Conceptual Design of Coconut Haustorium (*Cocos nucifera*) Simplicia Dryer Integrated with Solar Power Plant

Stieven Netanel Rumokoy, Adriyan Warokka, Arnold Robert Rondonuwu,
Karlah Lifie Riani Mansauda, I gede Para Atmaja, Mauren Langie

Department of Electrical Engineering
Manado State of Polytechnic
Indonesia, Pharmacy Study Program
Sam Ratulangi University

rumokoy@elektro.polimdo.ac.id

lifiekarlah@unsrat.ac.id

adryan.w@gmail.com

igedeatmaja69@gmail.com

sinkron003@gmail.com

mauren.langie@elektro.polimdo.ac.id

Abstract. Coconut commodity has significantly contributed to Indonesia as a foreign exchange source through exports. Typically, farmers process coconuts into copra. On the other hand, the potential of other coconut derivative products still holds considerable opportunities for further exploration. Innovation in engineering is required to facilitate the development of specific products. One of the coconut components with potential for development into a specific product is the coconut haustorium. This research aims to conceptualize a design for a dryer apparatus for coconut haustorium simplicia products. The research method begins with a literature study to delve into drying technology advancements and coconut haustorium simplicia products. Another research method involves descriptive research conducted through interviews with parties related to this study. The subsequent stages involve conceptual design, which is embodied through detailed dryer apparatus design. The outcome of this research is a dryer apparatus conceptual design for coconut haustorium simplicia application, taking into account both mechanical and electrical aspects. On the mechanical side, the design encompasses capacity, dimensions, racks, and drainage. On the electrical side, it involves the capacity of electric energy supply sourced from the Solar Power Plant and encompasses eight scenarios of control for regulating the electric energy source through a mathematical model of relation.

Keywords: Coconut; Simplicia; Dryer

M. U. H. Al Rasyid and M. R. Mufid (eds.), *Proceedings of the International Conference on Applied Science and Technology on Engineering Science 2023 (iCAST-ES 2023)*, Advances in Engineering Research 230,
https://doi.org/10.2991/978-94-6463-364-1_29

1. Introduction

Drying technology for specific raw materials has been carried out through various methods, including solar drying systems. Various agricultural applications have utilized solar drying for crops [1][2][3]. Solar drying is a conventional technique in which the drying process is designed to expose the material directly to sunlight. This approach is cost-effective as it typically requires minimal equipment to focus sunlight or protect the products from external disturbances. However, its drawback lies in its dependency on intermittent sunlight.

In a previous study [4], solar energy was employed to enhance the drying of olives. Another study [5] highlighted the limitations of conventional open sun drying, including direct sun exposure, vulnerability to animal interference, lack of hygiene control, and unpredictable rainfall. To address these challenges, a forced draft solar dryer was developed using locally available materials. By modifying the agricultural drying apparatus designed in this study, several issues have been anticipated. The main challenge is the relatively lengthy drying process, around 2-3 days, which is also weather-dependent.

Another drying system involves using heat generated from combustion [6][7][8][9]. This process requires specific fuel sources such as biomass, biogas, or fossil fuels. The advantage of biomass drying lies in its high calorific value and controllable distribution. However, cleanliness levels can be lower compared to other methods. A study [10] focused on a drying apparatus with a combustion system. The design catered to the needs of small-scale rural entrepreneurs and included features like a combustion chamber, drying chamber, flue gas passage, and chimney. The system's thermal performance was evaluated based on moisture removal rate, drying rate, thermal efficiency, and heat transfer efficiency.

Another drying technique involves using electric dryers (electric ovens). Electric oven drying generally offers advantages in terms of temperature control and better hygiene. However, achieving high heat quantities necessitates a significant amount of electricity [11][12]. To maximize the use of this type of dryer, the required heat input for the specific product being dried must be considered.

In the context of coconut commodities (*Cocos nucifera*), many farmers process coconuts into copra. Yet, the potential of other coconut by-products, both primary and secondary, remains vast. Innovations are needed from farmers and entrepreneurs to establish positive branding and effective marketing for these coconut products. Coconut haustorium, for instance, hold immense potential as a planting medium [13] and for other functions [14].

