BUSITEMA UNIVERSITY
Pursuing Excellence

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL AND PROCESS ENGINEERING

FINAL YEAR PROJECT REPORT

DESIGN AND CONSTRUCTION OF AN AVOCADO FLESH OIL EXTRACTOR

By

OLUPOT CHARLES JOEL

BU/UP/2014/209

BUSITEMA UNIVERSITY
DATE:.....
LIBRARY

charlesjolupot@gmail.com

Tel: 0757499952/0781540216

SUPERVISOR: Mr. SSERUMAGA PAUL

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 2019

ABSTRACT

Avocado *(Persea Americana)* is one of the important fruits grown worldwide and majorly eaten in different forms and mainly as food additives. This fruit is prized for its high nutrient value and is added to various dishes due to its good flavor and rich texture. In addition of its importance it is grown for sale provides income to the growers and it is one of the fruits which are commercially valuable and are cultivated for sale and oil production since it containing oil in it and this makes it a special fruit. Avocado oil is used for various purposes like; cooking, lubrication and some cosmetic factories used it as a raw material for the cosmetic production and Pharmaceuticals as well use the oil for medicinal production.

However, the traditional methods used for avocado oil production involve the following shortcomings; high temperature which denatures the oil, use of chemicals in form of solvents are used which is not good for human health, hand squeezing of the oil yields less leaving most of the oil un extracted and the existing machines are for large-scale hence expensive and cannot be obtained by the small-scale industrial sector. This has left a big gap in the small-scale sector, most of the oil wasted and denatured and human health compromised due to the practices used. The aim of this study is to design and construct avocado flesh oil extractor to maximize the oil extraction, save time and add value to the avocado fruit, to meet the financial standards of the small-scale producers and to attain a suitable product for various applications.

The avocado oil extractor was designed and constructed using locally available materials and tested for oil production using the dried avocado flesh mixed with fiber. The machine consists of the machine frame, the feeder, screw shaft, barrel cage, and the drive system. Designing and constructing the avocado oil extractor involved determining the feeder angle of repose of the avocado, determining the forces and pressure produced by the shaft to squeeze out the oil. Engineering drawings of various components of the avocado oil extractor were developed before the machine was constructed and assembled. The performance of the avocado oil extractor after construction was evaluated taking in to consideration the capacity and the efficiency of the machine and the performance tests carried out on the developed machine showed an efficiency of 50.95% and an actual throughput of 66.24kg/hr. at the rotating speed of the shaft being $247.35rpm$.

DECLARATION

I, OLUPOT CHARLES JOEL, hereby declare to the best of my knowledge that this report is an outcome of my own work and has not been presented for any academic award in any university, college or higher institution of learning. Throughout the work, I have acknowledged all other sources in its compilation.

Name: OLUPOT CHARLES JOEL. BU/UP/2014/209 Signature.....

Date..15/05/2019..

BUSITEMA UNIVERSITY LIBRARY
CLASS No.:.....
ACCESS NO.: FET 0277

APPROVAL

This Final Year Project Report has been submitted to the department of Process and Chemical Engineering of Busitema University for examination with approval of my supervisor

Supervisor:

1) Mr. SSERUMAGA PAUL Signature..... Date.....

DEDICATION

This report is dedicated to my beloved parents Mr. OGWANG MOSES TUKEI and Mrs. TEDDY OGWANG in appreciation for their generous care and constant support provided to me all my time at school, and for the constant guidance and strength, courage and determination instilled into me, which have indeed made me what I am today, To my brothers and sisters and all my Class mates (Busitema University). I also dedicate it to my friends for the guidance and support that they have given me during my research, May the Almighty God reward you abundantly for such great work.

ACKNOWLEDGEMENT

Great thanks go to God Almighty for giving me strength, good health, wisdom, protection and His mercies and favor throughout the research process.

My sincere thanks go to my supervisors Mr. Sserumaga Paul and all my lecturers for their selfless guidance, knowledge and encouragement given to me throughout the writing of this report.

Finally, I thank all my friends and class mates (Agro Processing Engineers) for all the support and advice they have given me during my report writing. May the Almighty God

reward you abundantly.

Table of Contents

ABSTRACT i
APPROVAL iii
DEDICATION iv
ACKNOWLEDGEMENT v
CHAPTER ONE 1
1.1 Background 1
1.2 Problem statement 2
1.3 Justification: 2
1.4 The purpose of the study: 2
1.5 Objectives of the study 2
1.5.1 Main Objective: 2
1.5.2 Specific Objectives: 2
1.6 The scope of the study: 3
1.7 Limitation (s) 3
2 CHAPTER TWO: LITERATURE REVIEW 4
2.1 Avocado (Persea americana mil). 4
2.1.1 Structural parts of an avocado fruit: 4
2.2 Avocado (Persea Americana mil) oil. 6
2.2.1 Nutrient Composition of the avocado flesh 7
2.2.2 The chemical composition of avocado oil 9
2.2.3 Benefits of avocado oil 9
2.3 Unit operations in avocado oil extraction 12
2.3.1 Sorting: 12
2.3.2 Cutting and mashing/blending: 12
2.3.3 Drying: 13
2.3.4 Addition of fiber to the avocado (Rice fiber) 13
2.3.5 Extraction of the oil: 14
2.4 OTHER EXTRACTION METHODS USED. 14
2.4.1 Chemical extraction by solvents 14
2.4.2 Physical and mechanical extraction 14
2.5 Avocado oil properties aiding its extraction 15

