DEVELOPMENT OF AN IMPACT-TYPE CACAO *(Theobroma cacao L.)* BEAN HULLER

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ABSTRACT

The study mainly aimed to develop an impact type cacao bean hulling machine and evaluate its performance in producing cacao nibs in terms of input capacity, hulling capacity, hulling efficiency, nib recovery, large nib recovery, purity, noise level and power consumption. The cacao huller was subjected to three varying tangential velocities in cracking mechanism and with three different volumes of air in winnowing mechanism. The data gathered were arranged in a CRD Two Factorial and comparison among means using Statistical Tool for Agricultural Research (STAR) software. The analysis showed that tangential speed of the machine significantly affected all parameters except purity and noise level; moreover, the volume of air significantly affected the hulling efficiency, nib recovery, large nib recovery and purity

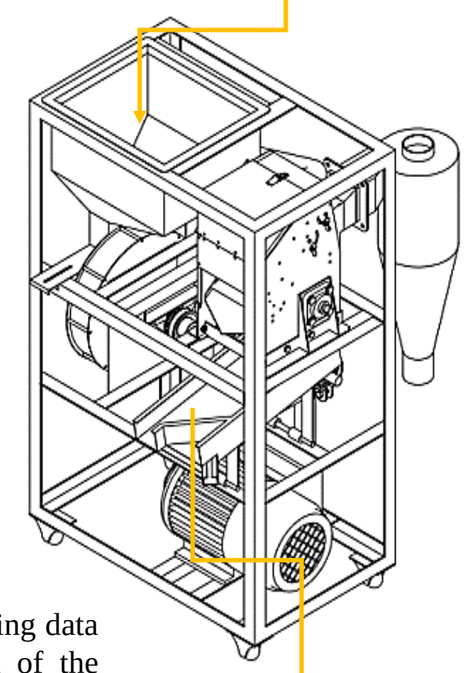
METHODOLOGY

Preparation of Samples

Locally available dried cacao beans were used as samples for the testing and evaluation of hulling machine. A food grade material was used to roast the cacao beans until the beans started to crack (a cracking sound is usually heard) and the outer shell became darker in color.

Fabrication of the Machine

The proposed mechanical cacao bean huller was fabricated by a certified agricultural machinery manufacturer in accordance to the approved drawings and design specifications. Locally available materials were used in the fabrication of the machine. Visual observations were made to assess the safety, proper alignment, and actual clearances that may affect the operation of the machine. The final testing was conducted after the machine was desirable for its intended function and ready for performance evaluation



Data Collection

During the test and evaluation, the following data were gathered for analysis and determination of the performance parameters of the machine namely; moisture content, initial and final weight, weight of large nib, duration of test, noise level, speed of rotating components, air velocity, and power consumption.

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Statistical Analysis

The machine was evaluated based on the three tangential velocities of the rotating cracking mechanism (40m/s, 47m/s, and 54m/s) and three different volumes of air in the winnowing system (41m^3/hr, 45m^3/hr, and 49m^3/hr). It was replicated three times. Each experimental unit used 3 kg of roasted cacao beans. The speed of the rotating mechanism was based on the resulting optimum speed during the preliminary testing of the machine which was 2400rpm. The Analysis of Variance was also computed using STAR software and Comparison among Means was done to parameter means with significant effects

CONCLUSIONS

The impact-type cacao bean hulling machine with combination of cracking and winnowing systems was successfully designed based on different considerations and fabricated using locally available materials and local manufacturing technologies and functions in a continuous manner with a capacity of 15kgs when full;

The machine performed satisfactorily with highest input capacity and hulling capacity using the combination of 40m/s and 41m^3/hr. Moreover, the combination of 40m/s and 49m^3/hr obtained the highest hulling efficiency, nib recovery, and large nib recovery. Additionally, lowest power consumption and noise level of were recorded from the combination of 40m/s and 45m^3/hr. highest purity of roasted cacao nibs was recorded from the combination of 47m/s and 49m^3/hr. **The machine delivered the most desirable performance when set at 40 m/s and 41m^3/hr.**