One underutilized component of the coconut is the coconut haustorium. In some regions, coconut haustorium is still considered waste. However, it possesses potential medicinal properties. Previous research titled "Antianemia Activity of Coconut Haustorium (*Cocos nucifera*) Waste Filtrate on Sodium Nitrite-Induced Mice" reveals that dried and dissolved coconut haustorium simplicia holds potential for creating anti-anemia medications for humans [15]. Similarly, in the study" Effect of Coconut Haustorium (*Cocos nucifera* L.) Extract on Immobility Time Reduction as an Antidepressant in Mice (Mus musculus", it is explained that coconut haustorium, processed into simplicia through washing and drying, and further extracted, has potential as an antidepressant [16]. Another study titled " Antidiarrheal Effect of Ethanol Fraction of Coconut Haustorium (*Cocos nucifera* L.) on White Mice (*Mus musculus*)" demonstrates the potential of coconut haustorium simplicia as an antidiarrheal medication [17].

Based on study [18][19], there is a need to design a drying apparatus for the production of coconut haustorium simplicia. The design includes capacity considerations, temperature control systems, drying rack design, drainage design, and dimensional specifications for the drying apparatus.

2. Methodology

The research methodology commenced with a thorough literature review to delve into the advancements in drying technology and coconut haustorium simplicia products. Another research approach employed was the descriptive research method, which included interviews with relevant stakeholders. Interviews were conducted with coconut farmers to explore the potential availability of coconut haustorium. Additional interviews were held with pharmacists to further understand the potential utilization of coconut haustorium simplicia as a raw material for medications. The subsequent step involved conceptual design, which was translated into detailed designs for the drying apparatus. The research stages are illustrated in Fig. 1

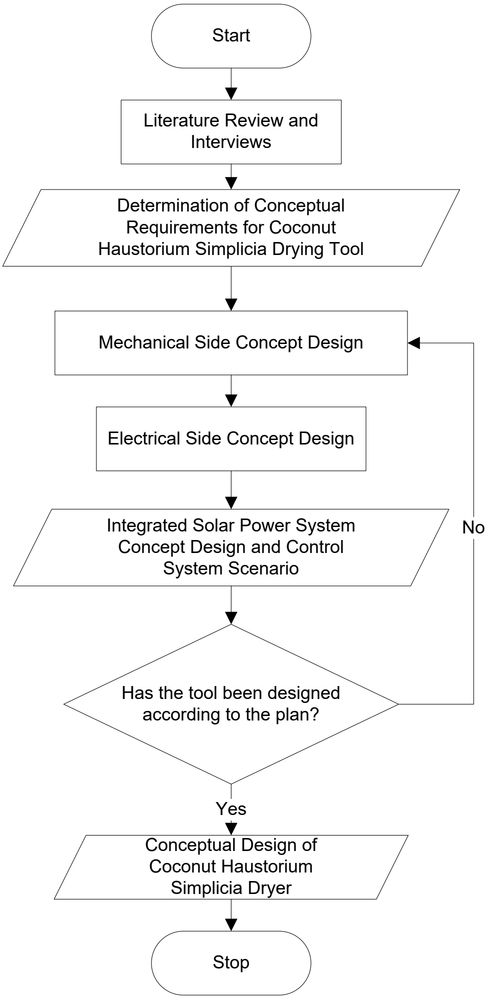

Fig 1. Research Flowchart.

3. Discussion

3.1. Potential and Uses of Coconut Haustorium as a Raw Material for Medicine

Coconut haustorium is the embryo within a mature coconut that has started to sprout. The availability of coconut haustorium is highly dynamic and depends on the presence of mature coconuts that have sprouted in the field. Its availability is intertwined with the utilization cycle of coconuts. In certain instances, an abundant supply of coconut haustorium occurs when coconut product prices decrease. Coconuts are sometimes left unprocessed to await higher prices, leading to the sprouting of mature coconuts and the emergence of coconut haustorium. Interviews with coconut farmers in North Sulawesi, Indonesia, revealed that coconut processing closely follows copra commodity prices. When copra prices are low, farmers tend not to process coconuts into copra due to the high operational costs associated with coconut processing. Consequently, mature coconuts with sprouts become abundant in such circumstances.

Based on literature and interviews with several coconut farmers, coconut haustorium remains underutilized, and in some cases, it is still considered waste. Although coconut haustorium can be directly consumed or used as animal feed, its utilization in this aspect remains minimal. Typically, coconut haustorium is discarded and treated as waste. This is unfortunate considering that coconut haustorium holds the potential for additional income in coconut production.

