ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3571958

INTERNATIONAL JOURNAL OF RESEARCH – GRANTHAALAYAH
A knowledge Repository

Science

COMPARATIVE STUDY OF THE DRYING EFFECT OF SMOKING KILN ON FRESH FISH AND FROZEN FISH

B.O. Afolabi [*1], O. Adegboye [2]
[*1] Department of Agriculture and Bio-environmental Engineering, Federal Collage of Agriculture Ibadan, Nigeria
[2] Department General Studies, Federal Collage of Agriculture Ibadan, Nigeria

Abstract

A gas powered fish smoking Kiln of 0.873 m3 capacity was utilized to investigate the possible variations in the heat utilized, body mass reduction and volume of gas utilized for drying fresh and frozen fish. Four fish types; two of frozen fish (mackerel and horse mackerel) and two of fresh fish (tilapia and catfish) of 2 kg each were prepared and were smoked for the period of 240 minutes with 30 minutes interval to measure mass reduction, volume of gas utilized, temperature variation in the smoking chamber and the vent. During the experiment, the maximum heat supplied was 128 OC and maximum heat utilized was 25 OC. The total volume of gas utilized is 5.2cm3 for the period of 240 minutes when the fishes were totally dried. The maximum body mass reduction was 1.3 kg and minimum was found to be 1.35 kg which corresponded to tilapia and horse mackerel, and mackerel respectively. The volume of gas utilized for drying each type of the fishes were ranged from 0.68 to 0.71 m3. Generally, the information gathered from this study establish the fact that other factors might be responsible for drying rate across the fresh fish and frozen fish.

Keywords: Body Mass Reduction; Drying Effect; Fresh Fish; Frozen Fish; Volume of Gas Utilized.

Cite This Article: B.O. Afolabi, and O. Adegboye. (2019). "COMPARATIVE STUDY OF THE DRYING EFFECT OF SMOKING KILN ON FRESH FISH AND FROZEN FISH." *International Journal of Research - Granthaalayah*, 7(11), 259-265. https://doi.org/10.5281/zenodo.3571958.

1. Introduction

The fisheries sector is crucial to food security, poverty alleviation and wellbeing. In 2008, the world consume 115 million tons of fish, and demand is expected to rise fish and fishery product are a vital and affordable source of food and high-quality protein. In 2008, fish as food reach an all-time high of nearly 17kg per person, supplying over 3 billion people with at least 15 percent of their animal protein intake (FAO, 2010). Fish is a major source of protein and its harvesting, handling, processing and distribution provide livelihood for millions of people as well as providing foreign exchange earning to many countries (Al-Jufaili and Opara, 2006).

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3571958

Processing of seafood mainly inhibits and/or inactivates bacteria and enzymes which results in shelf-life extension and also assures food safety. While the main role of processing is preservation, processing not only extends shelf life but also creates a new range of products (Blackwell, 2014). Smoking of fish is a major processing method prioritized in the tropics as a mean of preservation of fish from deterioration and spoilage. Also, it serves as business outlet for many through which values are being added to both fresh and frozen fish of different types. Okonta and Ekelemu (2005) submitted that fish is highly susceptible to deterioration without any preservative or processing measures. As a result of chemical compositions of fish, fish muscle is perishable and its flavor and texture changes rapidly after death and during storage (Sogbesan and Ibrahim, 2017).

In developed countries smoking of fish to increase its shelf life is not paramount due to availability of refrigeration systems and integrated infrastructures for efficient transportation of perishable farm produce are in place, rather smoking is employed to enhance the flavour of the fish. However, in developing countries, hot smoking is highly patronize as a means of fish preservation. As reported by Oyetoro et al. (2012) the utmost reason for all types of smoking is to preserve the product flavour and colour, these arise as a result of preservation function. In the process of improving shelf life and adding flavor to fish, drying is of paramount importance because level of moisture in the flesh of fish contributes to bacterial activity and spoilage (Olayemi *et al.*, 2013).

The main goal of this study is to investigate the disparity in drying rate of selected specie of frozen fish and fresh fish, which could provide vital information on processing cost for the people in smoking business.

