The Development of SORREL Systematic Roselle Harvesting System for Efficient Transfer Process

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Abstract. Roselle (Hibiscus sabdariffa L.) belongs to the family of Malvaceae or Hibiscus the Malaysian national flower. In Malaysia, this plant is first introduced in the state of Terengganu as one of the alternatives to replace tobacco plants in sandy soils. Studies conducted on Roselle plantation in Malaysia identified too many repetitive steps in harvesting and deseeding process, as well as separating different grades of Roselle flowers and its logistics. The paper focuses on the improvement of harvesting and deseeding Roselle flowers, aiming to hybridize both processes into one effective process. The reason of developing such combination is to prevent frequent transferring of Roselle flowers to avoid damages, at the same time increasing the quality of harvest. This study also considers embedding few appropriate but simple technologies for systematic harvesting, making sure the Roselle flowers collected are in top quality and in best hygiene by user-friendly, ergonomic and safe to use processes.

1. Introduction

In Malaysia, Roselle is locally called “Asam Paya”, literally means sour for “Asam” and swamp for “Paya”. Other names are “Asam Susur” (sour-rail) or “Asam Kumbang” (sour-beetle), or famously called “Ribena Malaysia” [1] used mainly for cordial drinks, juices, jam, sour pickled, piccalilli and halwa. The important component in commercialization of Roselle is on it’s calyx, a layer surrounding the fruit’s seed (capsules). The flower calyces can be used as beverages, dried to be soaked in water for cold drinks, or boiled in water and taken as tea. It also has some medicinal properties [2, 3], especially its Malic acid which known to increase body’s energy, promoting younger skin and other benefits [4]. In Malaysia, the plant was introduced by farmers in Terengganu as a new agriculture industry in 1993 by the Agriculture Department of Terengganu. The Roselle plant is one of the alternatives to replace the tobacco plants in the area of BRIS (Beach Ridges Interspersed with Swales) soil and it also become a new commercial plantation experiment in Malaysia [5]. Currently, Roselle type UMKL-1(Terengganu) and UMKL-2(Arab) [6] are planted actively in the state of Kedah, Pahang, Perak and Johor. The objectives of carrying the research on Roselle harvesting and deseeding are to identify potential improvement of both processes. Second objective is to develop a new product that can efficiently help in both processes by applying available simple technology as well as embedding ergonomic elements to make the product easy and safe to use.
2. Problems

To ensure the quality of Roselle at its best, the Roselle harvester and deseeding plant have to handle Roselle calyces carefully, avoiding damages and maintaining its freshness and cleanliness. This research focuses on Roselle plantation in the state of Johor, Malaysia. Although specific plantation is chosen, but in general, any Roselle plantation that practices the same harvesting and deseeding method may experience similar problems. There are two main problems associated with harvesting Roselle at the Johor plantation: 1) frequent transferring of Roselle flowers, and 2) inefficiency of Roselle deseeding process. Current practices of harvesting Roselle at the Johor plantation is that the flower collectors uses reusable items such as used paint bucket, used gunny sacks and used large baskets to collect and transfer Roselle flowers frequently from place to place before delivering them to the deseeding centre (Figure 1). At the deseeding centre (Figure 2), workers again transfer the Roselle flowers on the table, then deseeding the flowers with a deseeding tool, which again damaging the flowers as well as creating hygienity concerns.

In order to maximize the quantity of good and high quality Roselle flowers, minimizing the transferring process of Roselle flowers starting from picking Roselle from its plant up to the Federal Agricultural Marketing Authority (FAMA) of Malaysia collection center should be established. Minimising transfer will avoid Roselle from getting damaged and will affect its quality. An effective harvesting method should be introduced to ease the process of travelling the harvest and managing workers.

![Figure 1. Harvesting process at Roselle plantation at Kg. Teluk Rimba, Sg. Mati, Muar, Johor, Malaysia.](image-url)
3. Materials and Method

There are primary and secondary groups of data collected for this research. Primary data are collected through field research, observations, interviews, and video analysis. Meanwhile, secondary data comes from literature reviews, internet articles and online sharing video reviews. The investigation was carried out between 11th Sept 2017 to 30th June 2018, at two venues both at Johor state, Malaysia: the Roselle plantation at Kg Teluk Rimba, Sungai Mati at Muar district and the collecting centre, situated in Kg. Baharu, Senggarang at Batu Pahat district. At the Roselle plantation, the areas involved in planting up to 2000 plants of Roselle is around 3 hectares. The plantation was originally a paddy field (Figure 3:a). The main method delivered for this research is the field research by participant observations, named with Ob.1 and Ob.2.

