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Pursuing Excellence

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DEPARTMENT OF CHEMICAL & PROCESS ENGINEERING

BSc. AGRO-PROCESSING ENGINEERING

DESIGN & CONSTRUCTION OF A BIOMASS POWERED ONION CURER

BY

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A final year project proposal report submitted in partial fulfilment of the requirements for the award of the BSc. In Agro- processing engineering of Busitema University

DECLARATION

I Kungu Lazaro declare that all that is written in this proposal report is my original work and has never been presented for any academic award in any university, college, institution of higher learning

Signature: .....

Reg no: BU/UP/2014/192

ABSTRACT

Onion (Allium cepa) is one of the most popular vegetable that make up daily diet. It is valued for its distinct pungent flavor and is an essential ingredient for cooking in many regions

The onion curing machine was designed and fabricated consisting of four major functional units which included; combustion chamber, heat exchanger, suction unit, and drying chamber, with the components being connected together by circular pipes for air delivery.

The combustion chamber was a biomass-filled cuboid container with conical head from where heat energy was generated.

The heat exchanger conserved and preserved the heated air before being transferred to the drying chamber.

The suction unit conveyed the heated air to the drying chamber as the heated air passed over the onions on the drying trays, drying was taking place by heat and mass transfer and the residual/exhaust air was exit through the chimney.

The onion conditioner was evaluated based on its performance during no load and load tests. The source of energy was charcoal the average temperatures of the dryer and ambient were 38.7 ^{0}C and 26.5^{0}C respectively under no load. This shows a temperature increases above ambient providing a suitable onion curing conditions. During load tests, fresh onions with an average initial moisture content of 86.0%wb was dried to average moisture content ranging from 74% to 77%wb within 4-5 hours

The performance of the dryer was evaluated in terms of its efficiency and the drying rate. Results obtained from the tests showed that conditioner efficiency was 21%.

The drying rate was also found to be 0.16kg / hr

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Finally my great thanks go to the almighty God.

APPROVAL

This is to approve that this proposal has been written with full knowledge and consistently worked upon and submitted to the department of chemical and processing engineering under the supervision of the university supervisor.

Supervisor

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Signature

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Table of Contents

DECLARATION i
DEDICATION ii
ABSTRACT iii
ACKNOWLEDGEMENT iv
APPROVAL v
LIST OF ACRONYMS viii
1. CHAPTER ONE: INTRODUCTION 1
1.1 Background 1
1.2 Problem statement. 3
1.3 Significance of the study. 3
1.4 Objectives of the study. 3
1.4.1 Main objective 3
1.4.2 Specific objectives. 3
1.5 Justification of the study. 4
1.6 Scope of the study. 4
2 CHAPTER TWO: LITERATURE REVIEW 5
2.1 Onion production and common varieties in Uganda 5
2.2 Nutritional value and chemical composition of common varieties of onions grown 6
2.3 Chemical composition 6
2.4 Harvest and Post-harvest handling of onions. 8
2.5 Processing and value addition chain of onions. 9
2.6 Purpose of drying & curing onions. 10
2.6.1 Factors that affect onion curing and drying. 10
2.7 Drying and curing methods. 10
2.8 The link between the existing work and the current needs 13
3 CHAPTER THREE: METHODOLOGY. 14
3.1 Design considerations/specifications 14
3.2 Fabrication and Assembly of Machine Components. 14
3.3 DESIGN OF MACHINE COMPONENTS. 15
3.3.1 Energy balance equation required for drying: 15
3.3.2 Determining the amount of water to be removed from the onions. 16

