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Preparation of Dried Anchovies and Herrings from Eritrean Red Sea using an Indigenously Fabricated Solar Dryer

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Abstract

Drying of anchovies (*Stolephorus indicus*) and herrings (*Herklotsichthys punctatus*) harvested from Eritrean Red sea was carried out using an indigenously fabricated solar dryer. The initial moisture content of fresh anchovies and herring was 81.14% and 90.88% respectively. At the end of drying period, moisture content of anchovies reduced to 8.72% and that for herring to 8.87%. The solar dryer was found more suitable for drying of anchovies and herrings compared to sun drying because of its higher drying efficiency. Storage studies of dried fish packaged in 150 g LDPE pouches also was carried out. Protein content of anchovies has increased from 67.08% in 0 day to 72.16% on the 15th day, and decreased to 70.60% on the 30th day. In the case of crude fat, the values for dried anchovies and herrings on 0 day storage were 4.25% and 7.02% respectively. Steady decrease in fat content during storage was noticed in both the samples. It was observed that in both the samples there was no significant difference in sensory qualities ($p > 0.05$) between days of storage. Solar drying is found as an effective method for preservation of these trash fishes.

Key words: Solar dryer, anchovies and herrings, quality

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Introduction

The fishery for small pelagic fish in Eritrea is highly seasonal. Fish start appear in the southern Red Sea coast line in November or December, but the fishing season usually starts some 2-3 weeks later and ends in May while fish schools can be seen till June. (Magoha, 2003). Fishes like anchovies and herrings are excellent source of high quality animal protein. The high content of lysine and other essential amino acids make these species a suitable complement to carbohydrate-rich diets that are consumed in places where protein sources are limited (Pellet & Young, 1990). Drying of fish after harvesting is an important stage in the processing and preservation of fish for the domestic and export market. Yet, it is at this stage where most of the fish is handled in an unhygienic manner. Solar drying is an alternative method for drying fish in hygienic conditions with zero energy costs. It saves energy and time, occupies less area, improves product quality, makes the process more efficient and protects the environment (FAO, 1991).

Presently in Eritrea, small pelagic fish such as sardine and ancovies are mainly used for the production of animal feed. The objective of this study was to develop a solar drier using indigenous materials for preparation of hygienically dried anchovies and herrings harvested from the Red Sea.

Materials and Methods

Fresh whole anchovies (*Stolephorus indicus*) and herrings (*Herklotsichthys punctatus*) used for this study were collected from the Hirgigo fishing area in Massawa, Eritrea. The fish were placed in icebox with required quantity of ice (1:1 ratio) and brought to the Laboratory.

A solar dryer was designed to dry about 5-7 kg of fish at a time. The solar dryer designed had five parts namely base frame, light absorbing chamber, wire mesh platform for drying samples, inlet and out let of air covered with wire mesh and outer covering of polythene sheet (200 micron) (Fig 1). External covering of polythene sheet allows sun light to pass through and protects fish from external contamination like dust, insects, flies and other pests. Base frame of 2 x 1 m was fabricated using wooden logs. This frame acts as overall support and avoids directed contact of fish with ground. The drying chamber had black coated aluminum sheet that helped to absorb the heat. Above the aluminium sheet there was wire mesh of equal length. Fish sample to be dried was placed on the wire mesh which allowed free movement of incoming air at the same time heat was absorbed by the black coated aluminium sheet. The area of air inlet was 0.1 m^2 whereas the out let was of 0.2 m^2. A 200 micron polythene sheet covered the entire part of the solar dryer except inlet and outlet. On one side there was an opening chamber which was used for placing samples to be dried on the rack. The out let was supported by a wooden log inclined at 45^0. Moisture evaporated was removed through the outlet along with incoming air through inlet. Fig. 2 gives an isometric view of the solar drier.

The fishes were salted with granular salt (1:1 ratio) and placed in the drying chamber. Ambient temperatures were recorded for every 5 h during the drying period. Samples were continuously maintained in the chamber till the drying process was over. The dried fish was packed in LDPE pouches and kept for storage study under ambient temperature. During the period of storage, temperature ranged between 28 and 38^0C and relative humidity between 62% and 88%.

Samples were drawn at intervals of 15 days and analyses were carried out. Protein content was determined by Kjeldahl method (AOAC, 1975). Fat content was determined by using chloroform methanol extract (Folch et al., 1957). Moisture content of fish sample was estimated by the method suggested by Bradley & Vander warn (2001). Sensory evaluation was carried out using the score sheet developed by Ahmed (2011).

Sensory analysis of solar dried fish was carried out as per Odote et al. (2010) for the three intervals (0 day, 15 day and 30 day). The sensory panellists were chosen from among College of Marine Science and Technology students. The attributes taken in the case of raw meat were colour and odour, while colour, odour, taste, bite texture and overall acceptability in the case of cooked meat. The range of score was 7 to 1.

