

**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING

**DEPARTMENT OF CHEMICAL AND PROCESS
ENGINEERING**

FINAL YEAR PROJECT

DESIGN AND CONSTRUCTION OF A TOMATO SORTER

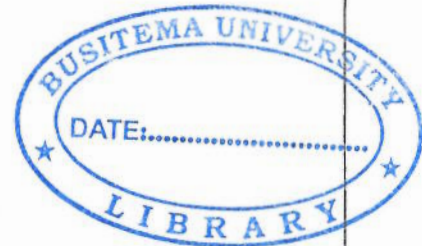
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A final year project report submitted in partial fulfilment of the award of a bachelor's degree in Agro Processing Engineering of Busitema University.

MAY, 2019

ABSTRACT.

Sorting and grading are the most important unit operations in packing houses by which it enables to obtain a good and appealing packing system. To standardize the tomatoes for marketing in the local and export markets, the rotary screen tomato sorter was developed. It consists of cylindrical wire meshed screens, pedal operated system. The performance evaluation was done to optimizing the peripheral speed and feed rate. As the tomatoes are fed through the hopper into the rotating drum like wire mesh, it gets separated according to size. It is portable and can be used in the field. By conducting different studies, the efficiency of the sorter at best speeds of 5rpm and 10rpm were found to be 86.5% and 75.8% with through put capacities of 89.6Kg/hr and 111 kg/h respectively at 10° inclination angle of the screens.

DECLARATION

I hereby declare that the contents of the synopsis, "design and construction of a tomato Sorter" are product of my own research and no part has been copied from any published source (except the references, standard mathematical or genetic models/equation/formulate/protocols etc.). I further declare that this work has not been submitted for award any other diploma/degree. The university may take action if the information provided is found inaccurate at any stage

Signature..... Richard

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APPROVAL

This project proposal is submitted to the Faculty of Engineering for examination with approval of my supervisors and the contents are satisfactory for the award of the degree in Agro Processing Engineering.

Supervisors name:

MRS. KABASA MARY SALLY

.....

DEDICATION

This report is dedicated to my beloved parents Mr. Oketch Stephen and Ms. Auma Jackline 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.

ACKNOWLEDGEMENT

My greatest appreciation goes to the Only Wise, Gracious and Merciful God for being my Pillar through thick and thin of this study. He is faithful indeed!

Well acknowledged is my Sagacious and Scholarly Supervisor whom despite his tight schedules never failed to give me all the needed attention required to successfully complete of this research work.

I am heartily grateful to my amiable family for standing by me prayerfully, financially and morally to ensure that my aspiration is realized. May God reward you all for being so supportive even in the midst of challenges.

My thanks to the entire staff of the Department of Chemical and Process Engineering, Busitema University for providing me with the enabling environment suitable for research work of this kind.

With deep friendliness, I am thankful to my friends, colleagues and associates of Busitema University for their patience and understanding, the motivators and catalyst who never relented to ensure that I give-in my best to my study.

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1 CHAPTER ONE: INTRODUCTION

1.1 Background

Tomato (*Solanum lycopersicum* L.) is a juicy berry fruit of the nightshade family (solanaceae) and one of the most widely cultivated and extensively consumed horticultural crops globally consumed by millions of people daily (*Grandillo S., 2002*). Tomato is one of the important products in human nutrition that is consumed by millions of people daily. According to FAO statistics, world tomato production was 314 million ha in 2010 (*Omidi ARJENAKI, 2012*).

In Uganda, tomatoes are among the most important and prominent horticultural crops grown for both home consumption and the domestic market. Tomato is considered to be a top priority for production, viewed as the main income crop compared to other vegetables and is grown and consumed in every district of Uganda. Production of tomatoes in rural areas of the country has increased employment and improved farmers' livelihoods (*Tusiime, 2014*). In 2016 the total production of tomatoes was 38234 tons from 6,485 ha with areas including districts of Kasese, Kabale, Mbale, Kapchorwa, Mubende, Masaka, Mpigi, Wakiso and Mbarara (*Kennedy, 2008*) have the largest area of production. Ugandan farmers grow different commercial tomato cultivars in the different regions of the country where about 3,000 small-scale farmers grow fresh fruits and vegetables for export with more than 20,000 smallholders growing vegetables for income (*Sonko et al., 2005*). Cultivars include, Marglobe, Pakmor, Tropic, VF 6203, Peto-C-8100159, Heinz1370, Moneymaker, Roma and Tengeru-97 (*Marsic, 2005*). In African meals, tomatoes are consumed in sauces, soup, domestic meat or fish dishes, and fresh in salads. They can also be processed into purées, juices, and ketchup. Canned and dried tomatoes are additional important processed products (*Tusiime, 2014*).

(Post-harvest) Handling practices of fruits and vegetables like harvesting, precooling, cleaning and disinfecting, sorting and grading, packaging, storing, and transportation plays an important role in maintaining quality and extending shelf life (*Areej Saif El-Deen Muhammad Babiker, 2015*). One of the most important processes in packaging and product supply to the market is sorting. This operation requires different parameters for quick identification and management. Parameters include maturity, color, shape, size, and defects. According to Jarimopas and Jaisiri (2008), the efficiency and effectiveness of sorting governs the quality standard of the packing

