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Research Article
Fish Processing and Exports on the Zambezi/Chobe Floodplain, Zambezi Region, Namibia

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Abstract

Background and Objectives: In the Zambezi Region, a large number of people, many of whom live below the poverty line, find employment in fish marketing and processing. A survey on fish processing and exports was conducted on the Zambezi/Chobe floodplain between June 2015 and December 2016. The main objective of the study was to assess the fish processing techniques employed by fish processors herein referred as fish vendors to preserve fish products on the Zambezi/Chobe floodplain and to quantify the volume of fish exported from the area. **Materials and Methods:** Survey questionnaires were used to determine fish vendor's characteristics and their methods of fish processing and preservation. Daily fish products destined for exports were weighed and recorded using a hanging scale at Wenela border. **Results:** The study found that women are the key players in the fish processing and preservation on the Zambezi/Chobe floodplain. The major processing techniques employed by the fish vendors were sun drying and smoking. A total of 2515 bags of fish were recorded in 122 days from June, 2015 to December, 2016. Approximately 1575.8 t of fish products worth N$36 million were exported to foreign markets in Zambia. **Conclusion:** The active involvement of women in the fish processing and export suggested that this sector has the potential to contribute immensely to improving the economic and livelihood of the Zambezi region. However, the fish vendors faced challenges of inadequate cold storage facilities, poor weather and packaging.

Key words: Fish processing, fish vendor , Wenela border post, fish marketing, moon-phase, fish products

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The Zambezi/Chobe and its associated wetlands have been reported to support an important cichlid fishery yielding over 6700 t/year[1]. Fishermen and their families are the sole beneficially in fish processing, handling and trading[2]. The key players in the fish handling and processing are the fishermen, fish traders and fish vendors[3]. Fishermen land their catches and sell them to fish traders who buy fish, usually in bulk and sell them wholesale to fish vendors at local or regional markets[4,5]. Cichlids of the genera *Oreochromis*, *Tilapia*, *Sargochromis* and *Serranochromis* are the major components in fish landings in the Zambezi/Chobe floodplain fishery[6]. Susceptibility of fish to spoilage is mainly determined by the distance between the landing site and the target market place. Fish landed at distant sites are highly susceptible to spoilage as a result of poor handling and harsh weather conditions[7]. Spoilage is defined as a series of complex enzymatic bacterial and chemical changes in a fish upon being caught[7], a development which lead to loss of market and nutritive values of the fish. This is more pronounced in summer than winter. Hence, preservation and processing, therefore becomes a requirement[7]. The process ensures that the fish remain fresh under harsh warm condition with a minimum loss of flavour, taste, odour and nutritive value. Therefore fish processors and handlers employ various traditional methods in order to preserve the harvested fish products and prolong its shelf life[8]. Most fish are either taken directly to markets as whole fresh on ice or rather split dorsally, salted and dried in the villages[9]. Drying involves dehydration of moisture contents of fish so that the rate of enzymatic autolysis is reduced[7]. This author verified that, one can cut down on rate of spoilage by reducing the fish moist content to 10% under dry conditions. Fish drying can be achieved naturally using sunlight or artificially by smoking under low heat intensity[9]. Once the fish are dried they can be stored until large enough quantities are amassed at which time the dried product is transported straight to local and foreign markets[9].

The main fish species exported from Namibia are large breams (Tilapia) mainly exported as fresh, dry, salted and smoked products (Simasiku[5] pers.obs.). Most fish are trans-bounded through the Wenela border and sold at various markets in Zambia and the Democratic Republic of Congo (DRC)[9]. However, these fish trade activities are not recorded and regulated by any known agency. Thus, gaining an understanding into post-harvest activities and the chain of trade centered on the Zambezi/Chobe floodplain is an essential step towards fisheries management in the area. At the moment, the fish sector is often neglected in rural development and in the planning of interventions, but should be seen as an important component of the livelihood system and can be the principal way that a resource is transformed into a direct family income[10]. However, a good understanding of the present fish processing techniques and the problems encountered by fish processors at the different stages of processing, preservation and export are crucial before any helpful interventions can be considered. Therefore, the aim of this study was to assess the fish processing techniques employed by fish processors herein referred as fish vendors to preserve fish products on the Zambezi/Chobe floodplain and to quantify the volume of fish exported from the area. The main objective of the study was to determine the fish processing techniques employed by fish processors to preserve fish products on the Zambezi/Chobe floodplain and the fish volume exported from the area. The following research questions were addressed:

- What were the demographic profile of fish processors/vendors involved in fish processing and preservation for exports on the Zambezi/Chobe floodplain?
- What were the common fish processing and preservation techniques employed by processors/vendors to prevent fish spoilage between the time of landing and supply on the Zambezi/Chobe floodplain?
- What was the total volume, source, destination and turnover of fish exported from the Zambezi/Chobe floodplain in Namibia?

