FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL AND PROCESSING ENGINEERING

# DESIGN AND CONSTRUCTION OF A SOLAR POWERED SILVER FISH DRYER.

BY

BWAMIKI DENIS MUTASA

BU/UP/2014/184

Email: bwamikidenis25@gmail.com

Phone: 0752724558 or 0785860560



SUPERVISORS:

Mrs. KABASA MARY SALLY

MR. KILAMA GEORGE

*A final year project report submitted in partial fulfillment of the requirement for the award of a Bachelor of Science in Agro-Processing Engineering of Busitema University.*

MAY 2018

## ABSTRACT

Silver fish is one of the protein foods we have in Uganda and the world at large. It is consumed in a dried form most especially by middle income people across East Africa and other countries and mainly caught between January and May. After harvest, silverfish is highly perishable due to its high moisture content (73%) and therefore this moisture content has to be reduced up to 5% for a long shelf life in order for it to be used for either consumption or the animal feeds industry. Dried silverfish essential in brain development to children and helps pregnant women against the coronary heart diseases as a result of concentration of the unsaturated fatty acids caused by the drying effect.

Silver fish is mainly consumed in a dried form by the usage of solar energy. The common forms of drying include the use of open air sun drying and the use of improved raised racks which have drawbacks such as extended drying hours due to uncontrolled drying conditions and high post-harvest losses such as contamination from dust, animal droppings, and subjection to pests.

This research report therefore provides for utilization of the renewable solar energy, optimization of the drying conditions with emphasis on temperature and humidity, and providing a hygienic and enclosed drying environment to minimize the post-harvest losses.

A solar powered silverfish drier was designed and fabricated through the methodology, data was collected which involved literature reviews, designing the system components, constructing the prototype which was tested and the results analyzed.

In this research project, thermometer readings gave a maximum temperature of 43°C recorded at 2:00pm being the peak sun hour of maximum insolation from the ambient temperature of 25°C; the transparent glazing was used a solar concentrator with a concentration ration of 1 to about 337W/m$^2$/day. A solar collector of 1.25 m$^2$ with a working principle of a black body radiation was used. Drying temperatures inside the dryer were monitored using a thermometer and records were made at hourly intervals records. Any further increase in temperature beyond 43°C, a solar powered sanction fan with a power rating of 15W and a speed of 0.76ms$^{-1}$ was used to cause a

temperature drop thus restoring the temperature inside the drier to ambient temperature. After achieving this temperature, temperature build is the allowed to continue as a result of the greenhouse effect created by the black body or the solar collector. However, testing the solar powered drier was not effective due to unfavorable weather conditions such as rainy and cloudy hours of the day.

Further work such as measuring the air temperature at the fan exit, was done in order to evaluate the effectiveness of the sanction fan. Since most of the fish landing sites lack electricity, the adoption of this environmentally and ecologically sustainable drier will help improve the standards of living and preservation of the silverfish.

Lastly, for purposes of further research, the solar angle of tilt sensors, temperature sensors connected to the fan has to be incorporated in order to automate the optimization process of the drying conditions inside the drier.

DECLARATION

I, ***BWAMIKI DENIS MUTASA*** hereby declare that this is an original copy of the research I have conducted my final year project which will act as a guideline for the design and construction of the solar- powered silver fish solar dryer and is submitted in partial fulfillment of an award of a Bachelor of Science in Agro Processing Engineering.

............................................ 23|05|18.......................

**Signature** **Date**

## APPROVAL

This report is an original copy of the research for the design and construction of the solar – powered silver fish dryer carried out under supervision and is submitted in partial fulfillment of a Bachelor of Science in Agro Processing Engineering.

**MRS. KABASA MARY SALLY.**

Signature……………………………….

**Date**…………………………………..

**MR. KILAMA GEORGE**

Signature……………………………….

**Date**…………………………………..

## DEDICATION

This report is dedicated to my beloved parents Mr. Kalinaki James and Mrs.Gwerumbye Harriet in appreciation for their selfless care and unflinching support provided to me since childhood, and for the spirit of hard work, courage and determination instilled into me, which attributes I have cherished with firmness and which have indeed made me what I am today, To my brothers and sisters and all my church mates BMC Bugiri. I also dedicate it to my pastors, Fred Sewanyana and Dorcus Sewanyana for the guidance that they have given me in all aspects of life, May the Almighty God reward you abundantly for such good work.

## ACKNOWLEDGEMENT

My sincere thanks go to the Almighty God for giving me strength, good health, wisdom, and protection throughout the preparation of this work.

I extensively appreciate all my dear supervisors; Mrs.Kabasa Mary Sally and Mr. Kilama George and other lecturers for their selfless guidance, knowledge and encouragement given to me throughout the writing of this report.

Finally, I thank all my friends and fellow Agro Processing Engineering students for all the support and advice they have given me during my final year project report writing.

May the Almighty God reward you.

## TABLE OF CONTENTS

## LIST OF TABLES AND FIGURES

List of figures



List of tables

## CHAPTER ONE

### 1.0 Introduction

This chapter presents the general information about the research design giving its background, problem statement, significance, objectives, justification and scope of the study.

### 1.1 Back ground

Silver fish (*Rastrineobola argentea*) is one of the protein foods we have in Uganda and the world at large. It contains 18% proteins, 12% fat, 1.35% ash and 73% water (Kirema-Mukasa, 2012). Silverfish is the mostly widely captured and spread fish due to a reduction in the capture of Tilapia and Nile perch. It is consumed in a dried form most especially by middle income people across East Africa and other countries and mainly caught between January and May. It essential in brain development to children and helps pregnant women against the coronary heart diseases.

