STUDY OF FISH WEIGHT LOSS IN SOLAR DRYER ACROSS DIFFERENT AGRO-ECOLOGICAL ZONES OF NIGERIA

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ABSTRACT

Drying sessions were conducted across Nigeria to study the interaction between fish weight loss and the meteorological parameters. Correlation analyses using weight loss values show that latitude is strongly related (r =+0.96) to weight loss of fish inside the dryer while altitude had a weak relationship (r = +0.24) with weight loss. The results show that New Bussa recorded more weight loss of fish than Jos, despite their uniform latitude. Weight loss records in Jos, was however better than those of Warri and Ibadan.

KEYWORDS: Meteorological; Drying; Weight loss; Solar dryer; Correlation

INTRODUCTION

The relative high moisture content and high degree of unsaturated fatty acids in fish accounts for its perishability either during processing or storage. Recent developments in fish preservation suggest that dynamic aspects of fish systems rather than equilibrium properties could be very crucial in extending the shelf life of processed fish.

Basically, in tackling the problems of post harvest losses in the developing economies, the role of the fish scientist would mean exploring means to maximizing yields, assure safety and ultimately to transfer product technology from one country to another. There is much potential for the study of fermentation processes, mechanics of smoking as well as frying to develop quality products in a friendly environment. Equally, it is increasingly important to understand the basic interactions between the deteriorative processes, the products formed in these processes, and the effects of external factors influencing these processes. This will also provide a firm basis for the technology, and identify critical points at which greater success may be achieved in controlling quality deterioration and functional properties in order to provide a firmer basis for predictive methods of quality deterioration.

Fish preservation requires both basic and adaptive research. In sun-drying, energy is used to evaporate the water. The main sources of energy are solar energy, used either directly as in sun-drying, or indirectly as in crib drying; and energy derived from burning material such as wood, coal, gas or oil. In all cases, except direct sun-drying, the energy is transferred to air (the temperature of which is thus increased), and thereafter to the fish where it evaporates the water and is itself cooled.

During the day ambient air increases in temperature as a direct result of the sun's heating effect. The air stores the sun's energy which can then be used to dry fish during the day. During the middle hours of the day, the air temperature is raised but relative humidity is also reduced allowing air to have an increased capacity for drying through its increased temperature, and therefore more energy available for evaporation.

The drying of food is the world's oldest known preservation method, and dried fish has a storage life of several years. The method is cheap, the work can be done by the fisherman and family, and the resulting product is easily transported to market.

As has already been acknowledged by previous studies such as those of Trim and Curran (1983), Doe *et al.* (1977), Doe (1998), Jason (1988), and Eyo (2001), the primary principles behind the sun drying of fish using traditional open sun methods or solar dryers are meteorological. Thus, it requires a proper understanding of the working of these principles to obtain better and faster drying. The physics behind the natural drying of fish is the interplay of temperature, relative humidity, sunshine duration, and radiation and wind speed. Previous studies took these parameters into consideration while calculating drying rates. Attempt is made in this study to correlate all these parameters and see their individual impact on the rate of fish drying using fish weight loss data from the Kainji Solar Dryer.

MATERIALS AND METHODS

Data for this study were collected from drying sites in New bussa, Baga, Jos, Ibadan, and Warri using a 50kg top loading casella weighing balance, thermometer, hygrometre, windvane,cup anemometer and photometre. The meteorological data were collected in March and August of 1999 and 2000, period of dry and wet season respectively. The data were collected at different times as shown in table 1.

A suitable site in each zone was chosen based on exposure to sunlight. The solar dryer made up of sticks, fish drying rack all covered by a transparent polyethylene sheet is set up before sunrise. The fresh fish to be dried were gutted from the dorsal part, washed, salted and spread on the rack inside tent. Weight loss data was obtained by deducting final weight from initial weight.

RESULTS

Table 1: Meteorological data obtained near drying site and Percentage weight loss of fish inside solar dryer in March and August 1999 and 2000

Days 3-day intervals	Weight loss %	Temperature ^{o}C	Relative Humidity %	Sunshine duration Hours	Radiation Cal/cm^2	Wind speed Km/hour
15/03/20	57.4	38.1	24.5	6.6	7.27	11
18/03/20	60.1	38.1	20.8	6.8	7.21	10.8
21/03/20	52.8	37	29	6.9	6.95	11.2
9/08/20	38.1	31	68.8	4.4	5.1	6.5
14/08/20	35.5	31.8	68	3	5.1	7.1
19/08/20	38.7	32	75.5	4.1	5.3	6.8
3/03/99	51.2	36.8	24.8	7.3	6.86	10.2
6/03/99	58.2	36.8	21.5	7.6	6.88	12.1
9/03/99	50.1	36.8	32.1	6.7	6.29	12.4
12/08/99	36.3	31.8	67.8	4.1	5.22	6.6
17/08/99	37.1	28.3	71	4.1	5.01	6.1
22/08/99	38.2	30.8	77.1	4.4	5.81	7.3