MATERIALS AND METHODS

Fish export surveys were undertaken between June, 2015 and December, 2016. All fresh and dry fish leaving Namibia through the Wenela border post were monitored and recorded for 2 days in a week. These days were alternated per week in order to cover all 7 days of the week. Recordings done included the number of hessian bags and cooler boxes of variable sizes leaving the border by taxis, trucks or pickups during operating hours (06:00 am-18:00 pm) taking note of their places of origin and areas of destination. The weight of each bag or carton was measured to the nearest (kg) using a weighing scale which was strategically placed along the drive way at the border. Heavy bags were measured for dimensions and calculated for volume depending on the shape (square/cylinder) and these were converted to estimated weights using the conversion tables (Table 1). Fresh fish with ice were corrected using a factor 0.4 to eliminate the weight of the ice[1] while dry fish products were converted to wet

Table 1: Conversion factors used for determining estimated weight of fish bags at Wenela border post

Square bags	Conversion factors	Linear regression
Fresh weight	(Volume+8043.1)/3817	R = 0.58
Dry weight	(Volume-20429)/5284.5	R = 0.39
Ice fresh weight	(Volume-54981)/2349	R = 0.27
Salted dry weight	(Volume+500180)/12315	R = 0.59
Cylinder bags		
Fresh weight	(Volume-13288)/1881.7	R = 0.32
Dry weight	(Volume-72699)/4401.1	R = 0.33
Ice fresh weight	(Volume+1.66683)/8694.1	R = 0.57
Salted dry weight	(Volume/14139)^1/0.7775)	R = 0.51

weight using the correction factor of 0.33 as described by Lewis and Tweddle[11]. In addition to export surveys, a short survey of fish processors (vendors) who were directly involved in processing and preservation of fish for exports was carried out for 30 days at the Katima Mulilo market. The Katima Mulilo market was chosen for this survey because majority of fish from across the floodplain for both export and local markets passed through the market, making it a critical component in the distribution chain of fish trade in the area. Vendors were interviewed on a range of issues related to the mode of processing, processing duration and different problems faced during processing. Vendor characteristics were obtained during the morning and afternoon when most fish vendors were always present. Structured questionnaires were filled by 80 fish vendors in order to obtain some socio-economic background of fish vendors in the study area.

Statistical analysis: Descriptive statistics (such as frequency counts, percentages, mean and standard error) were used to describe and summarize the data on the characteristics of vendors and volumes of fish exports. Data on fish export (expressed as kg/day) were first checked for normality and homogeneity of variances using Levene's test. To improve on assumptions of normality and homogeneity of variances, data were log10 transformed, but failed to normalize. Hence, the non-parametric Kruskal-Wallis test ($p<0.05$) was employed to test for any difference in daily weight of fish exports among sampling months and between areas of origins and destinations.

RESULTS AND DISCUSSION

Vendor's demography: A total of 80 fish vendors were interviewed at Katima Mulilo fish market between March and October, 2016 on a weekly basis. Dry fish vendors (n = 50) consistently outnumbered fresh fish vendors (n = 30) on the days of the interview (Table 2). All vendors in the market were female and the majority of fresh fish vendors indicated that they were single and that they were the heads of their households, vendors indicated that they were spouses of their household heads (Table 2). Majority of the interviewed vendors who were engaged in fish processing had basic education up to primary level (Table 2). The age categories of both fresh and dry fish vendors ranged between 24-65 years. The most representative age group for the fresh fish vendors was 41-45 years while 36-40 age group dominated the dry fish vendors.

Table 2: Distributions of the Vendors by positions in the household and level of education

	Fresh vendors		Dry vendors	
Parameters	Frequency	Percentage	Frequency	Percentage
Position in household				
Head	16	53.3	20	40.0
Spouse	8	26.7	23	46.0
Daughter	2	6.7	5	10.0
Relative	4	13.3	2	4.0
n	30	100.0	50	100.0
Level of education				
No education	2	6.7	5	10.0
Primary	24	80.0	42	84.0
Secondary	4	13.3	3	6.0
n	30	100.0	50	100.0

Modes of fish processing and preservation

Fresh fish preservation: The technique involved in fresh fish preservation is quite short owing to the fact that fresh fish products are susceptible to spoilage in the absence of adequate cold storage facilities. The fish preservation techniques indicated by most of the fresh fish vendors at the Katima Mulilo market surveyed include cooling of fresh fish using ice or freezing. Most of the fresh fish vendors (80%) used ice in the market. These vendors indicated that they often travelled a day in advance to villages on the floodplain where they spend the night and buy fresh fish from fishermen early morning the next day and conveyed to Katima Mulilo market. Depending on the demand and supply, vendors sold their fish locally at retail prices or as wholesale for exports. Fish products were typically transported in small (16.5 kg), medium (37 kg) and large (67 kg) cool boxes to the Katima Mulilo market. However, a lack of cold storage for fresh fish preservation was identified as the most challenging factor indicated by most fresh fish vendors (Fig. 1).