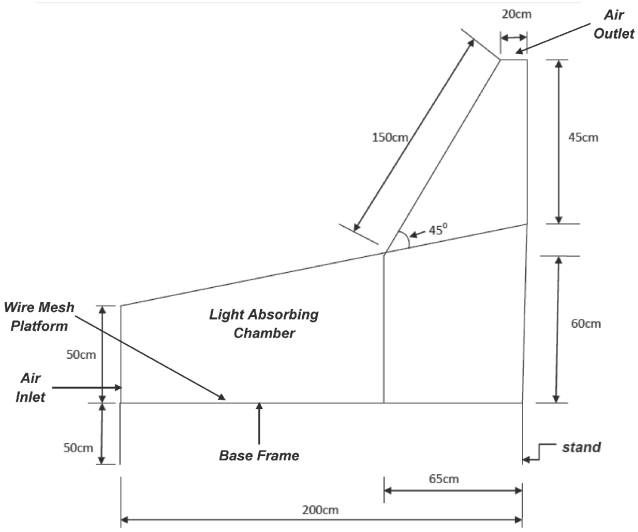

Fig. 1. Front view of solar dryer

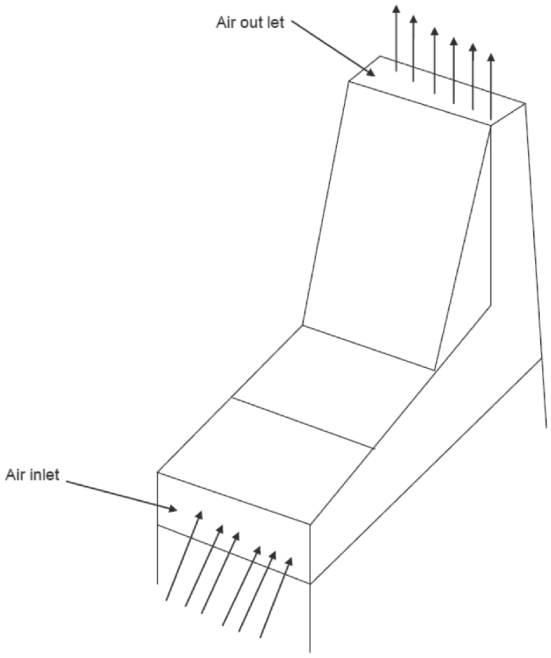

Fig. 2. Isometric view of solar dryer

Results and Discussion

Drying of salted whole anchovies and herrings was carried out using an indigenously fabricated solar dryer (Fig. 1). Temperature in the solar dryer during the drying period was in the range of 28-52^{0}C and relative humidity varied from 25% - 39%. Fish drying was facilitated by the natural air circulation caused by differential air temperatures in the solar dryer. Initially the moisture content of fresh anchovies and herring was 81.14% and 90.88% respectively (Table 1). After drying in the solar dryer, the moisture content of anchovies fell to 8.72% and that of herring to 8.87%. It was reported that in the case of *Pampus argenteus* dried in solar dryer, the average moisture content was 14.87% (Morshed et al., 2004). Protein and fat content did not show any steady pattern of change during the storage period of 30 days. This observation is in agreement with the findings of Dewi et al. (2011) in shark samples stored at room temperature.

As can be seen in Fig. 3 there was a slight decrease in the sensory quality of both the fishes from 0 day to 30 days storage. Colour score for raw herring increased from 5.2 to 5.5 and odour decreased from 5.6 to 5.1. In dried samples, colour increased uniformly from 5.2 to 5.4 whereas odour decreased from 5.6 to 4.7. Scores obtained for taste decreased from 5.5 to 5.3. Texture score showed increase from 5 to 5.5. Based on two way ANOVA no significant difference ($p > 0.05$) was observed between days of storage for both samples.

It was observed that solar dryer was more suitable than sun drying for drying of anchovies and herring. This is because of its higher drying efficiency. Fat content of herring was 0.366% and that of anchovies was 0.12%. Since herring was having more fat content it took longer time for drying than anchovies. The time taken for drying anchovies was 48 h while for herring it was 72 h. During the period of drying ambient temperature ranged from 28 to

