the indigenous method of fish drying in Bandipora district of Kashmir valley, J. Chem. Bio. Phy. Sci. Sec. B (3) 1927-1932.
- [9]. Chakrabarti R, Varma PRG (1999). Halotolerant fungi in salted and dried fish at lower Visahapattinam coast. Fish. Tech. 36:28-31.

- [10]. Chirife J. and Iglesias H. A. (1978) Equation for fitting watersorption isotherms of food, Part-I. A review, *J. Food Technol.* 13:159-74.
- [11]. Cole R, Greenwood-Barton LH (1965) Problems associated with the development of fisheries in tropical countries: The preservation of catch by simple processes. *Trop. Sci.* 7:165-183.
- [12]. Cole R. C. and Greenwood-Barton L. H. (1965) Problems associated with the development of fisheries in tropical countries. The preservation of catch by simple processes, *Trop. Sci.* 7: 165-183.
- [13]. DFID(2001). Livelihood analysis and development or planning support for the poor in aquaculture and aquatic resource management, 13–15 February 2001. Department of Agriculture and Rural Development (DARD) Research Institute for Aquaculture (RIA), Thai Nguyen, Vietnam.
- [14]. Flowra FA, Mohmud MS, Mondal RC (2012). Traditional fish drying activities and socio-economic status of dried fish processors of ChalanBeel area, Sirajganj, Bangladesh. *Bang. J. Prog. Sci. Tech.* 10(1):065-068.
- [15]. Gopakumar K (1994). Salted dried fish in India: a review of methods and quality control. p 84. In: Champ BR, Highley (eds.). 1995. Fish drying in Indonesia. Proceedings of an international workshop held at Jakarta. Indonesia. 9-10 February 1994. ACIAR Proceedings No. 59: p 106.
- [16]. Govindan TK, 1985. Fish Processing Technology. Oxford and IBH co. Pvt. Ltd., Tanpath, New Delhi, 137-143.
- [17]. Graikoski J. T. (1973) Microbiology of cured and fermented fish. In: Microbial safety of fishery products (eds. Chichester and Graham, H.D.), pp. 97-110.
- [18]. Graikoski JT (1973). Microbiology of cured and fermented fish. In: Chichester, Graham HD (eds). Microbial Safety of Fishery Products. 97-110
- [19]. Kamruzzaman AKM, 1992. Qualitative evaluation of some commercially dried fish products of Bangladesh. M. Sc. Thesis, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh, Bangladesh, p.37.
- [20]. Kibria MG, Ahmed K (2005). Diversity of selective and non-selective fishing gear and their impact on inland fisheries in Bangladesh. *Naga, Worldfish Center Quarterly.* 28(1-2):43-48.
- [21]. Latif, Kamariah, Ismail, Salleh M, Yassin, Zaiton, Bardaie, Zohadie (1983). Production of dried fish in the East Coast of Peninsular Malaysia - a survey. In: Workshop on the Production and Storage of Dried Fish, 2-5 November 1982, UPM, Serdang.
- [22]. Mazid M. A. (1994) Proceedings of the SAARC workshop on fisheries socio-economics and marketing, BARC, Dhaka.
- [23]. Mazid MA, Kamal M (2005). Development of low cost solar dryer for the production of improved quality dried fish. Final Report. BFRI, Marine Fisheries & Technology Station and Bangladesh Agricultural University, Mymensingh. p 65.
- [24]. Newsad A. A. (2002) Review of solar drying techniques used in the fish drying. GOB/UNDP/FAO Project. BGD/97/017.
- [25]. Newsad A. A. (2003) A new method of fish drying in a solar dryer (in Bengali). Food and Agricultural Organization of the United Nations. BGD/97/017.
- [26]. Newsad A. A. (2005) Low Cost Processing of Fish in Coastal Bangladesh. Empowerment of Coastal Fishing Communities for Livelihoods Security. GOB/UNDP/FAO Project: BGD/97/017/5/2005, 73p.
- [27]. Newsad AKMA (2007). Participatory Training of Trainers: A new approach applied in fish processing, Bengal Com-print, 68/5, Green Road, Dhaka, Bangladesh. 151-191.
- [28]. Nurullah M., Kamal M., Wahab M. A., Islam M. N., Yasmin L., Shakuntala H., Thilsted and Mazid M. A. (2005)
- [29]. Patil PV, SP Taware and DK Kulkarni, 2014. Traditional knowledge of broom preparation from Bhor and Mahad region of western Maharashtra, India. *Bioscience Discovery*, 5(2):218-220.
- [30]. Present status of harvesting, transportation and marketing of freshwater Small Indigenous Species of Fish (SIS) of Bangladesh, Bangladesh J. Fish. Res., 9(2):159-168.
- [31]. Rabbaneh FK, Yasmin S, Haque A (2012). Women involvement in dry fish value chain approaches towards sustainable livelihood. *Aus. J. Busi. Manage. Res.* 1(12):42-58.
- [32]. Reza MS, Bapary MAJ, Azimuddin KM, Nurullah M, Kamal M (2005). Studies on the traditional drying activities of commercial important marine fishes of Bangladesh. *Pak. J. Biol. Sci.* 8(9):1303-1310.
- [33]. Reza S. M., Kamal M, Akteruzzaman M. and Islam M. N. (2005) Presentation of drying activities of marine fishes in the coastal region of Bangladesh. *Bangladesh J. Fish.* 27: 46.
- [34]. Samad MA, Galib SM, Flowra FA (2009). Fish Drying in ChalanBeel areas. *Bang. J. Sci. Indust. Res.* 44(4):461-466.
- [35]. Scott W. J. (1957) Water relationships of food spoilage microorganisms, *Adv. Food Res.*, 7: 83-127.
- [36]. Shanthini F, Patterson J, 2002. Fungi in salted and sundried fishes in Tuticorin, Southeast coast of India. Symposium presentation on seafood safety: Status and strategies at CIFT Cochin : 28-30.
- [37]. Soegiyono (1994). Problems Associated with Dried Fish Agribusiness in Indonesia. P.21. In: Champ BR, Highley (eds.). 1995. Fish drying in Indonesia. Proceedings of an international workshop held at Jakarta. Indonesia. 9-10 February 1994. ACIAR Proceedings No. 59: p 106.
- [38]. SUFER Project (DFID-UGC), Khulna University, pp. 2.
- [39]. Sugaphapala RMNS, Suntharabathy TV, Edirisinghe U, 2012. Salt based dry fish processing and marketing by fishers of Minneriya reservoir in Sri Lanka, *Trop. Agri. Research*, 23(4):357-362.
- [40]. Sugumar, G. Jawahar Abraham T, Jaychandran, P., 1995. Sanitation in fish curing yards of Tuticorin, Tamilnadu. *Fishery Technology*. 32(2): 136-138.
- [41]. Troller J. A. and Christian J. H. B. (1978) Water activity and food, Academic Press, New York, pp. 216.
- [42]. Waterman JJ (1976). The production of dried fish. FAO, Fish Tech. Pap. 160:52.

International Journal of Computational Engineering Research (IJCER) is UGC approved Journal with Sl. No. 4627, Journal no. 47631.

Nahid Sultana\*. "Traditional Method of Fish Drying Technology in Chalanbeel, Bangladesh." International Journal of Computational Engineering Research (IJCER), vol. 07, no. 12, 2017, pp. 33-42.