3.1 Ob.1: Roselle Plantation at Kg Teluk Rimba, Sungai Mati, Muar, Johor

Based on the observations, all workers are using reusable products as main tools for collection of harvest (Figure 3:b). The reusable products are used paint buckets, used gunny sacks, and large baskets. To start the harvesting process, workers use the paint bucket to collect the Roselle flowers at the Roselle plants. After the bucket is full, they need to transfer it to gunny sack at certain checkpoints. They will repeat the process back and forth from 8 am until 5 pm, with lunch breaks daily during harvesting season, a time and energy consuming activities. Filled gunny sacks then brought to the plantation center for another transferring process, into large baskets. Supervisors of the plantation calculate the weight of the large baskets for worker’s wage payments purposes. All workers are paid based on the weight of the Roselle flowers collected per day. The flowers are transported using FAMA’s refrigerated lorry, where a suitable temperature of 10°c maintained to keep Roselle flowers fresh. Time taken to travel from the Roselle plantation to the deseeding centre located in Kg. Baharu Senggarang takes up to two and a half hours.
3.2 Ob.2: Deseeding center at Kg. Baharu Senggarang, Batu Pahat, Johor

At the deseeding center (Figure 4: a), all collected Roselle flowers are poured onto table for deseeding workers to starts separating Roselle’s capsules from Roselle calyces. The existing deseeding tool (Figure 4: b) is made out of stainless steel rod with pointy sharp end to punch out the capsule from the flower. The workers will deseed Roselle until the rod is full, about 10 flowers before transferring them into a bucket. During deseeding, workers often found damaged flowers, capsule stuck at the tip of the tool and Roselle juices all over gloves occurred frequently (Figure 5). The stained gloves raises issues on hygienity and again, transferring deseeded Roselle into large basket repeating.

Based on observations done at both venues, there have been numerous transferring activities. Too frequent transfer can affect the quality of Roselle flower and also its hygienity. When the quality already affected, it can lower the grade of the Roselle harvest simultaneously lowers the grade and its pricing per kilogram.
4. Solution Development

The development of this project involved several stages using ADDIE method (Figure 6). ADDIE is an adapted model based on Instructional Systems Design consisting of Analysis, Design, Development, Implementation and Evaluation [7]. ADDIE act as the main structure of this research starting from idea to the validation of the proposed solution. The “Analyze” part of ADDIE is done by participant observations and interviews at both venues, meanwhile the “Design” part of ADDIE is done at the Department of Industrial Design, Faculty of Design & Architecture, Universiti Putra Malaysia.

![Figure 6. The ADDIE Model [8], with additions of research activities conducted on each process.](image)

4.1 Product Design Specifications (PDS)

At the “Development” stage of ADDIE, apart from abstraction and generalization of the problem process that considers safety in product concept design [9], the Product Design Specification (PDS) [10] model is used to capture several elements for design consideration that suits for harvesting and deseeding Roselle, particularly for Johor plantation. Elements shown in Figure 7.

![Figure 7. Product Design Specification (PDS)](image)
The elements from the PDS model are elaborated as:

i. Safety: deseeding Roselle flowers must be safe, avoiding any sharp shapes in contact with hands.

ii. Shape: the shape of harvesting and deseeding tools should be simple and easy to operate.
   a. Ergonomic: the shape of both tools should be comfortable and promotes hygiene.
   b. Size: sizing of harvesting and deseeding product should fit comfortably with Malaysian anthropometric.

iii. Material: Should be durable for long term usage but low in cost, using waterproof material so that it is easy to wash.
   a. Maintenance: referring to material types.

iv. Technology: Efficient and systematic harvesting and deseeding even logistics requires suitable IoT technologies.

v. Function: The functions of the new product should be simple and easy to use.

In the development of the harvesting product design, few steps including ideation sketch, several 3-dimensional (3D) mock-ups and a product prototype are involved. Apart from the process of design development, establishments of IoT (Internet of Things) technology is also included in the prototype for the purpose of systematic management of harvesting and logistics of Roselle flowers between Roselle plantation and FAMA. After “Implementing” step, all the necessary information from “Analyze” part done at both venues, solution to systematic harvesting is developed, named “SORREL”.