Fish drying: The dry fish vendors indicated that they always travel to distant fishing villages on the floodplain and camp for a week or two to enable them to buy fresh fish directly from the fishermen and process into dry products. The processing of non-salted dried fish involved washing fish in clean water, cutting and splitting them dorsally in order to remove their visceral organs and minimize spoilage. Most dry fish vendors

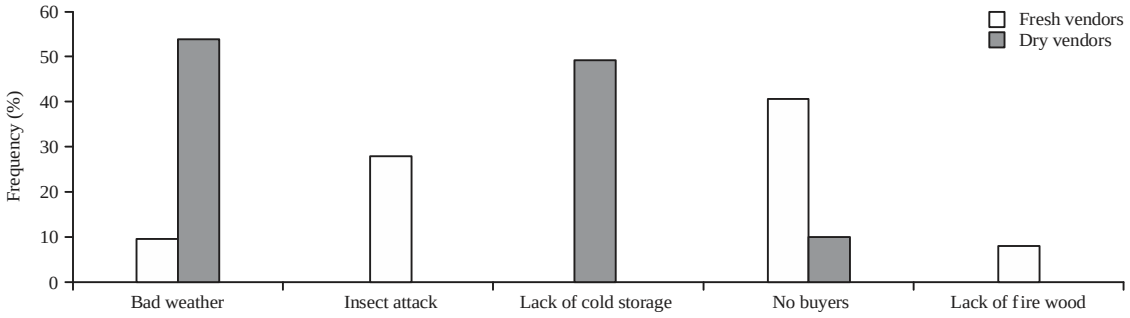

Fig. 1: Factor affecting fish processing and preservation in the study area

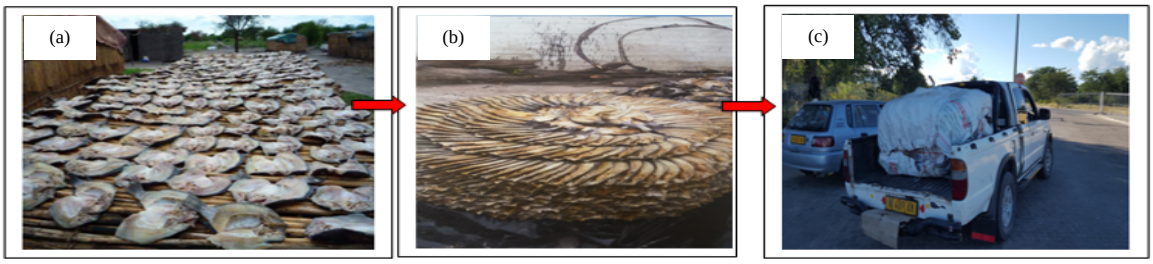

Fig. 2(a-c): (a) Salted drying fish, (b) Schematically packed smoked fish and (c) Destined for export in the Zambezi region

indicated that they dried their fish for 2 days in summer and smoked them under low heat intensity for 10-15 min on the 3rd day. Bad weather was identified as the most challenging factor faced by most dry fish vendors (Fig. 1). The preparation of salted-dried fish was very similar to the method of drying non-salted fish. In the salted-dried fish, a layer of salt is placed at the bottom of a container and a single layer of fish is placed on it with the flesh facing down. The first layer of fish would be covered with more salt before another layer of fish is added. The process is continued until the container is full and fresh fish under this condition can take 3-5 h to dry very well for packaging. Thereafter, the fish would be laid out and sundried either on a raised multi-purpose shelter (Fig. 2a). The final dried products was piled schematically (Fig. 2b) and wrapped in big sacks and loaded on pickup van or truck for shipping to both local and regional markets (Fig. 2c).

Fish exports

Monthly volumes: A total of 2515 bags were weighed and recorded in 122 days from June, 2015 to December, 2016 at Wenela border post, Katima Mulilo, Namibia. Different processed fish species were exported as dry products, salted dry and fresh on ice. A significant difference between fish products was detected (Kruskal-Wallis test; df = 3, p = 0.001), with most of the fish being exported as dry salted fish (Fig. 3). Monthly fluctuations in fish exports (expressed as kg/day) were observed between June, 2015 and December, 2016 (Fig. 4). The volume of fish for exports per day differed significantly between seasons (Kruskal-Wallis test; df = 18, p = 0.001). Major declines was observed in August, there was a significant increase in dry fish than fresh fish recorded over the entire sampling period (Fig. 5).

