SKILLED STUDY OF DRIED STELOPHORUS HETEROLOBUS, SARDINELLA GIBBOSA USING OPEN SUN STAND AND SOLAR SHELTER DRYING METHODS: A COMPARATIVE STUDY

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Abstract:
Investigation of processing of dry-salted fish is described. The use of a satisfactory ratio of salt to fish, optimization of salting time and the use of mechanical driers to decrease drying time. The open sun stand and solar shelter drier were evaluated for their drying efficiency to assess the excellence of Stelophorusheterolobus and Sardinellagibbose. The highest mean temperature in the solar shelter drier was found to be 450 c, with relative humidity 42%, while in the open sun stand drying was 350 c, with relative humidity 47% at an air speed of 1.8 meter per second. The average moisture, crude protein, total lipids, free fatty acid, peroxide, total volatile basic nitrogen and ash constant of the solar shelter dried products were 7.5 %, 79.32%, 3.74%, 0.50%, 14.66%, 19.65% and 9.90%, and for open sun stand were7.7% 75.32%, 3.20%, 0.54%, 13.66%, 21.80% and 9.20%, respectively. Total plate count (TPC) of 3.2 × 103 cfu/g and 5.7 ×103 cfu/g was found within the average level for solar shelter and open sun stand driers respectively. Theexcellence of the fish products dried in the solar shelter drier was superior compared to that of open sun stand-dried products. It took only three days for the fish to be dried in the solar shelter drier compared with the open sun stand dried fish products which took five days to dry.
Keywords:

1.Introduction:

Fish represents a valuable source of protein and nutrients in the diet of many people and its importance in causal to food security is rising significantly. Retaining the nutritional value of fish, preserving the benefits of its rich composition and avoiding costly and debilitating effect of fish-borne illnesses are significant. Many different techniques can be used to preserve fish quality and to increase shelf life. One of these techniques is based on temperature control and encompasses a wide array of methods used to decrease or increase the fish temperature to levels where metabolic activities catalysed by autolysis or microbial enzymes are abridged or completely stopped (FAO, 2009).

On a finished product basis this amounts to 77% of the total edible output of processed fish (Abdullah &Idrus, 1978). Dry-salted fish forms a relatively cheap source of high-quality protein especially for those residing in the rural areas. Except for the concrete vats for salting and the bamboo or wooden platforms for sun drying, no other equipment is used, Salting is carried out in concrete vats by arranging the fish in alternate layers with coarse rock salt. In order to prevent the fish from floating, weights are placed on the surface. The vats are housed within sheds to avoid excessive sun and rain and the length of salting times ranges from 1 to 5 days. When salting is complete the fish are removed and washed in the sea or brackish water to remove adhering salt. Sometimes the fish are soaked for 10-30 min to remove excess salt.

Sun-drying is the mutual practice and no mechanical driers or any other forms of accelerated drying methods are used. The fish are spread out on bamboo stages or on the ground and are decided so as to simplify drying. Bigger fish are split open and flattened out and may be hung by the tail to dry for a day before being transferred to the drying platforms. In some areas along the east coast, pepper is rubbed into the gut cavity and cut surface of the fish to prevent spoilage. This process is only carried out for fish that will fetch a good price. On the west coast, processed alum is used instead. Insect infestation becomes more serious in damp weather. During drying the fish are turned over once or twice daily. Processors detect the stage of drying usually by pressing the fish with the hand, by judging the colour and appearance of the skin and by the condition of the eye. If the eye is clear and not watery, then the fish is considered sufficiently dried. In the last stage of processing, the dried fish are packed into cardboard boxes which may be lined with polythene sheets before dispatch to the wholesaler. Storage conditions are poor and no attempts are made to maintain the quality of the fish during transit.

