

Material & energy flow analysis in cinnamon industry

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ABSTRACT - This paper briefly reviews the material and energy flow analysis and economic analysis of the cinnamon industry in Sri Lanka, in order to identify opportunities for improvements and waste minimization. The basis is taken as 1 acre. Boundaries are, harvesting cinnamon rods and receiving various types of end products. Data are taken from different plantations. Results of the MFA indicate the weights of the products and waste at different stages of processing. This paper reviews the average labor hours involved, electrical and thermal energy consumption from the results of EFA. And also the economic potential of this industry

INTRODUCTION

Cinnamon is the one of major commercial plant in Sri Lanka. Cinnamon is cultivated for taking bark as the main product and cinnamon leaf oil is extracted from the by-products of the cinnamon tree. Although high-income, get from the cinnamon industry, still used traditional methods for producing type of barks & leaf oils. Therefore, that if we can do something for developing for the industry it is most valuable for the country.

The main objective of the research is developed the mathematical model to identify total income, total cost, waste and energy requirements using material and energy flow analysis for cinnamon leaf oil and cinnamon bark production processes from harvesting. When consider the literature review there is no any research papers which have touch this are in cinnamon industry. It can be helpful to increase the profit through minimizing the waste from the process and optimizing energy requirements. Moreover, this report can be a resource for researchers in this

field and investors to get idea about income of the cinnamon industry.

METHODOLOGY

Literature review on cinnamon cultivation and economies, material and energy flow analysis of processes.

Identify of unit operations & quantifying all flows in the cinnamon industry.

Collect data for material & energy flow analysis.

Energy and material flow analysis on the processes and economic analysis of cinnamon industry.

The following equation can be used to analyse the material flow of the cinnamon processing.

Here, is the input material quantity of the certain step whereas, is the output material quantity of the certain step.

RESULTS AND DISCUSSIONS

Results of the material flow analysis are shown below for each unit steps. The basis is taken as 1 acre.

Harvesting: This is the initial step. Usually about 3000 well-grown cinnamon rods are harvested from an acre. The weight is 6294 kg.

Transporting to the

peeling: Here, leaves are removed from the rods.

Weight of the harvested rods =6294kg

Weight of the leaves removed rods=4670kg

Weight of the leaves=1624kg

Removing knots: Knots are removed at the start in order to have a smooth peeling procedure. Weight of the leaves removed rods=4670kg

Weight of the knots removed rods=4600kg

Weight of the knots=70kg

Scraping with 'Ko ketta': A metal equipment is used to scrape the outermost bark of the cinnamon rod.

Weight of the knots removed rods=4600kg

Weight of the outermost bark removed rods= 4265kg

Weight of the scraped outermost bark= 335kg

Rubbing with the brass rod: This is done to remove the moisture of the rod and facilitate the peeling process.

Weight of the outermost bark removed rods= 4265kg

Weight of the brass rod rubbed rods=4260kg

Weight of the moisture removed=5kg

Peeling with a small knife: This is the step where the valuable cinnamon bark is taken out of the rod. Weight of the brass rod rubbed rods=4260kg
Weight of the quills removed rods=3715kg

Weight of the wet quills=545kg

Making quills: The quills are made by filling the smaller peeled bark in to the longer peeled bark. The normal size of a filled quill is about 40 inches. **Drying the quills:** This is done to remove the moisture content of the quills.

Weight of the wet quills=545kg

Weight of the dried quills= 249.14kg

Weight of the moisture removed=295.86kg

Drying the remaining rods: The peeled rods are then dried and can be used as firewood.

Weight of the quills removed rods=3715kg

Weight of the dried rods= 2260.96

Weight of the moisture removed=1999.04kg

3.1 Energy flow analysis

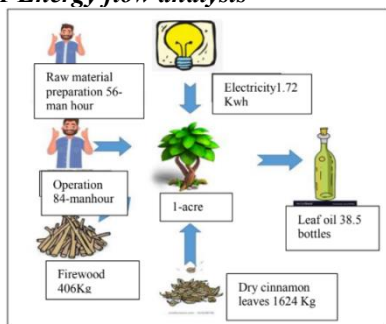


Figure 12

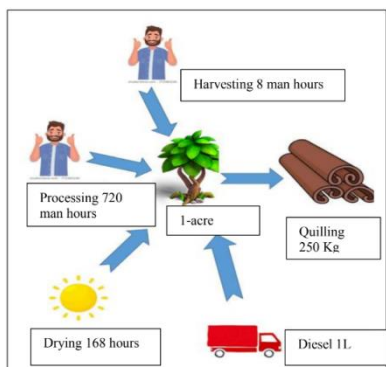


Figure 13

CONCLUSIONS

This paper has reviewed the relevant literature on material and energy flow analysis, discussed the concept, methodology and its applicability to the cinnamon industry in Sri Lanka. The essence of this study is to identify improvement opportunities in the cinnamon industry as high profit cultivation crop in Sri Lanka. The results obtained are of significance to cinnamon cultivators as they can be used to modify the processing conditions in terms of material usage, amounts of energy consumed, water usage and waste generation. The study discussed in the

paper leads to the following major findings and conclusions.

The overall energy and material inputs are lesser compared with other industries because of its lack of product differentiation. The study reveals that the weight of the harvesting rod is 6294 kg from an acre. This includes cinnamon rod and leaves. From these harvests, leaves are used to extract cinnamon oil. 1624 kg of leaves can be obtained from an acre to extract cinnamon oil. In addition, 4670 kg of cinnamon rods are taken from an acre to make quills and quilling.

Energy consumption is low with comparing with the other industries. Electricity, manpower and thermal energy are the main energy sources. The average specific electrical and thermal energy is found to be 0.64kWh/kg and 13.41KWh/kg respectively. The highest energy input is provided by labours (man-hours), followed by thermal and electricity. Very less machines are used in cinnamon industry. Therefore, manpower is much more important. Today this industry has faced many threads because of lack of labours.

Main products of Cinnamon tree are exported for various countries according to their demands. These data were taken from Export Development Board and analysis was done for last 6 years. Cinnamon products are exported under quills, featherings, chips, quilling and some amount of other products. From the economic analysis, we can understand the importance of value addition to this industry for better contribution to Sri Lankan economy.

The findings demonstrate how MEFA provides early recognition of economic potential in cinnamon industry. These results highlight a very small portion of the life cycle of

cinnamon industry since it considered the processing stage only. Further work is required to find the sustainability of cinnamon industry from social and environmental aspects; also, to initiate continuous resource efficiency analysis in the cinnamon industry; and to extend the system boundary to include cinnamon cultivation and value addition in cinnamon industry.

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