Origin of fish products in the study area: The results in Table 3 showed different areas of origin of the fish products exported from the Zambezi/Chobe floodplain between June, 2015 and December, 2016. The results revealed that the fish products came from 25 different areas in the Zambezi Region. Large volumes (expressed as kg/day) of the fish came from Katima Mulilo market followed by Muyako village (Table 3). Daily volumes of the fish for export differed significantly between areas of origin (Kruskal-Wallis test; df = 3, p = 0.001). Most of the salted fish came from Muyako village while most fresh fish came from the Katima Mulilo fish market in Namibia (Table 3).

Destination of fish products in the study area: This study found that the different fish products were exported to thirty different destinations (markets) in Zambia (Table 4). Fish volumes for export differed significantly between areas of destination (Kruskal-Wallis test; df = 3, p = 0.001). Most of the fresh fish were exported to nearby towns such as Sisheke, Livingstone and Katima in Zambia while most dry fish were exported to Kasumbalesa (Table 4).

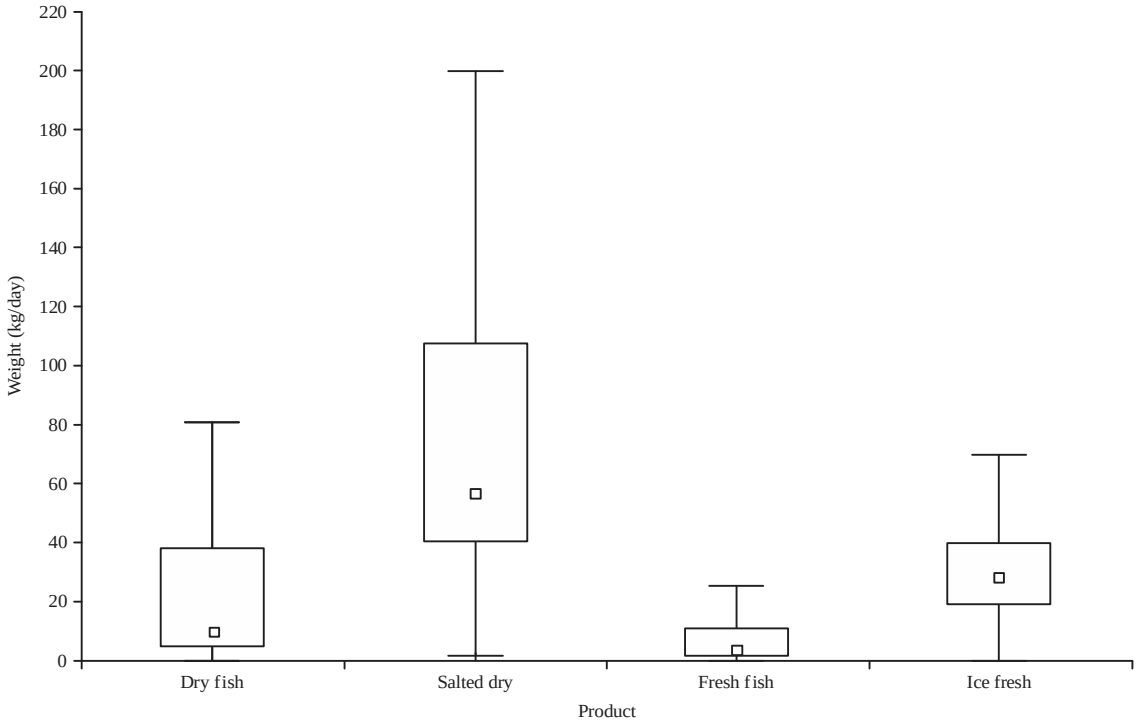

Fig. 3: Box and whisker of different processed fish products for exports at Wenela border post, recorded between June, 2015 and December, 2016