2. Materials and Methods

The experimental design for the study involved pre-test of the smoking kiln, with the usage of cooking gas as smoking fuel. The heating chamber was lighted up to heat up the smoking chamber until temperature is constant both in the chamber and at the vent. The temperature in the chamber and at vent were noted and recorded for reference. Four types of fish samples; two frozen [mackerel and 'kote' (horse mackrel)] and two fresh [catfish and tilapia] fishes were obtained from a market in Ibadan in south west Nigeria. The samples of 2kg for each type were thoroughly washed and salted. All the fishes were smoked together at the same time for duration of 4hours. Having established the initial weights, the fishes were weighed after smoking at interval of 30minitues until a period of 240minutes was reached. Drying Rate (DR), Gas Consumption Rate (GCR), Actual Heat Utilized (AHU) and Body Mass Reduction (BMR) were observed and recorded for each types respectively alongside with supplied heat for smoking as well as actual heat used for smoking by comparing temperature (^{0}C) in smoking chamber to the temperature (^{0}C) at the vent.

Determination of BMR

The reduction in weight was determined using:

$$BMR = W_i + W_f \quad 1$$

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3571958

The percent reduction in weight was determined using

$$\%\, BMR = \frac{W_i - W_f}{W_i} \times 100 \quad (2)$$

Where
W_i = initial weight
W_f = final weight

Determination of GCR (m^3/hr)

$$GCR_i = \frac{VGU_i}{t_{GUi}} \quad (3)$$

Where:
GCR_i = gas consumption rate for drying fish *i*
VGU_i = volume of gas utilized for drying fish *i*
t_{GUi} = time taken for volume of gas utilized to dry fish *i*

But,

$$\text{VGU } (m^3) = \frac{M_f - M_i}{\rho} \quad (4)$$

Where;
M_f = mass of remaining gas after fish smoking
M_i = mass of gas before fish smoking
ρ = Density of cooking gas (1.898kg/m^3)

And,

$$t_{GU} = t_{df} \quad (5)$$

Where:
t_{df} = time taken to dry fish

Determination of AHU (^{0}C)

Actual heat utilized in smoking fish is given as:

$$AHU = T_{sc} - T_v \quad (6)$$

Where:

T_{sc} = temperature at the smoking chamber
T_v = temperature at the vent

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3571958

The data from the experiment were analysed using Microsoft Excel 2016 to present the results mainly in descriptive statistics such as tables and graphs.

3. Results and Discussions

During the smoking process, changes occurred in temperature of the smoking chamber, temperature at the vent, gas volume, colour of the fishes and consequently, in the weight of the fishes. The results of variations in 30 minutes interval of fishes weights, smoking chamber temperature, vent temperature and quantity of gas used are presented in Table 1 while Table 2 presented percentages in weight loss across the fishes. Figures 1, 2 and 3 showed the trends of variations, while Figure 4 presented results on BMR, VGU and GCR.

Table 1: Variations in Fishes Weights and Operational Parameters during Smoking

	Weight of fishes (kg)						
Time (min)	**Tilapia**	**Mackerel**	**Cat fish**	**Horse mackerel**	**T_{sc} ^0C**	**T_v ^0C**	**Weight of Gas (Kg)**
0	2	2	2	2	103	93	9.2
30	1.75	1.8	1.7	1.75	82	75	8.7
60	1.5	1.5	1.45	1.5	90	82	8.4
90	1.3	1.35	1.2	1.3	112	87	8.1
120	1.15	1.2	1	1.2	115	101	7.8
150	1.1	1.2	1	1.1	118	106	7.7
180	0.8	1	0.8	0.8	122	111	7.4
210	0.8	0.9	0.7	0.8	115	103	6.7
240	0.7	0.85	0.68	0.7	128	107	6.6

Tilapia and horse mackerel showed same reduction rate in weights from 2 kg as smoking time increased from 0 minute upwards except at 120 minutes and as gas weight decreased from 9.2 kg downwards (Table 1). Mackerel has the lowest reduction rate weight with the final weight of 0.85 kg, while the cat fish has the highest reduction rate in weight with the final value of 0.68 kg as shown in Table 1. Temperature in the smoking chamber (T_{sc} ^0C) and at the vent (T_v ^0C) indicated maximum difference when the smoking time reached 90 minutes which means more heat was retained in the smoking chamber for drying (Table 1), however, the minimum temperature difference was observed within the first 60 minutes of smoking as presented in Table 1.