References

- Akbudak B., N. A. V. S. a. A. E., 2012. "Effect of pre-harvest harpin and modified atmosphere packaging on quality of cherry tomato cultivars 'Alona' and 'Cluster'," *British Food Journal*. Volume vol. 114, no. 2, p. pp. 180–196.
- Arab L. and S. Steck, 2000. "Lycopene and cardiovascular disease," *The American Journal of Clinical Nutrition*, , Volume vol. 71, no. 6, , pp. pp. 1691–1695, .
- Arafa, G. K., 2007. SOME PHYSICAL AND MECHANICAL PROPERTIES OF SESAME SEEDS CONCERNING THE SELECTION OF SEPARTION UNIT. *process Engineering journal*.
- Areej Saif El-Deen Muhammad Babiker, A. M. Z. A. A.-h. F. F. M. E.-F. E.-F. E.-M., 2015. *Design of sorting, and grading system for citrus fruits based on machine vision*, Khartoum: University of Khartoum Faculty of engineering Agricultural and Biological engineering department.
- Areej Saif El-Deen Muhammad Babiker, A. M. Z. A. A.-h. F. F. M. E.-F. E.-F. E.-M., 2015. *Design of sorting, and grading system for citrus fruits based on machine vision*, Khartoum: s.n.
- Arjenaki O., P. A. M. a. A. M. M., 2013. "Online tomato sorting based on shape, maturity, size, and surface defects using machine vision," *Turkish Journal of Agriculture and Forestry*,, Volume vol. 37, no. 1,, pp. pp. 62–68,.
- Basu A. and V. Imrhan, 2007. Tomatoes versus lycopene in oxidative stress and carcinogenesis: conclusions from clinical trials. *European Journal of Clinical Nutrition*,, Volume vol. 61, no. 3, p. pp. 295–303.
- Beckles, D. M., 2012. "Factors affecting the postharvest soluble solids and sugar content of tomato (*Solanum lycopersicum* L.) fruit," *Postharvest Biology and Technology*. Volume vol. 63, no. 1,, p. pp. 129–140.
- Burton-Freeman B. and K. Reimers, 2011. "Tomato consumption and health: emerging benefits," *American Journal of Lifestyle Medicine*, Volume vol. 5, no. 2, , pp. pp. 182–191,.
- Dattatraya Londhe, S. N. G. P. V. A. W., 2013. Grader: A review of different methods of grading for fruits and vegetables. *Agric Eng Int: CIGR Journal*.
- Earles, B. J. a. R., 2000. *Postharvest Handling of Fruits and Vegetables, Appropriate Technology Transfer for Rural Areas, Fayetteville, NC, USA*,, NC,: s.n.

- FAO, 2008. *Basic Harvest and Post-Harvest Handling Considerations for Fresh Fruits and Vegetables Handling and Preservation*, Rome, Italy: FAO.
- Ferreira M. D., J. K. B. S. A. S. a. J. J. A., 1994.. "Physiological responses of strawberry to film wrapping and precooling methods,". *Proceedings of the Florida State Horticultural Society*, , Volume vol. 107,, pp. pp. 265–269, .
- Gould.W.A, 1983. *Tomato production, processing and quality evaluation*, s.l.: AVI Pub.com.
- Grandillo S., D. Z. a. S. D. T., 2002. "Genetic improvement of processing tomatoes: a 20 years perspective,". *Euphytica*, , Volume vol. 110, no. 2, , pp. pp. 85–97,.
- Idah, P. A. E. S. A. A. a. M. G. Y., 2007. "Fruits and vegetables handling and transportation in Nigeria,". *AU Journal of Technology*, , Volume vol. 10, no. 3, pp. pp. 175–183,.
- Kennedy, 2008. s.l.: s.n.
- Liberty, J., 2015. *Role of unit operations in Agricultural products processing*. volume 3 ed. Enugu state, Nigeria: international journal of innovation and scientific research.
- Marsic, K. J. O. a. M. J., 2005. Evaluation of ten cultivars of determinate tomato (*Lycopersicum esculentum* Mill.), grown under different climatic conditions.. *Acta Agri. Slovenica*, , Volume 85: 321-328,.
- Moneruzzaman K. M., A. B. M. S. H. W. S. M. S. a. M. A., 2009. "Effect of harvesting and storage conditions on the post harvest quality of tomato,". *Australian Journal of Crop Science*,, Volume vol. 3, no. 2, , p. pp. 113–121.
- Omidî ARJENAKI, P. A. M. A. M. M., 2012. Online tomato sorting based on shape, maturity, size, and surface defects using machine Vision. *Turkish Journal of Agriculture and Forestry*, January, pp. 37: 62-68.
- Petro-Turza.M., 1987. *Flavor of tomato and tomato products*. volume 3 ed. s.l.:Food Rev Int.
- Prasad P. and A. Kochhar, 2014. "Active packaging in food industry: a review,". *Journal of Environmental Science, Toxicology and Food Technology*, Volume vol. 8, no. 5, p. pp. 1–7.
- Saltveit, M. E., 1999. "Effect of ethylene on quality of fresh fruits and vegetables,". *Postharvest Biology and Technology*,, Volume vol. 15, no. 3,, p. pp. 279–292.
- Shahi N. C., U. C. L. K. C. a. A. S., 2012. "Effect of pre-cooling treatments on shelf life of tomato in ambient condition,". *International Journal of Food, Agriculture and Veterinary Sciences*,, Volume vol. 2, no. 3,, p. pp. 50–56.

Tusiime, S. M., 2014. *Evaluating horticultural practices for sustainable tomato production in Kamuli, Uganda*. s.l.: Iowa University.

Tusiime, 2014. s.l.: s.n.

USDAVIS, 2015. *Post Harvest Technology*. s.l.: Western Institute of food safety and security..

Workneh T. S., G. O. a. M. S., 2012. "Effects of preharvest treatment, disinfections, packaging and storage environment on quality of tomato,". *Journal of Food Science and Technology*, , Volume vol. 49, no. 6, , p. pp. 685–694.