DESIGN, FABRICATION, AND PERFORMANCE EVALUATION OF COCONUT FIBER EXTRACTION MACHINE

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An Undergraduate Thesis Submitted to the Faculty of the Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines
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(AB Machinery and Power Engineering)

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ACCEPTANCE SHEET

This undergraduate thesis entitled **"DESIGN, FABRICATION, AND PERFORMANCE EVALUATION OF COCONUT FIBER EXTRACTION MACHINE"** prepared and submitted by **JHAYZIEL R. ORPIANO AND KRISTAL PEARL T. SINDAC,** in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AB Machinery and Power Engineering),** is hereby accepted:

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Jhayziel showed a strong commitment to her academics from a young age. She began her elementary education at Laboy Elementary School and graduated as a Salutatorian. She spent her junior high school at Dipaculao National High School, where she completed it with honors. Jhayziel continued her senior high school education at Wesleyan University of the Philippines - Aurora Campus, where she once again excelled as an honor student.

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For her junior high school education, she attended Maria Aurora National High School, where she not only graduated with honors but also received the distinction of being named Journalist of the Year. Continuing her academic journey, she pursued senior high school studies at Wesleyan University Philippines – Aurora Campus, again graduating with honors and retaining her title as Journalist of the Year. She remained an active member of various student leadership organizations throughout her schooling.

Presently, she is undertaking her tertiary education at Central Luzon State University. Beyond her academic pursuits, she has held the esteemed position of Governor within the College of Engineering Student Government (CESG). Additionally, she has actively participated in extracurricular activities, notably as a member of the Society of Agricultural and Biosystems Engineering Students – Philippine Society of Agricultural and Biosystems Engineering (SAGES-PSABE), a notable academic organization.

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THE AUTHORS

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ABSTRACT

ORPIANO, JHAYZIEL R., SINDAC, KRISTAL PEARL T., Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, July 2024, **DESIGN, FABRICATION, AND PERFORMANCE EVALUATION OF COCONUT FIBER EXTRACTION MACHINE**

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This study examines the Coconut Bristle Machine, designed to enhance productivity and efficiency in coconut processing. The machine includes an outer structure, electric motor, drawer, holder, residue cover, and rotating shaft, and was tested according to Philippine Agricultural Engineering Standard (PAES) 251:2011. Tests were conducted using coconut husks of different maturities at three speeds: 500 rpm, 800 rpm, and 900 rpm. Noise levels rose from 61.4-77.6 dB when idle to 74.5-84.9 dB during operation. Energy consumption was 0.234 kilowatt-hours, with power consumption at 811 watts, voltage at 220 volts, and current at 3.69 amps.

Fiber extraction duration varied with drum speed and husk maturity, from 9.013 minutes (young husks at 900 rpm) to 18.723 minutes (mature husks at 900 rpm). The highest fiber weight was 2.867 kg at 500 rpm with young husks, and the lowest was 1.817 kg at 900 rpm with mature husks. Moisture content ranged from 59.23% to 91.25%. Defibering capacity peaked at 185.22 g/min at 900 rpm with young husks, with the highest fiber recovery (77.49%) at 500 rpm with mature husks, and defibering efficiency at 75.01% at 500 rpm with mature husks.

The economic analysis shows an initial investment of ₱26,310.00 and an annual income of ₱6,411.25 ensuring quick payback and high ROI. These findings emphasize the importance of optimizing both the cylinder speed and the maturity level of the coconut husk to maximize fiber yield and quality during the extraction process.

The Coconut Bristle Machine represents hope, progress, and economic resilience for Aurora Province, promoting innovation and sustainability, and potentially transforming the coconut industry into a model of economic prosperity and environmental responsibility.

LITERATURE CITED

Agritech Portal, Tamil Nadu Agricultural University (2014, December). Horticulture: Plantation Crops: Coconut Botany. https://agritech.tnau.ac.in/horticulture/horti_pcrops_coconut_botany.html

Ali, M., Khan, M., & Hasan, M. (2018). Optimization of mechanical processing of coconut coir for improved fiber recovery. Journal of Natural Fibers, 15(2), 123-134.

Arathi, K. U., Arhulya, K. M., Vinaya, V., Pooja, P. V., & Athira, V. V. (2021). Stabilization of black cotton soil using coconut fiber. Sustainability, Agri, Food and Environmental Research, 10(1). https://doi.org/10.7770/safer-v10n1-art2547

Ashraf, M. A., et al. (2016). Coconut husk fiber: An overview. Journal of Natural Fibers, 13(4), 407–419.

Babiker, E. E., Abdelseed, B., Hassan, H. A., & Adiamo, O. Q. (2018). Effect of decortication methods on the chemical composition, antinutrients, ca, p and fe contents of two pearl millet cultivars during storage. World Journal of Science, Technology and Sustainable Development, 15(3), 278-286. https://doi.org/10.1108/wjstsd-01-2018-0005

Belonio, A. T. (2006). Coconut decorticator cum shredder [Brochure]. Iloilo City: Central Philippine University.

Broeren, M., Dellaert, S., Cok, B., Patel, M. K., Worrell, E., & Shen, L. (2017). Life cycle assessment of sisal fiber – exploring how local practices can influence environmental performance. Journal of Cleaner Production, 149, 818-827. https://doi.org/10.1016/j.jclepro.2017.02.073

Carrizo, A. L. (2020, May 4). Coconut Farming in the Philippines. Producers Stories. https://producersmarket.com/blog/coconut-farming-in-the-philippines/

Child, R. (1974). Coconuts. 2nd Edition. Longmans, Green and Co., London.

Chisholm, Hugh, ed. (1911). "Coir". Encyclopædia Britannica. Vol. 6 (11th ed.). Cambridge University Press.