INTRODUCTION

Mechanization across the different areas of the value chain is necessary in gaining competitive and relative advantage in cacao industry. Improvement of postharvest facilities is the primary challenge in the Philippine cacao industry given its growing demand particularly for the high value-added. On cacao production and management, majority of local farmers and cacao traders do not go beyond selling beans in the market due to high investments incurred in the hulling operation of cocoa beans. Cacao farmers and traders are still using the conventional way of cracking and winnowing roasted cacao beans to produce nibs. As a result, most local farmers and traders are not able to produce enough nibs to supply the local chocolate manufacturers.

Existing machines in the Philippine cacao industry employ cracking operation only wherein winnowing is done separately using conventional way. **Moreover, existing design of cacao hulling machines uses multiple contacts** to the beans including roller, screw/auger, serrated cone, and hammer types that cause more breakage thus developing more dust and smaller particles in the operation which decreases the recovery of large nibs with above 3mm particle size. Hence, the availability of a food grade compliant, efficient impact-type cacao hulling machine may address the aforementioned problem.

RESULTS AND DISCUSSIONS

Description of the Machine

The impact-type cacao bean hulling machine is composed of hopper; impeller type cracking component; winnowing component with aspirator and a cyclone that separates the cacao nibs to hulls and other impurities; transmission system that consists of v-belts and pulleys which was coupled to the main shaft powered by an electric motor; nib and hull discharge; and the support frame.

The machine is operated in a continuous manner wherein the material is constantly fed into the hopper by one person. An impeller type cracking chamber receives the input material and is then passed to the aspirator with a cyclone type vacuum which separates the cracked beans to its hulls. The cacao hulls are collected in the cyclone while the cacao nibs are then collected with a pail supported by inclined nib outlet. All materials used in the design and fabrication were of food grade quality except the support frame and cover, most of which was stainless steel especially components that are in direct contact of the roasted cacao beans.

Performance Evaluation

Statistical analysis showed that tangential velocity of the cracking mechanism significantly affected input capacity and hulling capacity of the machine at 5% level of significance. Moreover, the highest input capacity (195.60kg/hr) and hulling capacity (156.53kg/hr) of the machine were generated from the tangential velocities and volumes of air of 47m/s and m^3/hr, respectively. Also, tangential velocities and volumes of air of 40m/s and 49m3/hr garnered the lowest input capacity and hulling capacities of 166.39kg/hr and 124.99kg/hr, respectively.

For the winnowing mechanism, statistical analysis revealed that volume of air significantly affected the hulling efficiency, nib recovery, and large nib recovery at 5% level of significance. The combination of 40m/s (tangential velocity) and 41m^3/hr (volume of air) of the machine generated the highest hulling efficiency, nib recovery, and large nib recoveries of 96.84%, 96.98%, and 86.75%, respectively.

The interaction of the two treatments significantly affected large nib recovery and purity of the roasted cacao nibs. The combination of 47m/s (tangential velocity) and 49m3 /hr (volume of air) gained the highest purity of 99.00%, while 54m/s and 41m^3/hr garnered the lowest nib purity of 93.33%. Additionally, no significant effect was recorded in noise level of the machine; however, tangential velocity of the cracking system significantly affected the power consumption of the machine at 5% level of significance with 4.42kwh as the highest record in the combination of 47m/s (tangential velocity) and 49m^3/hr (volume of air).

Machine Performance

PARAMETERS	HIGHEST VALUE	LOWEST VALUE
Input Capacity	195.60 kg/hr	166.39 kg/hr
Output Capacity	169.69 kg/hr	136.43 kg/hr
Hulling capacity	156.53 kg/hr	124.99 kg/hr
Hulling Efficiency	96.84%,	76.86%
Hulling Recovery	96.98%	45.29%
Large Recovery	86.75%	69.36%
Purity of Nibs	99.00%	93.33%
Noise Level	91.17 dB	88.20%
Power	4.42 kwh	3.99 kwh