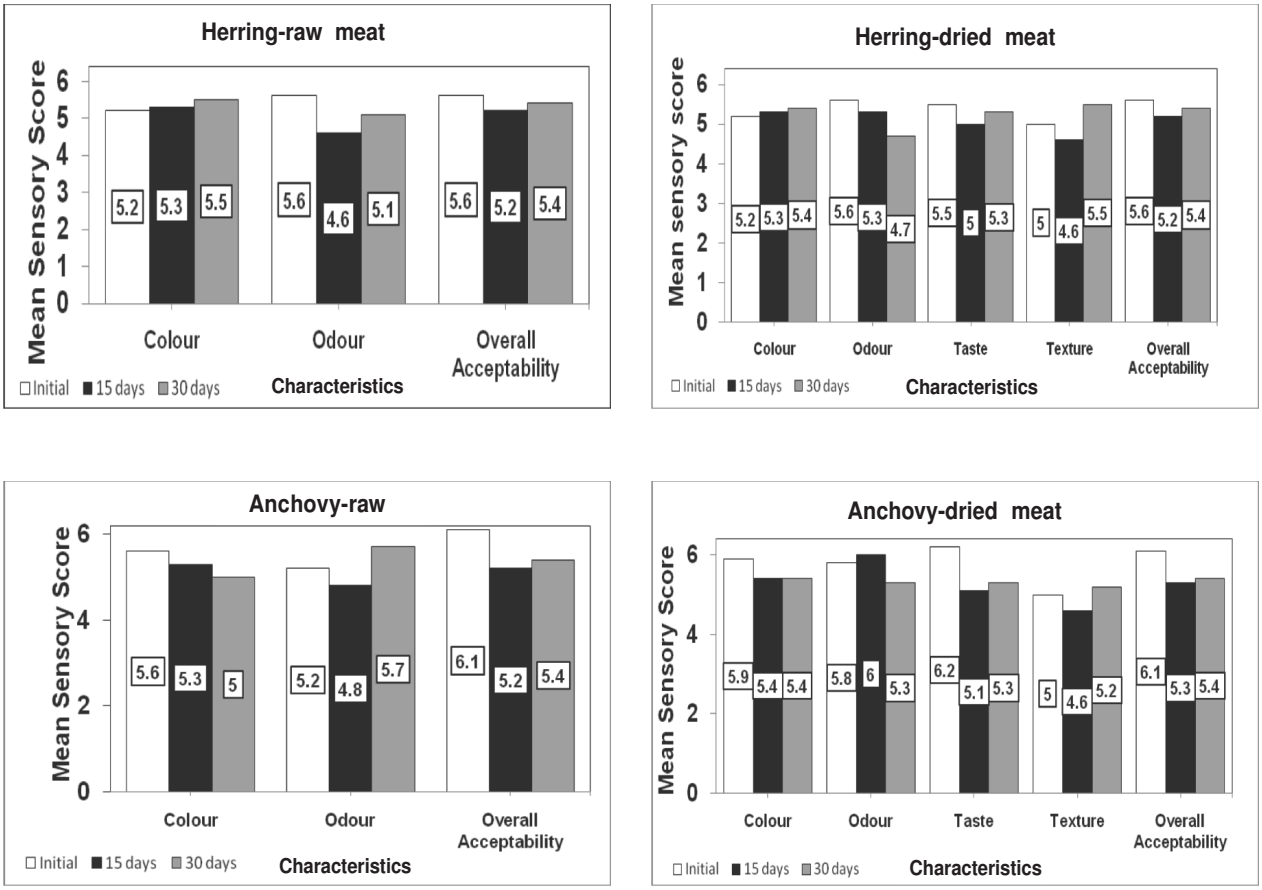

Fig. 3. Sensory evaluation of herring and anchovies

Table 1. Biochemical composition of anchovies and herrings, during solar drying and storage

Parameters	Fresh fish		Storage period of dried samples					
			0 day		15 day		30 day	
	Anchovy	Herring	Anchovy	Herring	Anchovy	Herring	Anchovy	Herring
Moisture at 100°C %	81.14	90.88	8.72	8.87	9.72	10.58	10.16	11.58
Crude protien (%N x 6.25) %	17.78	16.06	67.07	58.89	72.60	65.63	70.59	61.62
Crude fat %	0.120	0.35	4.24	7.02	3.87	8.44	3.20	6.28

38°C and relative humidity was in the range of 62-88%. Komolafe et al. (2011) designed and constructed a similar fish dryer to alleviate the problems associated with fish processing in Nigeria. A comparison between traditional sun drying on rocks, drying on racks and drying in three types of solar dryer was conducted on the Galapagos Islands, Ecuador (Trim & Curran 1983). The solar dried fish had a lower moisture content (13%, on average) than sun dried sample (21%, on average). On a cost basis, the solar tent dryer (Doe et al, 1977) was slightly cheaper than the solar cabinet dryer (Excell & Kornsakoo 1978) and considerably less than the cabinet dryer (Brace Research Institute, 1973). The three solar dryers had about 60% more area (mass of dried fish m^{-2} day^{-1}) than the sun drying methods (Doe et al., 1977). Morshed et al. (2004) designed and developed solar tunnel dryer with locally available raw materials having length 20 ft and width 3 ft to produce improved quality dehydrated *Amblypharyngodon mola* and *Pampus argenteus*.

Present study reveals that drying fish using solar dryer and hygienic packaging in LDPE pouches has positive influence in enhancing shelf life of dry fish. In a country like Eritrea there is a great need for preserving trash fishes such as anchovies and herrings in peak seasons for human consumption. Solar drying is an effective method for preservation of these trash fishes.

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