3.3.3 Calculating the Heat Energy Q Required to Remove the desired water. 16
3.3.4 Sizing of the drying chamber 18
3.3.5 Design of the vent tubes dimensions. 19
3.3.6 Determination of the average drying rate 19
3.3.7 Design and sizing of blower fan to convey the drying air. 20
3.3.8 Sizing for the battery 21
3.3.9 Sizing for solar panel 21
3.3.10 Design for the main frame 21
3.4 FABRICATION OF THE ONION CURER MACHINE 21
3.4.1 DESCRIPTION AND MODE OF OPERATION OF THE MACHINE CONSTRUCTION 23
4 Chapter four 24
4.1 Results and Discussions 24
4.2 Design specifications for the machine components 24
4.2.1 Determining amount of water to be removed 24
4.2.2 Sizing the drying chamber 25
4.2.3 Determining the appropriate dimension of the tray 25
4.2.4 Calculating the heat energy, Q_t required to remove the desired water 26
4.2.5 Design for quantity of charcoal needed for combustion, Q_c 28
4.2.6 ***Sizing of the combustion chamber, Vc*** 28
4.2.7 Design of the vent tube 29
4.2.8 Sizing of the blower 29
4.2.9 Sizing for the battery 30
4.3 Performance evaluation of the conditioner. 30
4.4 Economic evaluation of the machine. 33
5 CONCLUSION AND RECOMMENDATIONS 36
5.1 CONCLUSION 36
5.2 RECOMMENDATIONS 36
APPENDIX 37
References ..... **Error! Bookmark not defined.**

List of figures

Fig 1-1 the post-harvest operations (Opara, 2003) I
Fig 2-1Artificial onion curing method (The Louis Berger Group, 2012) 11
Fig 2-2 solar curing and drying system (Mourad, 2009) 12
Fig 3-1 fully assembled diagram 23
Fig 5-1 view of the machine 37
Fig 5-2 top view of the curer machine 37
Fig 5-3 top view of the onion tray 38
Fig 5-4 side view of the curer machine 39
Fig 5-5 blower fan 39
Fig 5-6 onion tray 40

List of tables

Table 2-1: Major chemical composition of the common red onion varieties 7
Table 2-2: comparing open drying and solar drying 13
Table 4-1 chemical and mechanical properties of onion and curer machine 24
Table 2 test results for no load 31
Table 3 test results for load test 32
Table 4-4 proposed budget 34
Table 5 calculating the net present value 35

LIST OF ACRONYMS

TEMP - temperature

ASTM - American Society for Testing and Materials

ASME - American Society of Mechanical Engineers

EAC - East African Community

FAO - Food And Agriculture organization

HA - Hectares

HP - Horse Power

MAAF - Ministry Of Agriculture Animal and Fisheries

Mt/ha - Metric Tonnes per Hectare

Ms - Mild Steel

UBOS - Uganda Bureau of Statistics

^{O}C - Degrees Centigrade

K. - Degrees Kelvin

GHI - Global Hunger Index

PV. - Solar Photovoltaic Panels

1. CHAPTER ONE: INTRODUCTION

1.1 Background

Onion (Allium cepa) is one of the most popular vegetable that make up daily diet. It is valued for its distinct pungent flavor and is an essential ingredient for cooking in many regions (Getenesh Nega, 2015).

In Uganda, onions are important commercial crops widely grown is different parts of the country. Presently, Onions are suitably grown in areas between 1500-2100m above sea level and the highest production noted from districts of; Kigezi, Kasese, Rakai, Mbarara, Kiboga, Mbale and Tororo The total area under cultivation is estimated to be 37,000 ha, with a total production of 147,000 MT and an average yield of 4.0 MT/ha. The most popular varieties of onions grown in the country include, Red creole, Bombay red and the Texas Grano variety. (sonko R., et al., 2005)

Nutritionally fresh onions contain about 86.8 % moisture, 11.6 % carbohydrates, 1.2 % proteins, 0.2-0.5 % calcium and 0.05 % phosphorous and traces of iron, thiamine, riboflavin and ascorbic acid. Onion consumption helps the body fight against cancer, coronary heart disease, diabetes as well as ageing, and this is mainly attributed to organosulphur compounds, flavonoids, vitamins and some minerals it contains. (Rodrigues A S, et al., 2003).