Anchovies are small pelagic fish start to appear in the catches in late September or early October. The season ends around March/April but schools are said to be spotted until May, as reported in 1971. Sardine (Harengulapunctata) and anchovy (Stelephorusheterolobus) resources have been estimated at about 30,000 metric tons per year from the Red Sea of Eritrea from 1993 to 2008 (Pasience, 2009; FAO, 2015). Anchovies and Sardinellagibboseare highly nutritious food and particularly valuable for providing protein of high quality, better than those of meat and egg. However, they are the most perishable of all the foods because their suitable medium for growth of micro-organisms after death (Kader, 2005). Thus, the problem of spoilage could be solved and the shelf life can be extended by preservation using solar drying techniques. Sun drying is one of the traditional simple and economical methods employed to preserve fish, particularly small pelagic fish (Relekar, Joshi, Gobe, &Kulkarni, 2014). Some limitations of sun drying can be improved raising the drying fish rack off the ground on wooden frames which allows air to circulate in all the directions, that facilitates water evaporation from both sides (Sankat&Mujiaffar, 2004). Solar drying is an improved method of sun drying. It minimizes or stops some of the limitations of open sun drying (FAO, 1981; Relekar et al., 2014). Solar drying differs from open sun drying in a structure, often very simple in construction, which is used to enhance effect of the insulation (Yu, Siaw, &Idrus, 1982). This is due to the truth that solar Shelter dryer is asurrounded structure that traps heat inside the Shelter and make efficient use of the heat which is entrapped inside the Shelter during the day by the help of some rocky black stones that absorb heat (Doe, Ahmed, Muslemuddin, &Sachithhanathan, 1977). The end product has a long shelf life, providing a source of protein, vitamins and minerals when the fresh fish themselves may not be available in offseason (Sankat&Mujiaffar, 2004). For receiving better quality dried fish, it is very important to use better-quality method of fish drying. Indeed, the present study focused to determine and compare quality of dried anchovy by solar Shelter and open sun stand drying methods and to adopt improved method to get improved quality of dried anchovies. This type of drier is experienced for the first time in Eritrea which could be very useful to solve the afro- mentioned problems and improveapplication of the resource in an effective way. Moreover, anchovies are used as animal feed although the people are suffering from nutrition of fishery products. Despite the huge resource, the utilization is very low and these problems have prodigious impacts on the operative utilization of the resources. The main objective of the present study was to determine and to compare quality of anchovies Stelophorusheterolobus and Sardinellagibbose by measuring the proximate composition, chemical, microbial and sensory attributes of dried anchovies under open sun stand and solar Shelter drying methods.

2. Methods and Materials:

2.1 Raw materials:

The speciesStelophorusheterolobus and Sardinellagibbose was used, as it is the most commonly available dry-salted fish. The fish (Stelophorusheterolobus average thickness 4cm, average weight 17gm; Sardinellagibboseaverage thickness 6.5cm, average weight 30 gm were purchased fresh from the market and used for salting on the same day. Fine table salt was used.The experimental fish was anchovy, Stolephorusheterolobus,collected from Kanyakumarion 18/06/2022 using beach purse seine net and kept in fish boxes using ice for four days, ice was replaced. The fish samples were washed with potable water properly and decapitated. The beheaded fish were placed on the solar Shelter dryer and open sun stand drying. The temperature, humidity, wind speed was measured using thermometer (LCD portable multisystem thermometer, No. 201211253516 Hutaib Enterprise, India), hygrometer (Lutran HT-3003, Taspei, Taiwan), vane anemometer (KM-8022, No. VA 120708245, Kusma-mecor, India) respectively. At the end of the drying period, dried fish were collected and wrapped polyethylene bag after 1day, 3 days and 5 days and kept under refrigeration for further analysis.

2.2 Construction of Solar Shelter and Open Sun Stand Dryers

The solar Shelter drier was constructed in Stellamaris Institute of Developmental Studies (SMIDS) (Figure 1). It consists of a plastic polythene sheet stretched over a wooden frame work (1 m wide by 1.5 m long by 1.5 m high) with side and top vent (0.3 m by 0.3m). The fish stand (0.5 m by 0.5 m) was placed with wire mesh under and underneath black rocks, which can be used as a heat collector and transmitter area. The transparent plastic on the front side was wrapped around a stick at the bottom. In this way the plastic can be rolled up or let down to allow air into the Shelter and to regulate the temperature a bit. The air entering is heated in the Shelter and absorbs moisture when it flows pass the fish on the stand. The humid air can leave the Shelter through both air outlets in the top of the Shelter. Open Sun drying stand was constructed by a wooden frame of 0.5 m by 0.5 m and was constructed from chicken wire mesh that was placed directly under the sun for maximum heat utilization from the sun.