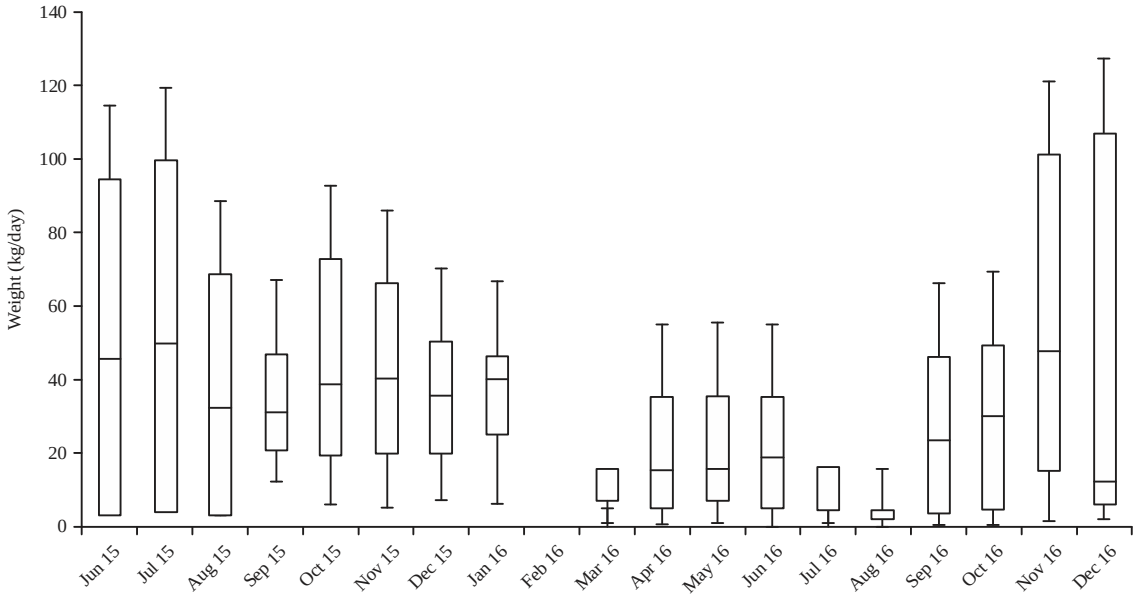

Fig. 4: Box and whisker plots of total monthly weights of processed fish products for exports at Wenela border post between June, 2015 and December, 2016

Total weight of fish exports: A total of 2918.20 kg/day of fish was recorded from June, 2015 to December, 2016 at Wenela border post, Katima Mulilo, Namibia (Table 5). By extrapolating this value to an average of 30 days in a month, this figure translates to 1,575,818.2 kg (1575.8 t) of fish exported from June, 2015 to December, 2016 (Approximately 72,214.6 kg/month).

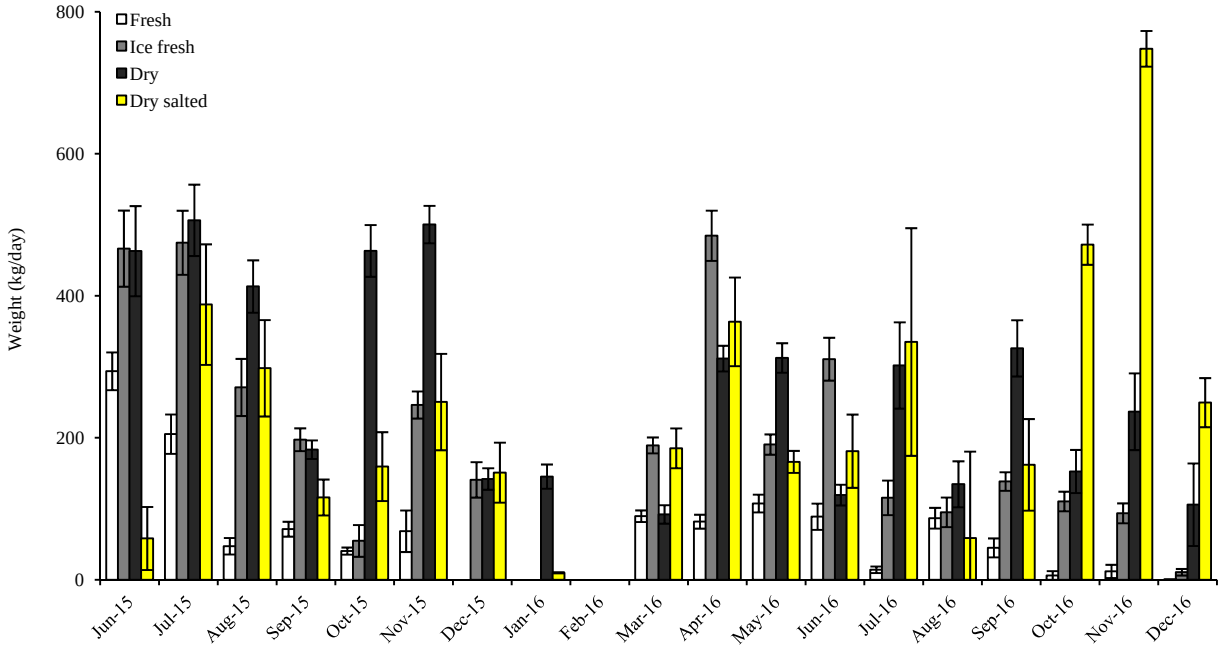

Fig. 5: Monthly weights of different processed fish products for exports, sampled at Wenela border post between June, 2015 and December, 2016

Table 3: Different processed fish products (kg/day) at Wenela border post and their areas of origin (June, 2015 to December, 2016)

