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Biochemical and microbial qualities of *Sardinella fimbriata* sun dried in different methods

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Abstract

Normally sardines are unhygienically sun dried by keeping on the seashore, on mats or palm leaves. In the present study the biochemical and microbial qualities of fresh sardine (*Sardinella fimbriata*), naturally sun dried, hygienically sun dried using solar dryer and fish rack were assessed. The fresh and differently dried samples were bought from the coastal villages near Tuticorin town at Southeast coast of India. The biochemical composition such as moisture, ash and Free Fatty Acid (FFA) content were lower in solar dryer dried samples, whereas the values of protein and lipid were higher. The microbes and pathogens were totally absent in solar dryer dried samples. The results indicate that different drying methods have a significant effect on the biochemical composition of *Sardinella fimbriata*. The samples dried using solar dryer have comparatively good nutritional value and hygienic status followed by fish rack dried sardine.

Introduction

Fishes plays an important role in the diet of human beings since it is a good source of animal protein. Among the total fish catch in India, 32% are different species of sardines (CMFRI News letter, 2009). Five species of sardines such as *Sardinella fimbriata*, *S. longiceps*, *S. gibbsa*, *S. albella*, and *S. clupeoides* are common in the east coast of India. Large quantities of sardines are being dried and supplied to the live stock feed industries (Sablani *et al*., 2002). Fish drying methods vary from species to species based on the type of end product and its quality requirement. In some countries, the fish are boiled before being dried. Sun drying of fishes is a traditional practice followed in many parts of the world (Sachithananthan *et al*., 1985; N'Jai, 1985). It has been observed that drying is the most convenient and cheapest method of preservation (Eyo, 1986). Major problems with traditional sun drying are loss of quality due to contamination due to infestation by animals. Sablani *et al*., (2002) studied the drying rates and quality parameters of processed sardines using solar driers. Afolabi *et al*., (1984) studied the changes in nutritional and organoleptic characters of traditionally processed Nigerian freshwater fish. Eves and Brown (1993) studied the effect of traditional drying process on the nutritional values of fishes. In tropics, spoilage is rapid at ambient temperature (Igene, 1983). Fishes normally spoil within 12 - 20 hours depending on the species and the methods of capture. If the fishes are not processed immediately after they are captured, certain irreversible spoilage and deterioration reactions begin to take place (Conne, 1995). Most of the processing or preservation operations are intended to reduce the rate of spoilage by reducing water activity of the fish (Eyo, 1986).

Solar drying and its improved processes minimize or stop some of the limitations of open sun drying. Drying in solar dryer is different from open sun drying because the solar dryer is an enclosed structure that traps heat inside the drier and make effective use of the heat. Several solar dryer designs have been constructed and tested for different fish species (Ogbonnaya, 2009; Sachithananthan *et al*., 1985). The potential advantages of solar drying techniques compared with sun drying were summarized earlier by Sachithananthan *et al*. (1985). Due to the high temperature maintained in the dryer, drying time, insect infestation and microbial spoilage can be reduced considerably. Effect of two drying methods using smoking kiln and electric oven on the nutritional properties of Tilapia fish, *Oreochromis nilotieus* and cat fish, (*Clarias gariepinus)* were studied and reported high quality in electric oven dried fishes (Ogbonnaya, 2009; Ogbonnaya and Ibrahim, 2009). The sensory analysis of sun dried and solar dried fishes were done and reported that the quality of solar dried fish was preferred by consumers (Oseie and Kukah, 1989; Ojitiku *et al*., 2009). Rillo *et al*.,

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(1998) studied the microbial quality of commercially available dried mackerel of Philippines. The pores and physio – chemical characteristics of tuna dried in different methods were studied and advantages have been noted in solar dried fishes (Rahman *et al*., 2002). Tao and Linchum (2008) reported the influences of hot air and microwave drying on the nutritional and odorous properties of grass carp (*Clenophryngodon dellus*). Experimental investigation of solar drying of fishes using solar tunnel dryer has been carried out earlier by Bala and Mondol (2001). In the present study, nutritional and microbial qualities of sardines dried using three different drying methods were analyzed.

The main hypothesis of the present study is to understand the effect of different drying methods on the nutritional composition and microbial quality of sardine and to find out the best method of drying for the consumer's safety and economic benefit of the coastal society who mainly depend on the dry fish for livelihood.