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2.3 Setting-up the Dryers

The two dryers were set-up side by side and exposed to the sun. The Shelter was positioned facing the direction of the prevailing wind, to allow air readily into the Shelter, since the drying process is a combination of air movement. A black igneous rocks were used that generate heat and black polythene was spread out on the base of the solar Shelter drier. Drying stand was fixed rigidly inside the Shelter and open sun drying stand was outside of the environment and heat. The dryers where set-up 30 minutes before fish were put inside.

Figure1. Open Sun Stand and Solar Shelter Drying Models.

2.3 Quality Evaluation

Quality of dried fish (Stolephorusheterolobus) were subjected to proximate composition, microbiological and organoleptic analysis.

2.4 Proximate Composition Analysis

Proximate analyses were carried out on the fresh and dried fish, on day 1, 3 and 5 respectively in Eritrean Standard Institution (Asmara) and Quality Control Laboratories (Massawa). For fresh fish, the proximate composition was determined from the body muscle tissues whereas, dried one's, it was carried out from dried flesh. The analysis were done according the method of Association of Official Analytical Chemistry (AOAC, 2000). The following parameters were measured: crude protein (Kjeldahl method), ash (muffle furnace), crude fat (Soxhlet method), moisture content (thermostatically controlled forced air oven, 105o c for 8 hours), free fatty acids (FFA) value, peroxide value (PV) and total volatile basic nitrogen (TVB-N). The analysis was carried in triplicate and the average values were calculated and expressed as mean ± SD in triplicate observation.

2.5 Protein Content

Crude protein was determined using the microKjeldahl method (AOAC, 2000). About 0.5 g powder laver sample was used to analyze protein of commercial laver. The total protein was calculated by multiplying the nitrogen content a sample with a conversion factor of 6.25. Data was expressed in grams per kilogram of dry weight sample.

2.6 Ash Content

Ash content was determined by complete igniting of the sample (5 gram) in a muffle furnace at a temperature of 550 °C for 6 hours and ash was calculated in percentage as:

2.7 Fat Content

Lipid content was determined by extracting required quantity of samples with analytical grade nhexane for 8 hours in a ground joint Soxhlet apparatus. The oil obtained by evaporation of the solvent on a steam bath was weighed in a sensitive balance and percent lipid was calculated and the extracted fat was used for the determination of free fatty acid and peroxide value. The fat content was calculated in percentage using the following formula:

2.8 Moisture Content

Residual moisture was determined gravimetrically by heating the sample at 105 ^{0}C for 8 hours in hot air-drying oven until a constant weight has achieved. The moisture content was stated as percentage by dry weight of sample.

2.9 Determination of acid value or free fatty acids (FFA)

Two gram of fish oil dissolved in 15 ml of neutral fat solvent and few drops of 1% phenolphthalein indicator was added. The mixture was titrated against 0.1 N NaOH until faint pink colour persisted for at least 30 seconds in the fume hood. The free fatty acids were calculated and expressed as percentage of oleic acid by the formula:

2.10 Peroxide Value

Primary oxidation products in fish, hydro peroxides, were determined by peroxide value measurement. Peroxide values of fresh and dried fish oils were measured by titration of liberated iodine with standardized sodium thiosulphate solution according to the AOAC official method (2000).

2.11 Total Volatile Basic Nitrogen (TVB-N)

The total volatile basic nitrogen was determined by Conway's micro-diffusion analysis (Osman, Suriah, & Law, 2001). In the procedure, the trichloro acetic acid (TCA) extract prepared sample was treated with potassium carbonate, ammonia liberated and absorbed by boric acid. The quantity of ammonia absorbed was volumetrically determined by titrating the ammonium borate against standard sulphuric acid. The TVB-N content was calculated and expressed as milligram nitrogen per 100 g sample.