	Fresh		Ice fresh		Dry		Salted dry	
Area of origin	kg	%	kg	%	kg	%	kg	%
Imusho	1.8	0.01	-	-	789.90	4.14	41.80	0.22
Katima Mulilo	1116.3	6.11	3467.60	18.18	2368.14	12.42	1414.54	7.42
Masokotwani	1.6	0.01	0.00	0.00	158.30	0.83	230.80	1.21
Muyako	108.4	0.60	135.20	0.70	1146.49	6.01	6089.20	31.92
Lusu	15.2	0.08	0.00	0.00	85.40	0.45	97.30	0.51
Ngala	-	-	-	-	-	-	67.00	0.35
Kapani	1.0	0.01	-	-	70.00	0.37	-	-
Linyanti	-	-	-	-	-	-	28.30	0.15
Lyansulu	-	-	-	-	1.85	0.01	-	-
Malundu	-	-	-	-	58.30	0.31	-	-
Zilitene	1.8	0.01	-	-	0.18	-	541.40	2.84
Angola	-	-	-	-	43.10	0.23	-	-
Bukalo	53.0	0.28	-	-	-	-	-	-
Ihaha	-	-	-	-	3.20	0.02	-	-
Kalimbeza	0.7	-	-	-	-	-	-	-
Kwena	0.2	-	-	-	0.28	-	41.50	0.22
Libula	-	-	-	-	4.50	0.02	-	-
Lisikili	-	-	-	-	1.40	0.01	-	-
Machita	1.5	0.01	-	-	18.10	0.09	-	-
Musanga	-	-	-	-	1.70	0.01	-	-
Nachisangani	-	-	12.80	0.07	-	-	-	-
Nakabolelwa	-	-	-	8.12	0.04	-	-	
Namwi	-	-	-	-	16.30	0.09	-	-
Ngoma	-	-	-	-	10.70	0.06	-	-
Sangwali	-	-	-	-	0.30	-	-	-
Total	1301.4	5.70	3615.6	18.90	4786.3	25.10	8551.8	44.80

Table 4: Different processed fish products (kg/day) at Wenela border post and their areas of destination (June, 2015 to December, 2016)

	Fresh		Ice fresh		Dry		Salted dry	
Region of destination	kg	%	kg	%	kg	%	kg	%
Boma	-	0.00	41.00	0.22	-	-	0.00	-
Choma	-	0.00	-	-	194.33	1.06	44.40	0.24
Kalomo	8.30	0.05	-	-	-	-	-	-
Kashongami	0.00	0.00	-	-	3.13	0.02	-	-
Kasumbalesa	86.8	0.48	96.10	0.53	634.91	3.48	8110.0	44.43
Katima	451.0	2.47	624.50	3.42	322.70	1.77	28.60	0.16
Kazungula	-	0.00	14.50	0.08	3.86	0.02	-	-
Kitwe	3.3	0.02	11.70	0.06	273.11	1.50	-	-
Likanda	1.2	0.01	-	-	1.43	0.01	-	-
Livingstone	5.1	0.03	911.10	4.99	1181.65	6.47	141.60	0.78
Lusaka	-	0.00	56.40	0.31	425.68	2.33	105.50	0.58
Lusu	2.5	0.01	-	-	1.10	0.01	-	-
Lyamangu	0.9	0.01	-	-	4.00	0.02	-	-
Mangamu	-	-	-	-	1.38	0.01	-	-
Manyekanaga	-	-	-	-	0.76	0.00	-	-
Mayondo	-	-	-	-	10.50	0.06	-	-
Mazabuka	-	-	-	-	76.17	0.42	-	-
Mukusi	-	-	-	-	0.18	0.00	-	-
Mwandi	52.5	0.29	-	-	2.14	0.01	-	-
Mulobezi	-	-	-	-	0.71	0.00	-	-
Mushukula	-	-	-	-	0.83	0.00	-	-
Nalisa	0.4	-	-	-	3.65	0.02	-	-
Nangula	0.5	-	-	-	-	0.00	-	-
Sikauzwe	-	-	7.50	0.04	1.67	0.01	-	-
Sililo	-	-	-	-	80.33	0.44	-	-
Simungoma	-	-	-	0.00	8.13	0.04	-	-
Sisheke	592.8	3.25	1664.8	9.12	1630.73	8.93	101.80	0.56
Sizuka	-	-	0.10	-	-	-	-	-
Nambwe	-	-	-	-	1.00	0.01	-	-
Nakatindi								
-	-	-	-	226.33	1.24	-	-	
Total	1205.2	6.60	3427.61	18.78	5090.40	27.88	8531.94	46.74

Table 5: Mean weight (kg/day) of fish products exported via the Wenela border between June, 2015 and December, 2016 (N = 570 days)

