INVESTIGATION AND EVALUATION OF AN EXTRACTING SYSTEM FOR TOMATO SEEDS AND THE REQUIRED ENERGY

By

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B.Sc. Agric. Sc. (Agric. Eng.), Zagazig University, 2004
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ABSTRACT

Ahmed Mustafa Ibrahim Soliman: Investigation and Evaluation of an Extracting System for Tomato Seeds and the Required Energy. Unpublished Ph.D. Thesis, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, 2017.

Manual extraction of tomato seed is a tedious operation and has some drawbacks such as incentive labor, excessive water use, unfriendly environmental load, and much time consuming. Therefore, this study was dedicated to address the problems of manual extraction via fabricating a local machine to extract tomato seeds efficiently. Accordingly, some of physical and mechanical properties of tomato fruits and seeds, related to the mechanical seed extraction, were measured to aid in manufacturing the aimed machine. After that, an electric-motor powered machine was fabricated, and the machine mainly consisted of: mainframe, feed hopper, fruit cutting mechanism, delivery chute, seed separating mechanism, and power transmission systems. Subsequently, a techno-economic assessment was performed to investigate the effect of multiply machine operating parameters on the machine evaluative criteria, as well as to economically compare between the mechanical and manual seed extraction. Hence, the operating parameters were: drum speeds (400, 450, 500, 550, and 600 rpm), feeding rates (90, 120, 150, and 180 kg/h), drum holes diameters (4, 5, and 6 mm), and cutting speeds (50, 60, and 70 rpm). Additionally, the evaluation criteria were: extractor productivity (kg/h), extractor efficiency (%), seed purity (%), seed losses percentage (%), total specific energy consumption (kW.h/kg), germination percentage (%), and total costs (LE/h). The analysis of data could be summarized as next:

- The maximum extractor productivity equaled (10.48 kg/h) and was obtained from the drum speed of 600 rpm, feeding rate of 180 kg/h, the drum holes diameter of 5 mm, and cutting speed of 60 rpm.

- The highest value for the extractor efficiency (96.75%) was recorded at drum speed of 550 rpm, feeding rate of 150 kg/h, drum holes diameter of 5 mm, and 60 rpm cutting speed.
- The highest percentage of seed purity (98.94 %) was found at 600 rpm drum speed, 90 kg/h feeding rate, 4 mm drum holes diameter, and cutting speed of 50 rpm.
- The minimum seed losses percentage was equal to 3.25% and found at drum speed of 550 rpm, 150 kg/h feeding rate, drum holes diameter of 5 mm, and 60 rpm cutting speed.
- The lowest value for total specific energy consumption (0.038 kW.h/kg) was achieved at 600 rpm drum speed, 180 kg/h feeding rates, 6 mm drum holes diameter, and cutting speed of 60 rpm.
- Germination test proved that the mechanical extraction of seeds did not considerably harm the germinability of seeds (germination percentage average equaled to 82.2 %) as compared to the manual method (82.3%).
- The total cost of manual seed extraction rose by about 44 and 187 % in comparison with the cost of mechanical seed extraction before and after discounting pulp tomato revenue, respectively.

It can be concluded that using the fabricated machine to extract seeds from tomato fruits is more economic than applying the manual seed extraction method.

Keywords: Mechanical Seed Extraction, Centrifugation, Tomato Fruits, Tomato Seeds, Techno-Economic Assessment.

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INTRODUCTION

1.1. Background

Tomato, *Lycopersicum esculentum Mill*, is among well-liked vegetables crops worldwide. The continuing popularity of tomatoes comes from their preferable nutritional and organoleptic characteristics as well as the multi-health benefits of lycopene being in tomatoes. People often consume tomatoes directly as a raw food or after making industrial processing to produce juice, paste, ketchup, sauce, powder and canned tomatoes **(Sinha *et al.*, 2011 and Machmudah *et al.* 2012)**.

Tomatoes represent one of the most valuable products of Egypt. According to the latest statistics provided by **FAO (2016)**, approximately 6% of tomato world production is yielded by Egypt and, in consequence, the country is classified as the fifth world producer. Between the period of 1993 and 2013, the total average for tomato harvested area and tomato local production were estimated around 0.5 million feddan (464868.25 ha) and 7.214 Mg, respectively. When comparing the tomato domestic production to other agricultural commodities produced in 2013, in terms of quantity and dollar value, tomatoes attained the fourth and first rank, respectively. This shows that how tomatoes are a precious product and deserve the consideration of researchers.

Basically, tomato seeds are paramount to cultivate tomatoes. In 2013, the total quantity of imported and exported tomato seeds in Egypt were 0.837 and 0.02 Mg, respectively (**EAS**, **2014**). Therefore, the greatest quantity of seeds is imported from the outside. This, of course, exacerbates the problem of hard currency shortage in the domestic market due to the high price value of seeds in the world market, and the government cannot meet all demands. Additionally, the imported seeds may be diseases carriers so that the potential productivity can be negatively influenced owing to the spreading of diseases (**CAAES**, **2016**). Hence, aiding in addressing issues of local tomato seed production is common responsibility for all in this critical economy of Egypt.

Not only are tomato seeds a vital input to plant and produce tomatoes but also seeds, remaining after the industrial processing for tomatoes, can be used to produce value-added products such as tomato seed oil, proteins, vitamin B12 and feedstuff **(Sogia *et al.*, 2002; Giannelos, *et al.*, 2005; Sogi *et al.*, 2005 and Sinha *et al.*, 2011)**. After manufacturing tomatoes to produce juice or pulp, the solid waste, called tomato pomac, forms around 20 - 30% of unprocessed tomatoes, and this waste includes about 55 % seeds that can be extracted mechanically. As a result, the seed component of the waste has recently received considerable scientific investigations.

1.2. Problem statement

Considering the wider significance of producing tomato seed locally, its economic value, as well as the conspicuous lake of domestic-manufactured equipment targeted at extracting the seed, this study is going to be dedicated to manufacture a system for extracting tomato seeds.

1.3. Objectives

The overall objective is to fabricate a tomato seed extraction machine that may aid the producers of tomato seed in alleviating the problems of manual seed production. To meet this objective, the following specific objectives will be addressed:

1. Review previous studies in relation to the seed production systems and specify the guide points to fabricate the tomato extractor.
2. Get more knowledge about the physical and mechanical properties of tomato fruits and seeds related to the mechanical seed extraction process and then measure these properties in the laboratory.
3. Investigate which combination of operational and design variables that may have a significant impact on the efficiency of seed extraction process with the consideration of both power consumption and cost.
4. Manufacture the initial model to perform preliminary experiments, identify the missing practical points, and then fabricate the final model.