Initial weight of fish was 100g approximately

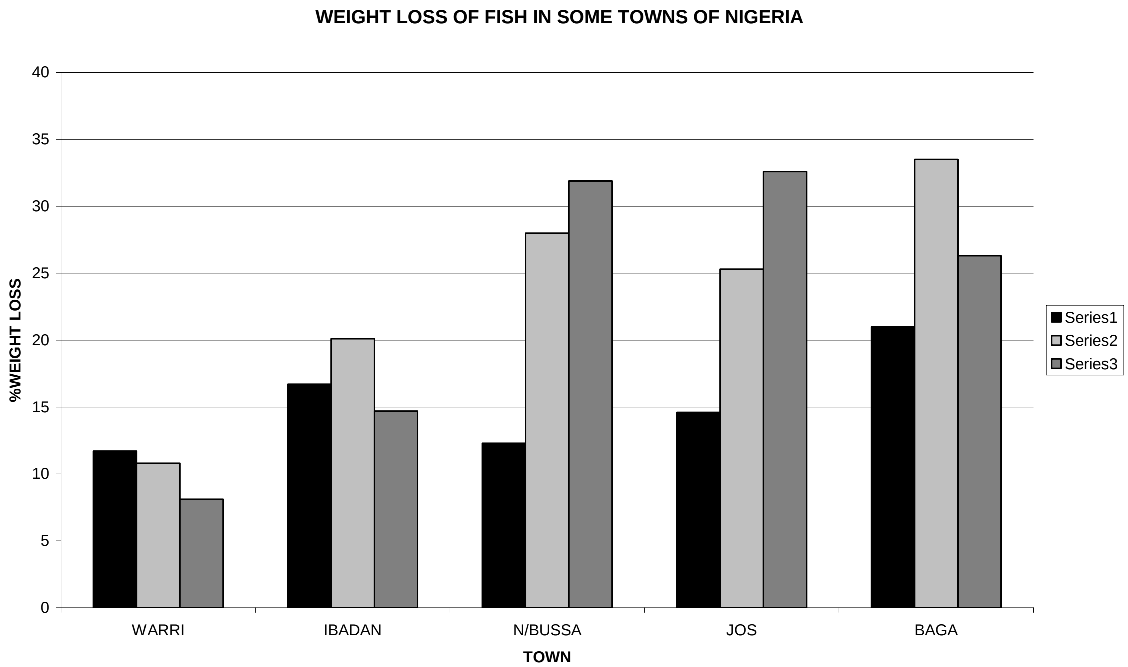

Figure 2: Weight loss of fish in some towns of Nigeria

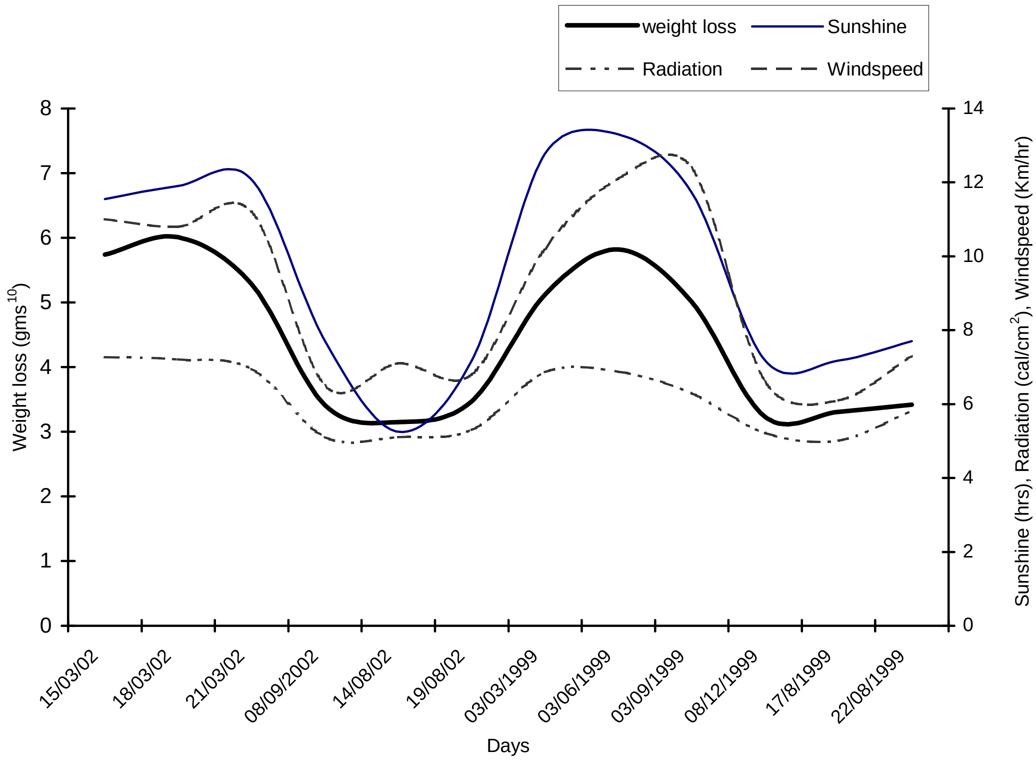

Figure 4.7: Relationship between weight loss, Sunshine, Radiation and Windspeed.

Table 2: Correlation coefficients between weight loss and meteorological parameters

	Temperature	Rel. Humidity	Sunshine	Radiation	Wind speed
Weight loss	R= +0.944	r= -0.974	r=+0.944	r=+0.970	r=+0.945

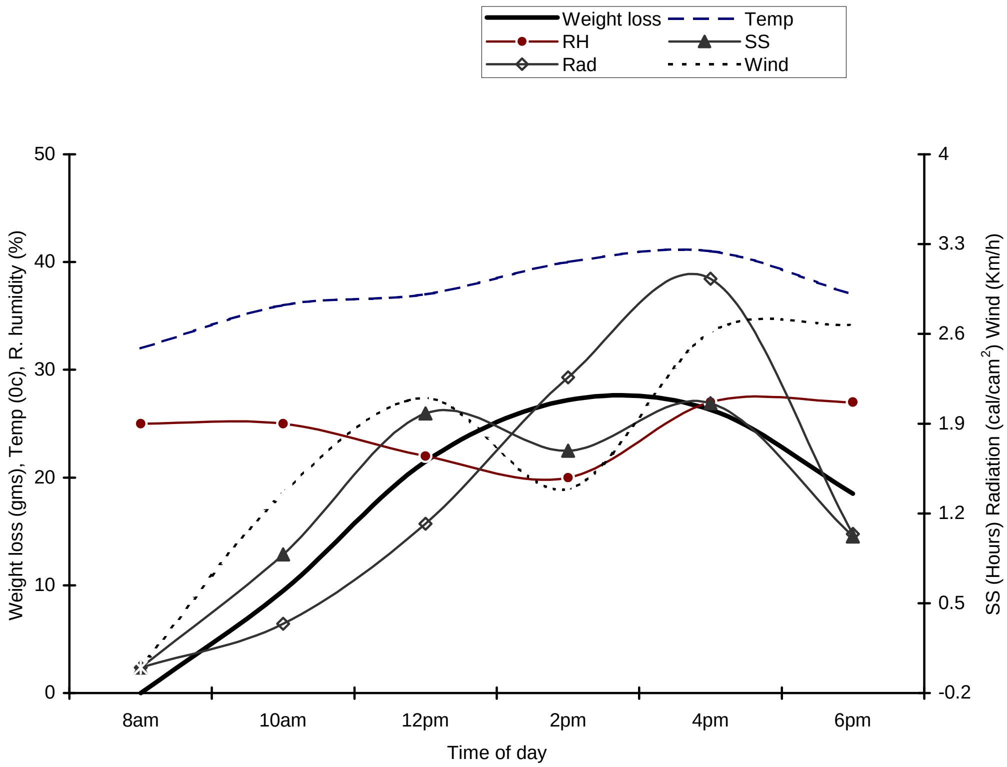

Figure 4.8 Hourly fluctuation in weight loss and metrological parameters affecting fish drying

DISCUSSION

Impact of Meteorological parameters on Weight Loss of Fish

Table 1 shows meteorological data collected during the period of fish drying trials in 1999 and 2000. These are shown against weight loss of fish in the solar dryer for the given day. The interaction between weight loss and the meteorological parameters are clearly shown in Figures 1 and 2. Figure 2 shows weight loss of fish rising and falling along with prevailing meteorological parameters from one season to another. It can be seen that, in March and August 1999 and 2000 meteorological parameters obtained outside the solar dryer were consistent with weight loss of fish inside the dryer. The line graph shows that weight loss pattern follow variability in the meteorological parameters.