2.6 Preparation of material for extraction 16
3 CHAPTER THREE: METHODOLOGY 17
3.1 Machine description 17
3.2 Machine working principle 17
3.3 Design of machine components 18
3.3.1 The Feeder/hopper 18
3.3.2 Angle of repose, (θr) 18
3.3.3 Determination of the capacity of the avocado oil extractor 18
3.3.4 Design of the shaft 19
3.3.5 Determination of the Diameter of the Screw Shaft; 19
3.3.6 Torque on the rotating shaft 19
3.3.7 Load lifted by the screw 19
3.3.8 Power determination 20
3.3.9 Determination of screw shaft Torque; 20
3.3.10 Design of the barrel (Extraction chamber) 20
3.3.11 pressure lifted by the screw thread 20
3.3.12 Longitudinal (tensile) and Hoop (circumferential) stress 21
3.3.13 Pulley design 21
3.3.14 Design of the Frame 21
3.4 Fabrication of the machine components 21
3.4.1 Material selection for the machine 21
3.5 Fabrication of the prototype 23
3.6 Performance evaluation of the prototype 23
3.6.1 Efficiency of the machine 23
3.6.2 Oil Yield output of the machine 23
3.7 Economic evaluation of the prototype 24
3.7.1 Net present value (NPV) method 24
3.7.2 Profitability index 24
4 CHAPTER FOUR: RESULTS AND DISCUSSIONS 25
4.1 Design of the machine components 25
4.1.1 The feeder/hopper 25
4.1.2 Angle of repose 25

4.1.3 Determining the capacity of the avocado oil extractor 25
4.1.4 Design of the shaft 25
4.1.5 Weight of the pulley, ... 26
4.1.6 Bending moments 26
4.1.7 Determination of the Diameter of the Screw Shaft; 27
4.1.8 Determination of the weight of the shaft 27
4.1.9 Torque on the rotating shaft 27
4.1.10 Power determination 27
4.1.11 Design of the barrel (Extraction chamber) 28
4.1.12 pressure lifted by the screw thread 28
4.1.13 Longitudinal (tensile) and Hoop (circumferential) stress 28
4.1.14 Pulley design 28
4.1.15 Design of the Frame 29
4.2 Performance Evaluation of the Machine 30
4.2.1 Procedure followed during testing of the prototype 30
4.3 Fabrication of the prototype 31
4.4 Extraction efficiency 31
4.5 Calculating the actual mass flow rate, ... 31
4.6 Design efficiency 31
4.6.1 Oil Yield output of the machine 31
5 CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS 33
5.1 Conclusions 33
5.2 Recommendations 33
REFERENCES 34
APPENDIX 36

LIST OF TABLES

TABLE 1: SHOWS THE COMPOSITION OF AVOCADO FLESH 8
TABLE 2: VARIETIES OF AVOCADO FRUITS GROWN, THEIR WEIGHT AND THEIR OIL CONTENT 11
TABLE 3 : SHOWING MACHINE COMPONENT, MATERIALS USED AND OPERATIONS IN MATERIAL ASSEMBLY 22
TABLE 4; SHOWS DIFFERENT PARTS AND THEIR DIMENSIONS 29
TABLE 5; SHOWING TEST OF THE MACHINE 31
TABLE 6; RESULTS FOR ECONOMIC ANALYSIS 32

TABLE OF FIGURES

FIGURE 1: FIGURE SHOWING AVOCADO VARIETIES GROWN IN UGANDA (GODDARD ET AL, 2018) 4
FIGURE 2: STRUCTURAL PARTS OF AN AVOCADO FRUIT AND THE AVERAGE COMPOSITION OF A HASS AVOCADO. (GODDARD ET AL, 2018) 6
FIGURE 3: SHOWING OIL, FIBRE, ASH, PROTEIN CONTENT IN THE AVOCADO FRUIT **(A.K. COWAN, 2013)** 6
FIGURE 4: SHOWING AVOCADO OIL (GIACOMO , 2015) 6
FIGURE 5: SHOWING UNIT OPERATIONS IN THE OIL EXTRACTION FROM AVOCADO 12
FIGURE 6: SHOWING DIFFERENT MECHANICAL EXISTING METHODS OF OIL EXTRACTION (ELLIOT, 2014) 15

CHAPTER ONE

1.1 Background

Avocado also known as *(Persea Americana)* is thought to have originated in South Central Mexico and its a member of the flowering plant family lauracea. The avocado fruit (or avocado pear or alligator pear), is botanically a large berry containing a single large seed (stone). Avocado is one of the fruits which are commercially valuable and are cultivated in tropical and Mediterranean climates throughout the world Uganda inclusive. (JF et al, 1998).