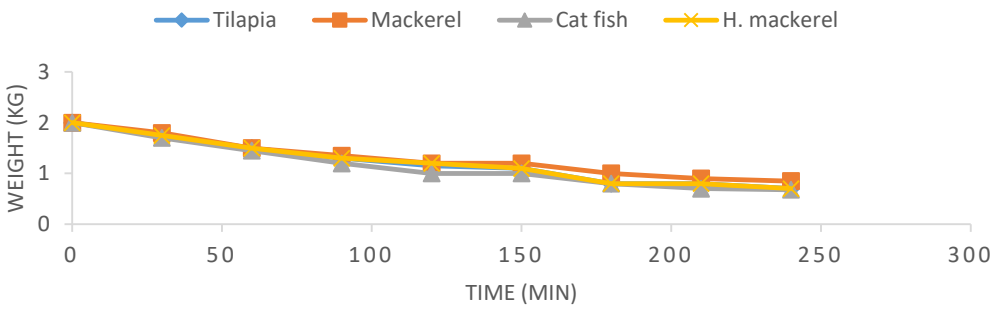

Figure 1: Trends in Weight Reduction across All the Fish Types while Smoking

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3571958

Generally, the weight reduction was evidently shown across all fish types. It decreased from 0 minute through to 240 minutes of the smoking duration, with catfish having rapid drops in weight up till 120 and 150 minutes of smoking where same weight of 1 kg was maintained before dropped to same weight of 0.8 kg with tilapia and horse mackerel at 180 minutes of the smoking process (Figure 1). Mackerel exhibited lowest decrease in weight as smoking time increased, and in the same manner with catfish, same weight of 1.2 kg was observed at 120 and 150 minutes during smoking process as presented in Figure 1. The decrease in weights for both tilapia and horse mackerel followed same trend in respect to increase in smoking time except slight variation in weights 1.15 and 1.2 kg respectively when it was 120 minutes smoking time (Figure 1).

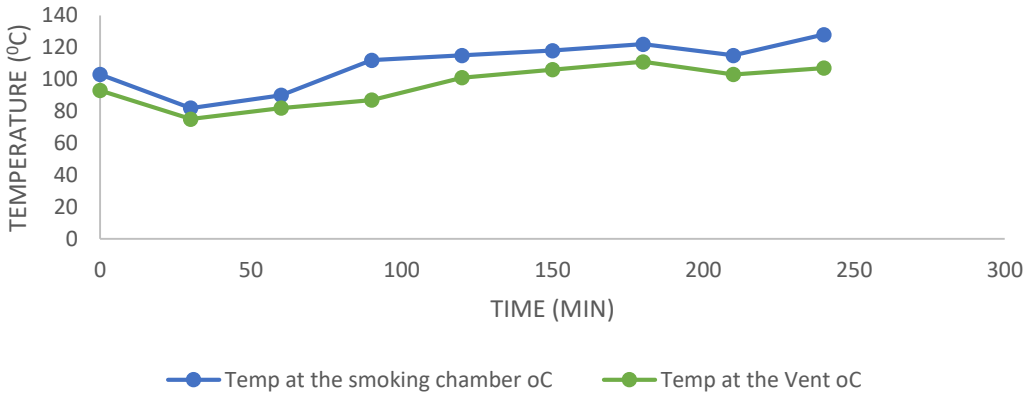

Figure 2: Temperature changes in the Smoking Chamber and at the Vent of the Smoking Kiln during Smoking Process