According to previous research and interviews conducted with coconut farmers, coconut haustorium still holds untapped potential. In some instances, it is even considered waste. Coconut haustorium can be consumed directly, used as animal feed, or processed into various products. Its potential uses include:

- "Antianemia Activity of Coconut Haustorium (*Cocos nucifera*) Waste Filtrate on Sodium Nitrite-Induced Mice": This study explains that dried and dissolved coconut haustorium simplicia have the potential to be developed into an antianemia medicine for humans.
- "Effect of Coconut Haustorium (*Cocos nucifera* L.) Extract on Immobility Time Reduction as an Antidepressant in Mice (*Mus musculus*)," indicating that coconut haustorium, processed into simplicia through washing, drying, and subsequent extraction, holds the potential to serve as an antidepressant.
- "Antidiarrheal Effect of Ethanol Fraction of Coconut Haustorium (*Cocos nucifera* L.) on White Mice (*Mus musculus*)," suggesting that processed coconut haustorium simplicia has potential as an antidiarrheal medicine.

Given the findings of previous research, it is imperative to explore effective utilization of coconut haustorium. This study focuses on designing a drying apparatus for coconut haustorium simplicia, intending to enhance its value and support its potential applications in medicine.

3.2. Design of the Coconut Haustorium Dryer

1) Mechanical Side Design

In the process of producing coconut haustorium simplicia, a drying apparatus is needed that meets the criteria for creating simplicia as a raw material for medicine. To fulfill this requirement, several technical designs and arrangements are necessary. Key considerations include:

a) Drying capacity design: The drying capacity design needs to consider energy utilization efficiency. It should be devised with attention to the quantity of simplicia products, ensuring a balance between energy utilization and resulting product yield.

b) Drying dimension design: The shape and size of the drying apparatus must align with its capacity and ergonomic conditions. The layout of heat sources and circulation within the drying system also needs consideration. The choice of materials for the drying apparatus should ensure their suitability for specific temperature conditions.

c) *Drying rack design*: The design of the drying racks should be adjusted to accommodate coconut haustorium simplicia. If the coconut haustorium is sliced to a specific thickness, the rack spacing needs to match the simplicia product. As coconut haustorium contains a considerable amount of water, arrangements should be made to prevent water droplets from falling onto the products below.

d) *Drainage design*: Given the moisture content of coconut haustorium, the simplicia drying apparatus should be designed with an effective drainage system.

2) Electrical Side Design

a) *Electrical energy source for the drying apparatus*: Ensuring the quality of simplicia is crucial for medicinal applications. To maintain proper coconut haustorium simplicia production, a reliable electrical energy source is necessary. A continuous supply of electrical energy is essential to meet the specified drying standards. In some cases, coconut haustorium may be harvested in locations far from electrical power sources. To maintain the freshness of the coconut haustorium, the drying process should ideally take place at the location of harvest. In tropical regions, utilizing solar energy is a potential solution. Solar energy can be converted into electrical energy through the construction of a Solar Power Plant using solar modules.

b) *Control system for the drying apparatus*: In the design concept of the drying apparatus, the control system can be divided into two parts. The first part involves controlling the heating system's temperature, either manually or automatically. The drying temperature for simplicia can range from 20°C to 90°C, with the optimal temperature being below 60°C. Hence, the drying apparatus design is tailored within this temperature range. The second part pertains to determining the control system for utilizing electrical energy sources. To ensure a reliable supply of electrical energy, the simplicia drying apparatus is equipped with two electrical energy sources: the grid and the Solar Power Plant. For efficient energy utilization, different scenarios for electrical energy utilization need to be established. Mathematical calculations are employed to determine control system scenarios, considering various potential system conditions. These calculations are then transformed into mathematical relationships and mapped out accordingly.

In mathematical terms: Given a relation between a domain "energy sources" and a codomain "energy availability conditions", represented as:

$R: A \rightarrow B$

where n(A) = x and n(B) = y, the formula for the number of possible relations is:

$$R = y^x \quad (1)$$

In this context, the domain "Electric energy sources" is defined as:

A = {Grid, Sunlight, Battery Energy}

And the codomain "Good condition/operational, Poor condition/non-operational" is defined as:

B = {Good condition/operational, Poor condition/non-operational}

So, n(A) = 3 and n(B) = 2. Plugging these values into equation (1):

$R = 2^3$

R = 8 possible relations.

In this scenario, it needs to be noted that the electric power production capacity of the Solar Power Plant has been adjusted according to the electricity consumption in line with the security system load. The main energy sources determined are derived from batteries. The energy sources consist of Grid, Battery, and Solar Illumination, while the codomain is defined as " Good condition/operational" and " Poor condition/non-operational" for each energy source. Regarding the battery's condition, the determination of its good and bad operational conditions can be regulated by the percentage of available energy within the battery. The mapping of conditions with a total of 3 domains and 2 codomains yields 8 different variations. Out of these 8 variations, operational system scenarios have been developed as illustrated in Table 1.