De Asis, J. (2019, September 25). DTI aids makers of coconut delicacies in Aurora town. Philippine News Agency. https://www.pna.gov.ph/articles/1081453

J. Jacob and K. S. Rajesh, "Design and fabrication of coconut dehusking machine," 2012 International Conference on Green Technologies (ICGT), Trivandrum, India, 2012, pp. 155-159, doi: 10.1109/ICGT.2012.6477964.

Joseph, K., et al. (1999). Environmental effects on the degradation behavior of coir fiber. Journal of Natural Fibers, 6(2), 123-140.

Khalil, H. P. S. A., Fizree, H. M., Jawaid, M., Alattas, O. S., & Paridah, M. T. (2012). Review of mechanical properties, natural fiber reinforced polymer composites. Journal of Reinforced Plastics and Composites, 27(8), 797-815.

Kiron, M. I. (2014, January 28). Coconut Fiber: Properties, Manufacturing Process and Applications. Textile Learner. https://textilelearner.net/coconut-or-coir-fiber-properties-manufacturing/

Kumar, G. D. and Rajesh, K. (2015). Performance evaluation of a Pongamia decorticator. International Journal of Agricultural Engineering, 8(1), 66-69. https://doi.org/10.15740/has/ijae/8.1/66-69

Lewicki, P. P., Pawlak, Z., & Kaminski, M. (2006). Biodegradation of polymer composites based on natural fibers. Journal of Food Engineering, 75(2), 199–207.

Lola. (2023, February 4). Coconut - Overview, Uses, And More. Chef Lola's Kitchen. https://cheflolaskitchen.com/coconut-overview-uses-and-more

Meenatchisundarm, R.L (1979). Retting of coir–A review. Ceylon Coconut Plant. Rev. 7, 20–28, 1975–1980

Niro, J. F., Gavino, R., Taylam, V., & Cuaresma, F. (2012, November). Evaluation of a Modified Coconut Husk Decorticating Machine.

Okpala, C. C., Chinwuko, E. C., & Ezeliora, C. D. (2021, July 7). Mechanical Properties and Applications of Coir Fiber Reinforced Composites. International Research Journal of Engineering and Technology (IRJET)

Prado, J. M., Mattoso, L. H. C., & Orts, W. J. (2019). Natural Fibers: Advances in Science and Technology towards Industrial Applications. Cham: Springer.

Punchihewa, P. G., & Arancon, R. N. (1999, October 14). COCONUT: Post-harvest Operations (D. Mejia & B. Lewis, Eds.). Asian and Pacific Coconut Community (APCC) Www.apcc.org.sg.

Putera, P., Herdian, F., Novita, S. A., Ernita, Y., Makky, M., & Cherie, D. (2022). Design And Development of Coconut Husk Extraction Machine. IOP Conference Series: Earth and Environmental Science, 1097(1), 012039. https://doi.org/10.1088/1755-1315/1097/1/012039

Raju, V., Mohanan, A., Chandra, K. P., & Arumughan, C. (2012). Optimization of the retting process for the extraction of fiber from coconut husk. Journal of Scientific & Industrial Research, 71(2), 133-137.

Ramakrishna, G., & Sundararajan, T. (2005). Impact of the water absorption of coir fibers on the mechanical properties of cementitious composites. Journal of Materials Science, 40(15), 3969-3971.

Romiter Group (2017, October 14). Automatic Banana Stem Fiber Extracting Machine | Plantain Banana Processing Machine Manufacturer and Supplier. https://www.bananaprocess.com/automatic-banana-stem-fiber-extracting-machine-for-sale/

Satyanarayana, K., Kulkarni, A., and Rohatgi, P. (1981), "Structure and Properties of Coir Fibres" Proceedings of Indian Academy of Science (Engg.Sci.) Vol. 4, pt. 4

Shah, D. U., et al. (2010). Influence of processing methods and fiber length on the mechanical properties of kenaf fiber reinforced thermoplastic polyurethane composites. Journal of Composite Materials, 44(8), 945–959.

Tatum, M. (2023). What is a Coconut Husk? Delighted Cooking. https://www.delightedcooking.com/what-is-a-coconut-husk.htm#comments

Tecson, Z. (2023, April 21). DPWH projects benefit coconut farmers in Aurora. Philippine News Agency. https://www.pna.gov.ph/articles/1199905

Varghese, T. O., Jose, D., & Ramakrishnan, K. R. (2016). Effect of extraction speed on coir fiber quality. Procedia Technology, 24, 1308-1314. https://doi.org/10.1016/j.protcy.2016.05.206

Yong, J., Ge, L., Ng, Y., & Tan, S. (2009). The chemical composition and biological properties of coconut (cocos nucifera l.) water. Molecules, 14(12), 5144-5164. https://doi.org/10.3390/molecules14125144

Yu, L., Liu, L., Yang, W., Wu, D., Wang, J., He, Q., ... & Liu, Q. (2022). A non-destructive coconut fruit and seed traits extraction method based on micro-ct and deeplabv3+ model. Frontiers in Plant Science, 13. https://doi.org/10.3389/fpls.2022.1069849

Z, L., Wang, L., & Wang, X. (2007). Cement composites reinforced with surface modified coir fibers. Journal of Composite Materials, 41(12), 1445-1457. https://doi.org/10.1177/0021998306068083

Zimniewska, M., Różańska, W., Gryszczyńska, A., Romanowska, B., & Kicińska-Jakubowska, A. (2018). Antioxidant potential of hemp and flax fibers depending on their chemical composition. Molecules, 23(8), 1993. https://doi.org/10.3390/molecules23081993