The temperature profiles are shown in Figures 2. The temperatures in the smoking chamber and at the vent showed sharp drop from 103 and 93 ^{0}C to 82 and 75 ^{0}C respectively which indicated maximum drop in temperatures different of 21 ^{0}C in smoking chamber and 18 ^{0}C at the vent during the smoking process (Figure 2). The maximum drop in temperatures observed could be due to higher moisture level of the fishes initially. Temperature gain was noticeable from 60 minutes of smoking process up to 180 minutes in both the smoking chamber and at the vent with same values of 3 ^{0}C and 5 ^{0}C gain in temperature in between 90: 120 minutes and 120:150 minutes of the smoking period. Figure 2 presented maximum available temperature of 128 ^{0}C at the 240 minutes of the smoking process in the smoking chamber. This may be as a result of reduction in moisture level of the fishes at the final drying state.

Table 2: Final Body Mass after Smoking and Percentage Weight Loss for All Fish Types

Fish Types	Final Body Mass (kg)	Percentage Weight loss (%)
Tilapia	0.7	65
Mackerel	0.85	57.5
Cat fish	0.68	66
Horse Mackerel	0.7	65

The percentage weight loss for all the fish types were determined from equation 2. Table 2 presented final body masses after smoking and percentages of weight loss from each fish type to smoking. The minimum percentage in weight loss is 57.5% which is corresponded to mackerel

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3571958

while the maximum percentage weight loss is 66% which is corresponded to catfish. Tilapia and horse mackerel exhibited the same percentage of 65% for their weight loss (Table 2).

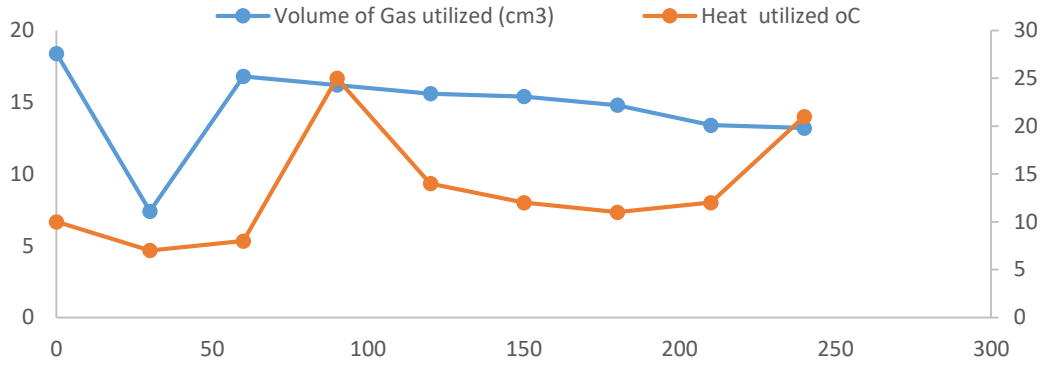

Figure 3: The Variation in Volume of Gas Utilized with the Heat Utilized in the Smoking Kiln

The result showed that the volume of gas utilized (7.4 cm^3) for the first 30 minutes was the smallness which is corresponded to minimum heat utilized (7 ^{0}C) in drying fishes as well as minimum temperatures at both in the smoking chamber and the vent (Figure 3 and Table 1). But contrarily, the maximum volume of gas utilized occurred at the second 30 minutes was 16.8 cm^3 and heat utilized was 8 ^{0}C, while maximum heat of 25 ^{0}C utilized for drying corresponded to 16.2 cm^3 during the 90 minutes of smoking process as shown in Figure 3.