Materials and Methods

In Tuticorin coast of Southeastern India, sardines with the length range of 14.5 to 15.5 cm and weighing 25 to 33 g are fished using sardine nets through out the year and used for consumption as fresh and dried forms. During summer months (April to June), the temperature ranges between 29 and 35°C and relative humidity ranges from 56 - 100%. During these months, most of the fishes are salted and naturally sun dried in coastal villages by keeping on palm leaves on the ground or on the sea shore and the product are sold in the local markets.

Hygienic sun drying on fish drying rack

For the hygienic drying, fish drying racks designed based on King and Johnson (1987). Fish drying rack was made using wooden poles and nets. Four wooden poles, 2 are taller and 2 are slightly shorter were taken and their one end is buried in sand and a square shape was formed. Then polythene net was thoroughly washed, sun dried and tied on the top in a slanting position and the square area was covered. Now the fish drying rack is ready for sun drying the fish.

Hygienic drying in solar dryer

Solar dryer was gifted by Department of Atomic Energy (DAE) to Suganthi Devadason Marine Research Institute (SDMRI) for experimental research purpose. Solar dryer is a rectangular box. The solar radiations are absorbed by black mat and the heat is send inside the box through wire to the metallic plates for hygienic drying of fishes. Since the box is closed the fishes are clean and this solar dryer dry the fishes faster than normal sun drying resulting in substantial moisture loss and weight reduction. The solar drier was given to Siluvaipatti coastal village near Tuticorin town for sun drying the fish.

Sample collection

To know the best method of sun drying of *Sardinella fimbriata*, samples were collected from different sources. Fresh and naturally sun dried sardines, at a size range of 11.2 – 13.3 cm were bought from local fish market .The fresh fishes were washed properly and dried in a hot air oven at 80°C for one day for further analysis. Hygenic sun drying of fishes using fish racks and solar drier is normally practiced only in the Siluvaipatti coastal village so that hygienically sun dried samples were collected from that coastal village and all the collected samples were brought to the laboratory for analysis.

Biochemical and microbial analysis of the samples

All samples for the present study were collected from the above-said drying activities. All the samples were powdered and used for moisture, protein, lipids, Ash, FFA analysis and microbial parameters such as Total Plate count (TPC), Total Fungal count (TFC), *Salmonella*, *Vibrio* and *E. coli* analysis. The moisture content of all the four samples was analyzed by drying the samples in a hot air oven. The protein content of the samples was estimated by Lowry's method of Lowry *et al*., (1951) and lipid by using gravimetric method of Folch *et al*., (1957). FFA content was analysed by following the titrimetric method of Ke *et al*., (1976) and the ash content was measured by Clucas and Ward. (1996) method using Muffle furnace. The microbiological characteristics such as Total plate count (TPC) were enumerated by using plate count agar and Total fungal count (TFC) was enumerated using potato dextrose agar by APHA. (1992). The pathogenic bacteria like *Escherichia coli*, *Salmonella* and *Vibrio* were enumerated by following the method of USFDA. (1995).

Results

The natural sun drying takes three days of proper drying of fish but the fish are dried in two days on fish racks assisted sun - drying, whereas fish are dried in a day in the solar dryer. The results of biochemical composition of all the samples are presented in Figure 1. Fresh samples had a moisture level of 41.3%, whereas the samples of naturally sun dried, hygienically dried on fish rack and solar