TABLE I. OPERATION SCENARIOS

Scenarios	**Condition Scenario**	**Control Setting Scenario**
Scenario 1	Grid operational, Good sunlight, Battery in good condition	Electric energy source for the dryer taken from the battery.
Scenario 2	Grid operational, Good sunlight, Battery in bad condition	Electric energy source for the dryer taken from the Grid.
Scenario 3	Grid operational, Poor sunlight, Battery in bad condition	Electric energy source for the dryer taken from the Grid.
Scenario 4	Grid operational, Poor sunlight, Battery in good condition	Electric energy source for the dryer taken from the battery.
Scenario 5	Grid not operational, Poor sunlight, Battery in bad condition	System off.
Scenario 6	Grid not operational, Poor sunlight, Battery in good condition	Electric energy source for the dryer taken from the battery.
Scenario 7	Grid not operational, Good sunlight, Battery in good condition	Electric energy source for the dryer taken from the battery.
Scenario 8	Grid not operational, Good sunlight, Battery in bad condition	System off.

3) Device Design Model

The device design model, in accordance with the established concept, can be created as shown in Figure 1. This design model can be further developed to accommodate the specific requirements of the drying device. The design takes into account the possible placement and form of the coconut haustorium simplicia drying apparatus.

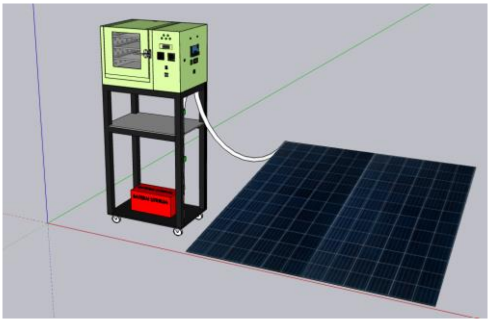

Figure 2. Dryer Design Concept.

4. Conclusion

Based on the research findings, the design concept of a dryer apparatus for coconut haustorium simplicia applications needs to consider both mechanical and electrical aspects. On the mechanical side, the design encompasses capacity, dimensions, racks, and drainage. On the electrical side, it involves providing electrical energy from a Solar Power Plant, with 8 (eight) control scenarios for managing the energy source through a mathematical model of relations.

Acknowledgment

The authors wish to acknowledge Politeknik Negeri Manado for their generous financial support through the research funding provided under the "Produk vokasi unggulan perguruan tinggi" scheme.

References

[1] P. H. Hien, L. Q. Vinh, T. T. T. Thuy, and T. V. Tuan, "Development of Solar-Assisted Dryers for Food and Farm Crops," Trans. ASABE, vol. 52, no. 4, pp. 1255–1259, 2009, doi: 10.13031/2013.27768.

[2] Y. Ruhiat and Y. Guntara, "Heat Transfer Analysis Cabinet-Type Erk Solar Dryer Machine for Drying Agricultural Products," EUREKA, Phys. Eng., vol. 2022, no. 4, pp. 86–92, 2022, doi: 10.21303/2461-4262.2022.002038.

[3] A. Opeyemi, O. S. Niyi, O. Ajiboye, and J. Ogunsua, "Comparative Evaluation Of Nspri Solar Dryers Using Fermented Cassava (Lafun) AND CASSAVA CHIPS," Niger. J. POST-HARVEST Res., vol. 3, no. 1, pp. 12–25, 2021.

[4] F. Zare, G. Najafi, P. Ghiasi, E. Fayyazi, T. Yusaf, and M. Mazlan, "Applying Solar Energy in the Combination of Solar Dryer with Olive Harvesting Machine to Reduce Energy Losses," Sustain., vol. 14, no. 3, pp. 1–29, 2022, doi: 10.3390/su14031091.

[5] I. Harrison, O. Martins, and B. Musa, "Design and Fabrication of Solar Dryer for High Potential Agro-Produce in Midwest Region of Nigeria," Int. J. Eng. Sci. Appl., vol. 05, no. 02, pp. 47–57, 2021.

[6] A. Jading, W. P. Aman, and B. Fangohoy, “Kajian Distribusi Suhu dan Efisiensi Alat Pengering Pati Sagu Agitated Fluidized Bed Tipe Silinder Bertingkat Berbahan Bakar Kayu dan Tempurung Kelapa,” Agritechnology, vol. 3, no. 1, pp. 10–20, 2020, doi: 10.51310/agritechnology.v3i1.52.