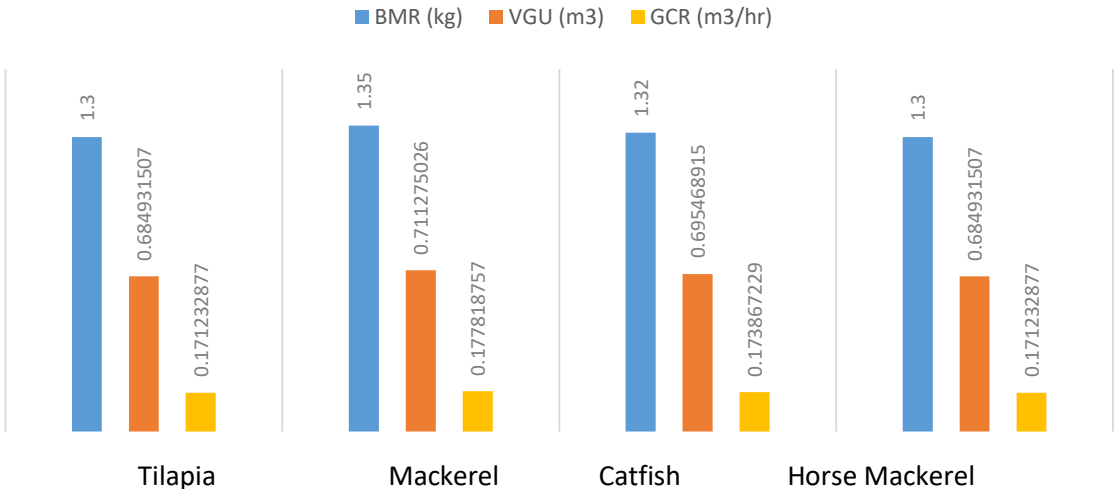

Figure 4: Changes in Body Mass Reduction (BMR), Volume of Gas Utilized (VGU) and Gas Consumption Rate (GCR)

The changes in BMR from 2 kg for all fishes were presented as 1.3, 1.35, 1.32 and 1.3 kg for tilapia, mackerel, catfish and horse mackerel respectively as shown in Figure 4. In all fish types the variations in VGU ranged from 0.68 to 0.71 m^3, while GCR ranged from 0.171 to 018 m^3/hr. the minimum values corresponded to tilapia and horse mackerel while the maximum values are corresponded to mackerel (Figure 4).

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3571958

4. Conclusions and Recommendations

Results obtained in present study indicated that irrespective of the fish source, be it frozen or fresh water it is not a major factor that influence the drying rate of the fish as BMR for tilapia (fresh) and horse mackerel (frozen) proved to be the same after specified smoking period.

Based on what were deduced from this study, it is recommended that further study can consider independent smoking for same period under the same environmental conditions for easy estimation of VGU, actual heat utilized for drying and GCR for each fish type.

Acknowledgements

Adeyemo Adeyinka Sherif and Sulaeman Kamorudeen Abiodun are acknowledged for the assistance they rendered in carrying out the study.

References

[1] Al-Jufaili, M.S. and L.U. Opara, 2006. Status of fisheries post-harvest industry in the Sultanate of Oman: Part1 handling and marketing system of fresh fish. J. Fish.
[2] Blackwell, W. (2014). Seafood Processing Technology, Quality and Safety. Chichester, UK: Institute of Food Science and Tecnology.
[3] FAO (2010) Fisheries and Aquaculture Technical Paper World Aquaculture 2010, 500/1
[4] Okonta, A.A. and J.K. Ekelemu, 2005. A prelimnary study of micro-organisms associated with fish spoilage in Asaba, Southern Nigeria. Proceedings of the 20th Annual Conference ofThe Fisheries Society of Nigeria (FISON), Port Harcourt, 14th-18th
[5] Olayemi F. F., Raji A.O., Oyelese, O., Oyewole S. N., and Ayodele O. M. (2013) effective fish smoking kiln for development country'' international journal of scientific & engineering researcher volume 4, issue 1, January-2013 IISSN 2229-5518.
[6] Oyetoro J.O, S and Eyo, A.A(2012) The effect of various smoking methods on the quality of differently saited oreochromis niloticus''. International journal of advance biological science. I.J.A.B.R., VOL. 2(4)2012: 717-732 ISSN 2250-3579
[7] Sogbesan O. A. and Ibrahim P. (2017) "Assessment of Smoked Fish Quality Using Two Smoking Kilns and Hybrid Solar Dryer on Some Commercial Fish Species in Yola, Nigeria" Journal of Animal Research and Nutrition ISSN 2572-5459, Vol.2 No.1:6

*Corresponding author.
E-mail address: bukkyblessed@ yahoo.co.uk