Figure 2 is a typical hourly pattern of meteorological parameters obtained at the drying site within a day. It shows that fish weight loss varies not only within seasons but also within the day. The extractive forces of the solar dryer are stronger by mid-day to late afternoons. This time was observed on the field as the period when weight loss is highest. Figure 2 shows weight loss increasing from 8am to a peak between 2-4pm when radiation, sunshine and temperature are highest and relative humidity lowest. Correlation analyses (Table 2) show that relative humidity had the highest relationship though inverse (r=-0.974) followed by radiation (r=0.970). The least, but still strong, is temperature (r=0.944). This shows that meteorological parameters are the primary determinants for fish drying either in the open sun or within the solar dryer, since weight loss during drying follow the pattern of these parameters

Pilot Trial of Solar Dryer in Eco-Zones of Nigeria

Weight Loss of fish inside solar Dryer

Figure 1 shows weight loss of fish inside solar dryer in five Eco-zones of Nigeria during a pilot trial. The table shows that at the end of three days drying, weight loss of fish was lowest in Warri, (Forest Belt, latitude 5^o 30´N), with a total of 204gm or 27.6%. This is followed by Ibadan (Wooded Savanna, latitude 7 ^{o} 22´N) with a total weight loss of 329.5gm or 44%. Fishes dried in the solar dryer in Jos (Sudan Sahel, latitude 9^o 55´N) recorded a total weight loss of 411gm or 56%. New Bussa (Guinea Sudan, latitude 9 ^{o} 51´N) was next with a total weight loss of 450.5gm or 60% while in Baga north of Maiduguri (Sahel, Latitude 13^o 10´N) total weight loss was 514.3gm or 63%.

Weight loss decreased as latitude increased from the south to the extreme north of Nigeria, except for Jos due to lower ambient temperature. This is in accordance with the results of previous studies showing a strong correlation between latitude and radiation. The correlation between latitude and global radiation for instance was put at r = +0.80 (Kowal and Knabbe, 1972; Udo and Aro, 1999).

Correlation analyses using weight loss values from Table 2 show that latitude is strongly related (r =+0.96) to weight loss of fish inside the dryer while altitude had a weak relationship (r = +0.24) with weight loss. The table shows that New Bussa (Latitude 9 ^{o}.51^0N) with an altitude of 180m recorded more weight loss of fish than Jos (Latitude 9^o 53´N) with an altitude of 1275m. This is likely due to cooler climate resulting from high altitude and frequent cloud cover experienced during the trial period in Jos. Despite its altitude, weight loss records in Jos, was better than those of Warri and Ibadan.

CONCLUSION

Processing could bring about the state of thermodynamic metastability in processed fish. At high humidity, dried fish flesh may absorb moisture from the air until equilibrium is reached. However, relative humidity influenced the weight loss of fish during drying as well as radiation and temperature. Across the different agro-ecological zones of Nigeria, fish weight loss was observed to be highest in the Northeast (63%) but was lowest in the South south (27%). Drying fish to a moisture content sufficient to inhibit the growth of xerophilic moulds and insects may not be feasible for commercial storage and may be unacceptable to consumers.

REFERENCE:

Doe, P.E. (1998) *Fish drying and Smoking, Production and Quality*, P.E. Doe (ed), Technocomic Publishing Co., Inc.: 851New Holland Ave. Box 3535 Lancaster PA. 17604 USA. ISSBN: 1533766680. 400pp.

Doe, P.E. Ahmed, M, Muslemuddin, and Sachithanathan, K (1977) A polyethylene tent Dryer for improved Sun drying of fish , *Food technology in Australia,* 29, 437 – 441

Eyo, A.A. (2001*) Fish Processing Technology in the Tropics*. UNILORIN Press. Pp 130-152

Jason, A.C (1988). A Study of Evaporation and Diffusion Process in the Drying of Fish Muscle. In: *Foundamental Aspects of Dehydration of Foodstuffs. Society of Chemical industry of London*. Macmillian, New York. Pp103-135

Kowal, J.M and and Knabbe, D.T (1972). *An Agroclimatological Atlas of Northern States of Nigeria with Explanatory Notes*. Zaria Pp 14-26.

Trim, D. S. and C. A. Curran (1983). A comparative study of solar and sundrying of fish in Ecuador *Tropical Product Institute* 56 / 62 Gray`s inn Road. London. Pp 11 - 17.

Udo, S.O and Aro, T.O (1999) Technical Note Measurement of global Photosynthetically-active and downward infrared radiations at Ilorin, Nigeria. *Renewable Energy;* Vol. 17n no 1. pp113-122