[7] N. Apriandi et al., “Karakterisasi Alat Pengering Tipe Kabinet Berbahan Bakar Liquefied Petrolium Gas (LPG) Dengan Penambahan Low Cost Material Heat Storage (LCMHS),” J. Rekayasa Mesin, vol. 17, no. 2, pp. 281–288, 2022, doi: 10.32497/jrm.v17i2.3690.

[8] Julian and F. L. Batu, “Effect of Cocoa Drying on Seed Quality,” AFoSJ-LAS, vol. 2, no. 4, pp. 57–68, 2021, [Online]. Available: http://j-las.lemkomindo.org/index.php/AFOSJ-LAS

[9] I. Wunarlan, “Pengujian Tingkat Efisiensi Alat Pengering Multi Komoditas Tipe Udara Hembus Berbahan Bakar Biomasa,” J. Tek., vol. 16, no. 1, pp. 12–24, 2018, doi: 10.37031/jt.v16i1.34.

[10] R. Nalawade and N. . Panwar, “Experimental Investigation on Biomass Fired Dryer for Drying of Agricultural Products,” Int. J. Ambient Energy, vol. 42, no. 15, pp. 1765–1768, 2021, doi: 10.1080/01430750.2019.1614990.

[11] T. N. Phan, V. H. Tran, N. Kaloyanov, and M. Zlateva, “An experimental study for drying Pisum sativum on an electric dryer and a heat pump dryer,” E3S Web Conf., vol. 327, pp. 1–9, 2021, doi: 10.1051/e3sconf/202132701006.

[12] J. L. Paes, V. de A. Ramos, M. V. M. de Oliveira, M. F. Pinto, T. A. d. P. Lovisi, and W. D. de Souza, “Automation of monitoring of drying parameters in hybrid solar-electric dryer for agricultural products,” Rev. Bras. Eng. Agric. e Ambient., vol. 26, no. 4, pp. 283–291, 2022, doi: 10.1590/1807-1929/agriambi.v26n4p283-291.

[13] N. Yusriani, “Pengaruh Media Tanam Sabut Kelapa (Cocopeat) Dan Pupuk Kandang Terhadap Pertumbuhan Dan Produksi Tanaman Cabai Rawit (Capsicum Frutencens L),” Hijau Cendekia, vol. 7, no. 1, pp. 41–45, 2022, doi: 10.32503/hijau.v7i1.2257.

[14] I. G. P. Atmaja and S. N. Rumokoy, “Pemanfaatan Arang Tempurung Kelapa Untuk Menurunkan Nilai Resistansi Tanah Pada Sistem Pentanahan Tenaga Listrik,” Fokus Elektroda, vol. 04, no. 04, pp. 4–8, 2019.

[15] A. Pradawahyuningtyas, M. Priastomo, and L. Rijai, “Uji Aktivitas Antianemia Filtrat Limbah Kentos Kelapa (Cocos nucifera Haustorium) Terhadap Mencit Yang Diinduksi N atrium N itrit,” ad-Dawaa’J.Pharm.Sci, vol. 2, no. 2, pp. 16–29, 2020.

[16] A. Azis and G. Rinding Lawan, “Pengaruh Ekstrak Kentos Kelapa (Cocos nucifera L.) Terhadap Penurunan Immobility Time Sebagai Antidepresan Pada Mencit (Mus musculus),” J. Kesehat. Yamasi Makassar, vol. 4, no. 1, pp. 1–8, 2020, [Online]. Available: http://

[17] Y. Wahyu Tri Mulyani, A. Rokiban, and S. Putu, “Efek Antidiare Fraksi Etanol Bakal Buah Kelapa (Cocos nucifera L.) Terhadap Mencit Putih (Mus musculus),” SNPPM-3 (Seminar Nas. Penelit. dan Pengabdi. Kpd. Masyarakat), vol. 3, p. 2021, 2021.

[18] S. N. Rumokoy, K. L. R. Mansauda, A. Warokka, and I. G. P. Atmaja, “Alat Pengering Simplisia Kentos Kelapa (Cocos nucifera): Studi Potensi,” J. Elektr., vol. 02, no. 01, pp. 10–15, 2023.

[19] K. Lifie, R. Mansauda, and C. N. Sambou, “KANDUNGAN DAN MANFAAT TERAPETIK KENTOS KELAPA (Cocos nucifera L.),” Pros. Semin. Nas. Kefarmasian, vol. 1, no. 1, pp. 53–58, 2022.