Fish products	Fresh	Ice fresh	Dry	Dry salted	Total
Actual mean weight (kg) exported/day	57.4	194.3	260.9	450.4	963
Mean weight exported (kg) per day (dry weight converted to wet weight)	57.4	194.3	790.6	1364.8	2918.2
Mean weight (kg) exported per month (dry weight converted to wet weight) (Extrapolated to a one month period)	1722.0	5829.0	23718.2	40945.5	72214.6
Total weight (kg) exported for the period June, 2015 to December, 2016 (dry weight converted to wet weight)	30996.0	104922.0	426927.3	737018.2	1575818.2

Table 6: Total value (expressed in Namibian dollars) of fish exported through Wenela border between June, 15 and December, 2016

Product types	Fresh	Ice fresh	Dry	Dry salted	Total
Mean weight (kg)/day	57.4	194.3	260.9	450.4	963
Value/kg (N$)	27/kg	27/kg	80/kg	80/kg	
Total value/day (N$)	1549.80	5246.10	20872	36032	63699.90
Total value/month (N$)	46494	157383	626160	1080960	1910997.00
Total value for 19 month (N$)	836892	2832894	11270880	19457280	36308943.00

Economic values: The prices of fish bought as whole sale from various areas in the Zambezi Region was dependent on quantity and demand. The average price obtained at the Katima Mulilo market was N$27/kg for fresh fish and N$80/kg for dry fish (1US$ = N$13.00 in 2015/16). Based on the above figures, the results showed that, daily fish products worth N$ 63 699.00 was recorded for exports at Wenela border post between June, 2015 and December, 2016 (Table 6). This value translates to approximately N$ 1910997.00 (1.9 million) per month and N$ 36308943.00 (36 million) over 18-month (June, 2015 to December, 2016) (Table 6).

Characteristics of fish processors: The current study has identified women as key players in the fish processing and preservation activities on the Zambezi/Chobe floodplain in the Zambezi Region of Namibia. In an earlier study, Purvis[10] observed that where the fisherman is part of the household, the most common entry point for fresh and dried fish into the marketing chain is through the wife or a female relative of the fisherman. As the fish are landed, the female members of the family usually sort out the catch for different uses[10]. Past reports also indicated the involvement of women as key players in post-harvest activities important for fish processing and marketing[9-13]. In some instances, women are the sole distributors of fish, which means the fishermen are dependent on the women in converting the fish into cash to sustain livelihoods. In a study in Koguta Kenya, it was reported that the migration of men to fishing camps and urban centers has left women to take up duties traditionally performed by men[14]. It has been noted that the entry into the fish trade was prompted by finances needed for clothing and the relatively low prices of fish compared to beef[15-18]. Women occupy a central place in the fishing sector in Lake Victoria, representing 70-87% of fish-workers[18,19]. Similarly, the majority of fish processors in central riverine zones of Nigeria were dominantly females[20]. Vendors as household heads than dry fish vendors in the Zambezi Region[21]. Similarly, the vendors in Lake Victoria were dominated by single, divorced and widowed women[13]. Other reports also held that female heads of households are likely to be poorer, stressing the importance of fish handling, processing and preservation as a cheap source of livelihood in the Zambezi Region[22,23]. It was also realized that, while the fresh fish vendors preferred to sell their fish products themselves owing to the high risk of spoilage, the dry fish vendors often engaged their children and relatives to sell on their behalf. This is even as the youngest age group (20-25 years) presented themselves as dry fish vendors in this study. The results further showed that most respondents' had basic education up to primary level. In a similar study in Kenya, it was reported that most of the country's fish processors were poorly educated with 65% having not gone beyond primary education[24].

Mode of preservation and processing: Choosing whether to sell fresh or dry fish is another important choice to make, given the advantages associated with each processing technique[10]. The common modes of preservation on the Zambezi/Chobe floodplain are drying and smoking. These techniques are also widely used around the world and have proven to be efficient[20,25]. A small proportion of fish processors in locations near the markets opted to chill and sell fresh fish products at the Katima Mulilo market. Washing and chilling fresh fish help to inhibit unfavorable enzymatic and microbial processes[26] and spoilage of fish is slowed down at freezing temperatures[27]. This preservation technique inhibits the development of bacterial, fungi and micro-organisms as well as retarding fat oxidation which causes rancidity[28]. Generally, no major changes in fish processing patterns was observed in contrast to earlier studies on post-harvesting of fish in the Zambezi Region[10]. However, fish processors now dry fish in conjunction with salting[3]. Salting promotes quick drying and reduces the accumulation of mold. An earlier research report indicated that salting fish can inhibit attacks by blowflies, especially in the wet season when conditions are humid[10].