The major leading regions growing avocado worldwide include; Mexico (25%), California (13%) and Brazil (6%) and these regions are the main origins of various avocado types (Bergh, 2001) (JF et al, 1998).

In Uganda, avocado is grown majorly in the west, central and some Parts of the east majorly for sale and as additives to various types of meals. This fruit is prized for its high nutrient value and is added to various dishes due to its good flavor and rich texture. (Hackett et al, 2018), (Kris et al, 2018). The major avocado varieties grown in Uganda include the following; Hass, Reed, Bacon, and Fuertes having different quantities of oil basing on the oil composition in each fruit.

The flesh of an avocado fruit contains water, fiber and oil in given percentages; 30% oil (based on fresh weight), but it is very little in the seed (≈2%) or the skin (≈7%) (Marie et al, April 2010). This oil is extracted from the avocado for various purposes which include; for cosmetic because of its very high skin penetration and rapid absorption, for medicinal manufacture and for cooking in some parts (AllanWoolf., 2009).

The physical and chemical methods are used for oil extraction and these methods give a relatively low yield, like the traditional cooking method which involves high temperature and the solvent extraction method which involves use of chemicals. The ultimate market of the oil basing on its use and benefits generally dictates the large amount of avocado in its due season required available for the production of good-quality oil,

REFERENCES

AllanWoolf., M. e. (2009). Avocado Oil. *Gourmet and Health-Promoting Specialty Oils*, Pages 73-125.

Armstrong et al, .. (2000). avocado varieties and oil content. *Fruits Of The Rose, Olive, Avocado & Mahagany Families – Laurel Family*.

Avocado central. (2012).

Bergh, B. (2001). California Avocado Society.

Blanca., a. e. (2012). Stability of avocado oil during heating: Comparative study to olive oil. *science direct*.

Britannica et al, .. (2018). Persea americana, aguacate, ahuacatl, alligator pear, avocado pear.

california difference, calfonia avocado. (2018). *The History of California Avocados*.

Costagli et al, .. (October 2015). Avocado oil extraction processes: Method for cold-pressed high-quality edible oil production versus traditional production. *Agricultural Engineerin*.

Costagli, G. (Oct 16 2015). *Avocado Oil Extraction Processes: Method for Cold-Pressed High-Quality Edible Oil Production Versus Traditional Production*.

Department of Agriculture, F. a. (2012). *Production Guideline of Avocado Persea americana*, 24.

Dipayan Mondal., S. H. (2016). Design and Construction of Oil Expeller Press with Structural Analysis of Screw with Ansys. *International Conference on Mechanical, Industrial and Energy Engineering*.

Elliot. (2014). Avocado Oil Extraction in. 25.

Francis et al, .. (2013). Critical Reviews in Food Science and Nutrition. *Hass Avocado Composition and Potential Health Effects*.

Francis et al. (2011). avocado flesh composition. *avocado nuetrients*.

Francis et al. (2011). avocado flesh composition.

Francis. (2010b). fruits nuetrients, avocado.

George. (2017). Solvent Extraction . *AOCS Lipid Library*.

Goddard et al, .. (2018). Avocado Types. *life in flavour*.

Gupta J. K, K. R. (2005). *A textbook of machine design* (14 th Edition ed.). New Dhelhi: Eurasia Publishing House.

Hackett et al, .. (2018). Avocado Calories and Nutritional Information. *the spruce eats*.

HHS et al,. (2013,). Cardiovascular Disease Risk Assessment.

Hrefna. (2016). healthline. *Evidence-Based Health Benefits of Avocado Oil.*

JF et al, .. (1998). Avocado; In: Fruits of Warm Climate.

Khurmi, R. e. (2015). *Theory of Machines, 14th ed.*

Kris et al, .. (2018). proven health benefits of avocado. *health line.*

Kris Gunnars, B. (2018, June 29).

Livestrong. (2011.). *Why Is Avocado Oil Good For The Skin?*

Marie et al, .. (April 2010). unrefined, extra virgin cold-pressed avocado oil. *AOCS.*

Mark. (2007-2018). Common varieties of avocado grown in Uganda. *Africa-Uganda-Business-Travel-Guide.com.*

Qin et al, .. (2016). A Review of Extraction Techniques for Avocado Oil. *Journal of Oleo Science.*

Shigley, J. (2003). *Mechanical Engineering Design* (Seventh Edition ed.). McGraw Hil.

Verma et al, .. (2016). *Application of atomic absorption spectroscopy to.*

Xiaoli et al, .. (2016). A Review of Extraction Techniques for Avocado Oil. *journal Oleo science*, 8.

Xiaoli et al. (2016). A Review of Extraction Techniques for Avocado Oil. *Journal of Oleo Science.*

Zhong et al, .. (2016). A Review of Extraction Techniques for Avocado Oil. *Oleo Science.*