Drying of silverfish is one of the oldest methods of preservation. Much of the harvested silverfish is dried on open grounds and in unhygienic conditions, where it's exposed to contaminants such as sand, animal droppings among others. Due to this, 80% of the silverfish captured is channeled to the animal feeds industry and only 20% remains for human consumption (LVFO, 2013).

Solar drying is an efficient system of utilizing solar energy to substitute the old preservation methods (Bala, 1997). The most commonly used solar preservation techniques for silver fish include open sun drying, drying by use of the improved raised racks, the use of the solar tent dyers which mainly face a challenge of controlling the drying conditions. This makes tricky to achieve uniform drying results and effective drying due to uncontrolled air velocity, air temperature and the relative humidity inside the dryers. Therefore there is need to adopt the solar powered silverfish dryer for controlling and optimizing the drying conditions.

### 1.2 Problem statement.

Silverfish drying is achieved in Uganda mainly using radiative heating from the sun as an energy source. This reduces the moisture content thus extending the shelf life, however, the degree of drying achieved by the ordinary open sun drying methods is non satisfactory due to the uncontrolled drying process conditions thus leading to inadequate or excessive drying and disintegration of the nutrients. This results into production of low quality silverfish thus fetching low market prices.

The study has been geared at employing a solar- powered silverfish dryer that has been able to control the drying process conditions with major emphasis on the temperature and relative humidity.

### 1.3 The project objectives

#### 1.3.1 The main objective

To design and construct the solar powered silverfish dryer

#### 1.3.2 The specific objectives

- To design the component parts of the dryer
- To fabricate the prototype of the dryer
- To test the performance of the dryer
- To conduct an economic analysis for the prototype.

### 1.4 The purpose of the study

The purpose of the study is to design and construct the solar powered silverfish dryer

### 1.5 The justification

The physical and quality postharvest losses in Uganda are 26 – 40% and 2 – 5% respectively and Uganda stands to lose about US$ 300,000 to 1.5million. These postharvest losses have a direct effect on the nutritional quality(Union, 2013)(LVFO, 2013). The adoption of the solar powered silverfish dryer has provided hygienic drying environment free from contaminants such as sand, dirt among others; uniform drying of the silverfish has been achieved without compromising the silverfish nutrients.

## References


1. Kabahenda, M. O. (2009). *Post-harvest handling of low-value fish products and threats to nutritional quality.* Kampala: MK Publishers.

2. Muhlbauer. (1986). Design of a biomass burner for thermal backup of a solar dryer. *Journal of applied sciences* , 1926-1936.
3. Bala, 1. &. (1997). *Solar drying of fruits, vegetables spices aqnd fish.* Bangladesh: Bala and janjai.
4. Trim, 1. (1985). *A Manual.* Ircland: Norton and company.
5. Bradbury et al. (1988). *Global Bio diversity.* Ankas: Catalogue of Life.
6. Youcef-Ali et al., (. (2001). *Design, Construction and Performance of a solar dryer.* Cairo: Elamin Akoy.
7. Duffie and Beckman, 1. (1974). *Thermal theory and modelling of solar collectors.* New York: Wiley, 1974.
8. Sodha et al., 1. (1987). Design and measured performance of solar chimney for Natural Circulation Solar energy dryers. *Solar energy Engineering* , 69-71.
9. Sukhatme, 1. (1996). *Principles of thermal collection and storage.* New Dehli: Mc Graw Hill.
10. Brooker et al., 1. (1992). *Preserving quality during drying.* New York: Mc Graw Hill.
11. Hernandez et al, 2. (2000). Journal of Biological sciences. *Biological sciences* , 510-513.
12. Earl, 1. (1986). *Solar angle of Tilt.* New York: Mc Graw Hill.
13. Werner et al. (2000). *Intensification of air flow.* Ohio: Mc Graw Hill.
14. Greensmith, M. (. (1998). *Practical Dehydration.* Ohio: Woodhead Publication Ltd.

15. African, S. (n.d.). *Post-harvest losses in small-scale fisheries.*
16. Kirema-Mukasa, C. T. (2012). SmartFish Working Papers Kirema-Mukasa, C. T. (n.d.). SmartFish Working Papers No 013 Regional fish trade in eastern and southern Africa - Products and Markets : A Fish Traders Guide Prepared by.No 013 Regional fish trade in eastern and southern Africa -.
17. LVFO. (2013). Processing and marketing of small-sized pelagics in eastern and southern Africa. *Smart Fish. Working Papers,* 42. Retrieved from http://www.fao.org/documents/card/en/c/527db4a3-80e4-499f-8f9e-

99405aa438f5/%5Cnhttp://tonypiccolo.wix.com/smartfish2#!about1/c15k8%5Cnhttp://www.commissionoceanindien.org/accueil/

18. Omony, M. K., & Hüsken, P. (1975). Post-harvest handling of low-value fish products and threats to nutritional quality : a review of practices in the Lake Victoria region.
19. Technology, F. (2011). *FAO Fisheries and Aquaculture Report No . 990 FAO , Rapport sur les pêches et l ' aquaculture n o 990 Report and papers presented at the THIRD WORKSHOP ON FISH TECHNOLOGY , UTILIZATION AND QUALITY ASSURANCE IN AFRICA Rapport et documents présentés au TROI* (Vol. 990).
20. Union, E. (2013). REPORT / RAPPORT : SF / 2013 / 40 REPORT / RAPPORT October 2011 INLAND SMALL-PELAGIC FISHERIES UTILIZATION OPTIONS , MARKETING AND OPPORTUNITIES FOR SUPPORT, (October 2011).