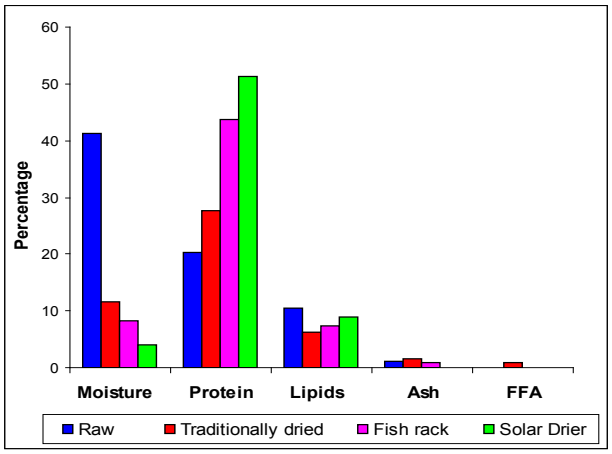

Figure 1. Biochemical composition of fresh and dried sardines

dryer dried had 11.60%, 8.3% and 4.0% moisture levels respectively. The crude protein content in fresh samples was 20.26% and it increased in dried samples. The lipid content in fresh samples was 10.5% and it varied in dried fish samples (6.3 to 8.9%) with high value in samples from solar dryer. The ash content varied significantly between samples and the value was very low (0.04%) in samples dried using solar dryer. The spoilage indicator FFA (0.02%) was very low in samples from solar dryer. Protein content varied between samples and comparatively high values were noted in dried samples and this could be the result of variable moisture content resulted due to different drying methods.

The biochemical composition data were statistically analyzed using two way ANOVA analysis. The proximate composition of the fishes dried in different methods showed a P-value of 7.783-05 and it has a significant difference ($P<0.05$) between proximate composition of the dried fishes whereas between proximate compositions of fresh and dried sardine samples had a p -value is 0.305996 and it was non significant ($P>0.05$).

The results of microbial analysis reveal that of the Total Plate Count and Total Fungal Count were high in naturally sun dried sardine, whereas it was totally absent in the solar drier dried samples. In the case of pathogens, *E.coli* is present only in naturally sun-dried samples, whereas *Salmonella* and *vibrio* pathogens were absent in all samples.

Discussion

The moisture content seems to be an exact indicator of the susceptibility of a product to undergo microbial spoilage. It has been reported that a fish well dried or moisture content reduced to 25% will not be affected by microbes and if further dried to 15%, the growth of mould will cease and thereby it increases the shelf life (Glucas, 1982).

The microbial contamination was observed in fresh and naturally sun - dried samples, but the samples dried in solar dryer were sterile due to low moisture content. Rillo *et al*. (1998) studied the microbial quality of commercially available dried mackerel of Philippines and reported presence of microbes. Microbial load in the samples from solar dryer was less due to clean and safe practice followed.

Increase of protein was due to dehydration of water molecule present between the proteins causing aggregation of protein and this result in the increase in protein content of dried fishes (Ninawe and Rathnakumar, 2008). Cowey and Sargent (1947) reported reduced moisture content and increased protein content in *Hyperopisus bebe occidentalis*. Ogbonnaya and Shaba (2009) reported that protein nitrogen was not lost during drying, so that the protein content increased with the reduced moisture content in cat fish (*Clarias gariepinus)*. The lipid contents were lower in dried samples than the fresh fish and this variation could be the result of evaporation of moisture content with lipids. The fat content may be reduced with the evaporation of moisture and increase during heat treatment. Clucas and Ward (1996) reported that inorganic contents remain as ash after the organic matter is removed by incineration. Naturally sun-dried as well as fish racks sun – dried samples had higher ash content than samples dried using solar dryer. Natural sun drying and fish racks sun drying are done in open space which allows settling of wind borne dust, insect and bird infestation and this would increase the inorganic contents in the samples and this may be the reason for higher ash content in these two samples, whereas the solar dryers are closed and so the samples are dried hygienically and have low inorganic contents resulting lower ash content. The ash content was low in solar dryer dried sample and the results are also in accordance with the earlier findings of Tunison *et al*. (1990); Ojitiku *et al*. (2009). The FFA value was nil in the fresh samples and a lower percentage was observed in the dried samples. Huss (1998) suggested that high level of FFA is an indication of microbial spoilage activity. Most fat acidity begins to be noticeable to the palate when the FFA value calculated as Oleic acid is about 0.5 -1.5 % (Pearson, 1976).

Conclusion

The present study reveals that different fish drying methods have a significant role on the proximate composition and microbial quality of sardines. It was observed that the hygienically dried samples using

solar dryer had comparatively good nutritional value and microbial quality. In general, the fish racks assisted sun – dried and solar dryer dried sardines are having better quality than naturally sun - dried sardines. The solar dryer is also useful to reduce the time of drying of fish. The saving of time and improvement of the quality in the dry fish process will help the poor Fish er folks getting better price for their products but also enhance consumer preference in the local market. In case, poor coastal people are not able to afford to have solar dryers, it is also advisable to adopt and practice fish racks assisted sun-drying method for better quality and enhanced income.

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