5. Development of SORREL

SORREL is a harvesting system aimed to ease the process of harvesting Roselle and reducing the transferring process drastically. In previous practice, transferring happened at least 6 times between buckets, gunny sacks and large baskets, not including travelling the harvest from place to place. SORREL suggests transferring happened only once and transferring happened again, at minimum recurrences at FAMA for grade sorting. The solution is equipped with QR code system, linking the code scanning with weighing machine and wage payments apps. FAMA will collect all filled bags and return empty bags for workers to continue harvesting until Roselle harvesting season ends.

5.1 SORREL Harvesting Bag

The harvesting bag (Figure 8), similarly look like a laundry bag, consists of handles both on the left and right side. The handles makes it easier to carry when its full, and the workers can easily change to another bag to continue harvesting the flowers. At first, workers will scan the QR code of empty bag, to secure the assignment of the bag to the worker. The workers will collect and deseed Roselle flowers at the same time, and put the deseeded Roselle into the bag until the bag is full. The bag can accommodate up to 5 kilograms and workers just have to bring the filled bag onto weight scan machine provided at the plantation’s weighing centre. The bag has both upper and lower opening, only to be operated at FAMA centre, where transferring deseeded Roselle flowers are much easier and uses less work. To secure the bag from spilling, the upper part of the bag uses zip while the bottom part uses buckle system. At the centre, scanning of the bag’s accurate weight linked with workers ID eases the process of facilitating wages to the workers. All Roselle filled bags will be collected by FAMA workers straight to FAMA sorting centre. The material used for the harvesting bag is from tarpaulin material, waterproof, easy to clean and high durability. The material also does not allow hot environment as to sustain the quality of Roselle flowers. The bag equipped with padding support on the shoulder, to reduce discomfort on the body when load is applied in the bag.
5.2 SORREL Deseeding Tool

The deseeding tool (Figure 9) consists of three parts: the hollow part for the knife, the part for the thumb and the handle. The knife is a detachable component, making it easier to replace, clean and store. The second part is the thumb section, which is important for the purpose of removing the capsule of Roselle flowers. The thumb section has a push point where it only requires little force when deseeding. The handle focuses on the ergonomic shape for user’s comfortability when using it in long hours. It has a gear system inside which makes the product easier to handle by the worker. The design of this product is based on the validation responses at the Roselle plantation.

Although the tool looks simple, the design is more focused on the ergonomic feature; easier to hold and to clean.

6. Efficient Transfer

Systematic transfer process is important to ensure effortless process and maintains the freshness and hygiene of Roselle flowers. The tools used must be suitable for Roselle picking and deseeding activity, avoiding damage or defect on the calyces that will decrease its quality and lowers its grade. As shown in Figure 10, the workers just need to transfer Roselle only once: from harvesting the flowers into the SORREL harvesting bag. There are no more Roselle transferring after that from the workers. Deseeded Roselles are kept inside the harvesting bag and travels to weighing machine, into pallets and into FAMA lorry straight to FAMA centre. Before, FAMA lorry have to travel to Roselle plantation and deseeding center and return back to FAMA. Now with SORREL system, FAMA lorries only have to travel between its center and Roselle plantation. This resulted to time and petrol savings.
The travel flow of the harvesting bag of Roselle are shown in Figure 11. At FAMA center, transferring will happened at minimum frequency, involving sorting Roselle’s grade, cleaning and logistics to Roselle food factories. By this improves system, the quality and freshness of Roselle are kept in maximum.

Figure 10. Workers workflow when using SORREL harvesting process.

Figure 11. The SORREL harvesting bag movement flow.

7. Conclusion

Any plant harvesting should have a systematic process flow so that the collection of the harvest is a smooth process, furthermore maintains the harvest freshness and quality. After research done on both venues in Johor, an effective harvesting, deseeding, wage payments and logistics of Roselle flowers are developed with an improved simple system, fulfilling the needs of the workers to complete the work at the minimum time and place. Therefore, it can reduce the cost for travelling and still maintaining the same amount of workers, provided they all can work at the plantation. The researchers are currently working on the improvement of the conceptual design, as the study presented in the paper is at preliminary stage at the time. In the future, validation of SORREL and proof of concept will be carried out to strengthen the proposed system. SORREL system consisting of harvesting bag, deseeding tool and SORREL apps is copyrighted under UPM.
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