2.12 Chemical analysis

Only the fish fillet which had been finely ground was used for analysis. Crude protein (NX6.25) was determined by the Kjeldahl method (Pearson, 1970). Crude fat was measured by the Soxhlet method using petroleum ether and sodium chloride (chloride ions) by the precipitation method (Pearson, 1970). Salt analysis was carried out using the modified method of Kam, Bauntlett and Smith (1964). Moisture content was determined using the oven method of Pearson (1970).

2.13 Salting

The fish were descaled, eviscerated and washed in clean water. They were then placed in alternate layers with salt in a salting vat (61 cm X 41 cm x 15 cm) and then covered with a plastic sheet and stored at room temperature (24°C). Salt ratio's of 10,20,30 and 40% (wlw) were used. At predetermined intervals samples were taken for analysis of salt and moisture.

2.14 Drying

For sun-drying, the fishes were dried to constant weight by suspending by the tails from hooks inside a drying chamber, consisting of stands supported by a metal frame covered with wire mesh. The fish were kept at a distance 15 cm apart in a staggered formation to ensure efficient circulation of air. The average temperature of the atmosphere during the drying period was 26.7"C and the relative humidity was 95.9%. Average wind speed was 1 mlsec. The oven-dried fishes were dried in a forced-air cabinet drier (Apex, U.K.) at 45°C using an air speed of 2.5 mlsec. The fish were placed on their sides on wire mesh and were turned over frequently for more uniform drying. The dried fishes were kept in sealed polyethylene bags until ready for sensory evaluation. 214 S. Y. Yu, C. L. Siaw and A. Z. Idrus

2.15 Sensory evaluation

A total of thirteen experienced panelists were chosen as assessors. The fish were cut into cubes (1.5 cm x 1.5 cm x 1 cm) and fried in vegetable oil at 200°C for 2-3 min before tasting. The panel was asked to assess the appearance, texture, flavour, presence of undesirable odour and overall acceptability of the samples using a hedonic rating scale of a maximum of five points for a favourable response. All samples were identified only by random numbers. The results were analysed using the Least Significant Difference method.

3.Results

The proximate and biochemical analysis of the fresh and dried StolephorusheterolobusSardinellagibbose were the open sun stand and solar Shelter driers are presented in Table 1. In this study significant difference was observed between the two drying methods, which was 3 days for the solar Shelter and 5 days for open sun stand drying methods resulted differences in the analysed parameters ($P \leq 0.05$), but there was no significant difference ($P \geq 0.05$) among the days of drying. All the proximate and biochemical composition, except moisture content were increased with drying time in both driers. The drying time was shorter in solar Shelter drier compared to open sun stand drier. Increase in temperature resulted in shorter drying time. The drying time was three days in solar Shelter drier and five days in open sun stand drier. The moisture content obtained from the solar Shelter drier decreased more than in the open sun stand drier which showed significant difference ($P \leq 0.05$). The contents of ash, fat and Table 1. The average values of Proximate Composition, Peroxide Value, Free Fatty Acid, and Total Volatile

Table 1. The average values of Proximate Composition, Peroxide Value, Free Fatty Acid, and Total Volatile Base Nitrogen, of Fresh and dried Stolephorusheterolobus And Sardinellagibbose

Parameters	Drying day						
	0	1		3		5	
	Fresh	OSSD	SSD	OSSD	SSD	OSSD	SSD
Moisture (%) ± SD	82.0±0.74	9.00±0.69	7.90±0.68	8.9±0.24	7.50±0.34	7.45±0.34	7.37±o.22
Ash (%) ± SD	1.8±0.55	8.60±0.45	8.68±0.66	8.69±0.72	8.39±0.06	8.9±0.88	9.03±0.40