Distribution channels: It was observed that different processed fish products of these species were exported to thirty different towns in Zambia. Bulk of the fish products was shipped to Kasumbalesa, Sisheke, Livingstone and Katima in Zambia, accounting for over 90% of the total fish exports between June, 2015 and December, 2016. The fish destinations were influenced by the mode of preservation. Most of the fresh fish were exported to nearby towns such as Sisheke, Livingstone and Katima in Zambia while most of the dry fish were shipped to distant markets such as Kasumbalesa, the biggest foreign market by "volume" for fishery products[3].

Monthly volume exports: The study revealed an estimated 1575.8 t of fish exported via Wenela border post, Katima Mulilo in Zambezi region of Namibia between June, 2015 and December, 2016. This was computed from an average of 9.6 t/day and 72.21 t/month. Monthly volume of fish for exports in the study area differed significantly between seasons, with distinctive peaks in June and November each year. It has been noted that for African floodplain fisheries, flood intensity, duration and draw-down conditions produce corresponding fluctuations in fish densities[29]. Fish are vulnerable to exploitation (i) When they return back to the main channel as the water drops in July and (ii) When they are confined to the main channel during November (dry season)[29]. Elsewhere in Malawi, it was also observed that the yield and species composition in the shallow floodplain lake of Chilwa varied as the lake levels fluctuated[30]. A decline in fish exports between December and March is allied to a closed fishing season imposed by the Namibia's Ministry of Fisheries and Marine Resources between December and March[31]. Establishment of closed seasons is one of the management options in the Inland Fisheries Act and currently one of the regulations in place on the Upper Zambezi River[31].

Export value: The difference in estimated values between this study and the former can be allied to the route of distribution. Firstly, it was assumed in the former study that the Katima Mulilo market was the hub of all fish from the Zambezi/Chobe floodplain[5,9]. In contrast, the current study revealed that large proportions of fish were shipped directly from their area of origin straight to Wenela border for export. Evidently, over 4 t of salted dried fish from Lake Liambezi was shipped straight to Wenela border for exports and this was not recorded into the market survey. This could lead to a general underestimation of the tonnage and economic value of the floodplain fishery in the Zambezi Region.

Constraints and opportunities to fish exports: Weather conditions (especially during the wet season) make efficient drying of fish very difficult[10]. During the wet and cloudy season when conditions are humid, drying can be very slow. Most of the fresh fish processors stressed the lack of efficient and reliable cold storage facilities as a major constraint limiting their businesses. The absence of efficient and reliable storage was also identified as a major constraint in fresh fish trade in the Zambezi region[10].

CONCLUSION

This study revealed that women played an important role in the fish processing and marketing of the Zambezi/Chobe floodplain fishery in the Zambezi Region. The main processing techniques employed by fish vendors in the area include sun drying and smoking. These techniques are widely employed in fish preservation for both local and foreign markets. The major foreign markets for fish products from the Zambezi/Chobe floodplain fishery are found in Zambia and DRC. Most of the salted dry fish were conveyed to distant markets such as Kasumbalesa while the fresh fish were taken to nearby markets in Sesheke, Livingstone and Katima in Zambia. The major areas of origin of the fish products were Muyako village, Katima Mulilo market and Imusho in Angola along the Namibian border. Approximately 1576 t of the fish worth over N$ 34 million was exported to foreign markets between June, 2015 and December, 2016 and this suggests the fish trade could play a significant role towards the economy of the study area. However, the major constraints in fish processing and preservation in the area include seasonal poor weather conditions, lack of cold storage and poor packaging for exports. Therefore, it is recommended that government and non-governmental organizations should intervene in the provisions of infrastructures to enable the fish vendors cope with the fish processing and preservation challenges. The study also calls for training programs dedicated to training of the fish processors in hygienic handling of fish products, quality control and packaging of processed fish products to conform to human health standards. This will ensure a stable supply of healthy fish products which in turn would result in stable incomes for the traders.

NOVELTY OF THE STUDY

This study provides documented baseline information on the fish processing and exports on the Zambezi/Chobe floodplain fisheries in the Zambezi region, Namibia. Despite the complexity of the Zambezi/Chobe floodplain fisheries, the study established the operational challenges and the economic potentials of the Zambezi/Chobe floodplain fisheries. Based on these interesting findings, appropriate recommendations were made with a view to entrenching the best practices to minimize health hazards related to poor handling of processed fish products and maximize profit.

SIGNIFICANCE STATEMENT

The findings of this study provide significant information on the socio-economic aspects of floodplain fisheries often neglected in the domain of this research, yet important. The results of the study provide interesting economic information on floodplain fisheries as a source of livelihood and income generation. The study shows the economic gain and significant contribution to GDP of the study area. Based on the processing challenges identified which could threaten sustainable activities of the Zambezi/Chobe floodplain fisheries, relevant recommendations were made with emphasis on the best practices to minimize health hazards related to poor handling of fish commodity and maximizing profit.

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