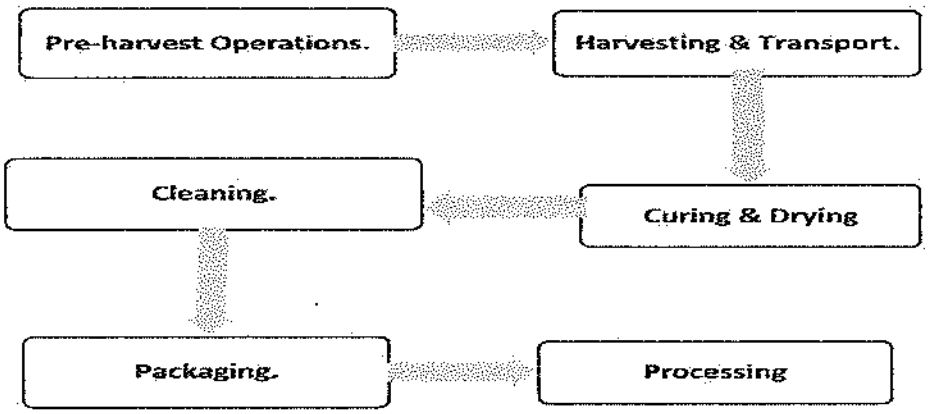

Fig 1-1 the post-harvest operations (Opara, 2003)

After harvesting, onions have to be dehydrated to reduce the post-harvest decay and moisture loss by removing excess moisture from the outer skin (scales) and neck of freshly harvested onion to a level where shrinkage from the interior is less hence reduction in microbial infection.

References

ABD-EL RAHMAN, M. M. and EBEAID M. T . (2009). SOME FACTORS AFFECTING ARTIFICIAL CURING OF ONION BULBS AND ITS EFFECTS ON THE STOREBILITY. *Misr J. Ag. Eng., 26(2)* .

Akoy, E. O. (2015). ONION DEHYDRATION.

EARO. (2004). Directory of Released Crop Varieties and Directory of Released Crop Varieties and .

Getenesh Nega, A. M. (2015). Effect of Curing and Top Removal Time on Quality and Shelf. *Global Journal of Science Frontier Research: D Agriculture and Veterinary, 15*(8).

Getenesh Nega, A. M. (2015). Effect of Curing and Top Removal Time on Quality and Shelf Life of Onions. *Global Journal of Science Frontier Research: D Agriculture and Veterinary*, 11.

Gouda, G. P. (Apr-May. 2014). *Dehydration of Onions with Different Drying Methods.*

KJ, S. (1993). Development of improved techniques. *Associated Agricultural Development Foundation, Nasik India*, 13-14.

Landbouwtechniek, E. (2011). onion windrower. *windrowin macine*, 3.

Mourad, H. S.-G. (April 2009). *A SOLAR DRYER PERFORMANCE OF ONION SLICES UNDER FAYOUM CLIMATIC CONDITIONS.*

Mourad, H. S.-G. (2009). A SOLAR DRYER PERFORMANCE OF ONION SLICES UNDER FAYOUM CLIMATIC CONDITIONS . *Misr J. Ag. Eng., 26(2): 953- 976 PROCESS ENGINEERING*, 5.

Opara, L. U. (2003). Post-Harvest Operation. *Post-harvest Compendium*, 17.

Opara, L. U. (2003). Onion post-harvest operations. (P. F. Danilo Mejía, Ed.) *post-harvest compedium- FAO.*

Rodrigues A S, F. V. (2003). NUTRITIONAL VALUE OF ONION REGIONAL VARIETIES IN NORTHWEST PORTUGAL . *Electrinic juornal of environment, Agricultural and food chemestry.*

SHARMA, A. (2014). Nutritional benefits of onions. *Market survey*, 28-30.

sonko R., N. E. (2005). The horticultural sector in uganda. *Pro- poor horticulture in east and south africa.*

The Louis Berger Group. (2012). *Onion Production: Planting Through Harvest* . United States Agency for International Development.: USAID-USAID-Inma Agribusiness team.

Wilson, L. G., & Estes, a. E. (1994). Postharvest cooling and handling of onions . *North Carolina Cooperative Extension Service.*