Fat (%) ±SD	1.5±0.10	2.89±0.11	3.11±0.09	3.28±0.13	2.98±0.08	3.29±0.17	2.9±0.30
Crud protein± SD	19.32±0.43	59.29±0.87	61±0.4	70.9±0.62	64±0.34	74.9±0.3	78.3±0.35
FFA AEX (%) ± SD	1.33±0.09	1.56±0.12	18.9±0.01	19.5±0.08	1.34±0.1	1.45±0.12	1.56±0.03
PV AXE (%) ± SD	4.6±0.52	14.13±0.28	13.8±0.07	13.67±0.12	12.89±0.18	12.3±0.13	13.89±0.02
TVB-N (%) ±SD	19.1±0.22	19.03±0.14	18.23±0.06	25.9±0.24	24.01±0.24	24.01±0.23	19.12±0.03

Values represent the mean ± standard deviation of fish for each drying method.
*SSD: Solar Shelter drier
*OSSD: Open sun Stand drier
*SD: Standard deviation

4. Conclusion:

In the present study, drying time was found to be different in the two drying methods. Solar Shelter drier required less time (5 days). The reason behind was circulation of hot air within solar Shelter drier, which increased internal drier temperature and reduced drying time. However, open sun stand drier required 5 days for drying fish since it was placed in an open air so there was no creation of hot air as it was in a solar Shelter drier. This finding is in agreement with (Curran, 1985), observed that three days were required for fish drying in solar Shelter drier. Also, he reported that fish dried on sloping stand-required 4 days for reducing moisture up to 20%. Table (3 and 4) describes the organoleptic indices of fresh, dried boiled and dried nonboiled fish, the results show that there was no significant difference between appearance, colour, odour, texture and flavour at level, while in the general acceptability, the method of SSD score was higher than the OSSD. None of the dried boiled products in these two drying systems had a value of less than 6.56 10-point hedonic sale measurement. In the meantime, nonboiled dried products solar Shelter a value of 7.11 and open sun stand a value of 6.44 on the 10-point hedonic sale measurement. The colour, texture and odour of dried fish were evaluated from both driers in boiled and nonboiled conditions. Although, the colour, odour and texture of fish dried in the solar Shelter dryer was having high levels of acceptability and obtained high scores by the taste panelists compared to the open sun stand dryer, the texture of nonboiled dried fish was firm, dry, good in colour, very pleasant odour and freshly appearance in both driers. The flavour of dried fish from both driers was evaluated in a dried boiled form, fish dried in 3rd day using solar Shelter dryer was found to be relatively higher in value (7.33 on the 10-point hedonic scale measurement) and showed higher level of acceptability, while fish dried using open sun stand scored lower value (6.8 on the10 point hedonic scale measurement). The organoleptic evaluation showed that the appearance of the two dryers were in good condition throughout the experiment. Also, no discoloration was observed in the driers. This result agrees with (Blight, Shaw, &Woyewoda, 1988) studies showed the dark colour and rancid odour of cured fish is an indication of deteriorated quality. The result of statistical analysis conducted using one-way analysis of variance indicated that drying had no effect on the organoleptic properties. Appearance,Flavour and colour appeared to be the three most important characteristics that influenced panel's preference for products. Colour, flavour, texture, odour and over all acceptability of sun and solar Shelter dried fish were acceptable by panelists; but solar Shelter dried was superior in quality than open sun stands dried. From the results it was observed that solar dried products provided fish with better organoleptic qualities. It is evident that the thermal energy generated helped in drying up the fish products. This heat was then transfer to the air by contact between the air and absorber and similar analysis was reported by Lawand (1966). This resulted in the higher temperature and thereby increased drying rate and also high quality of the solar Shelter dried products. This result is in agreement with the studies of (Relekar et al., 2014) who thought the consumers may have strong opinions, they usually find it difficult to explain in detail why they prefer one product to another, and the results may be difficult to interpret. The finding in agreement with studies of (Adam &Sidahmed, 2012) which showed that descriptive sensory analysis carried out by trained sensory panels provides accurate and detailed description of the sensory properties of the products under study. From this study the solar Shelter dryer has proven to be more efficient and reliable form of fish preservation using the ambient solar energy. The products were of good quality compare to open sun stand drying in terms of proximate composition, microbial, organoleptic analyses and hygienic.

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