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A microcontroller based flour processing machine for Coconut pulp

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Key words: Pressed coconut pulp, Flour processing machine, Automated, Microcontroller, Coconut flour

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Abstract

This study aimed to develop a microcontroller-based flour processing machine for pressed coconut pulp. The entire system is automated to carry out the task continuously with minimal interaction of the user. The designed project used software written in C++ and executed on the Arduino UNO. Developmental research was utilized in the study and an online survey was distributed to five bakers, five coconut sellers, and five computer engineering professionals to evaluate the acceptability of the automated cocoflour machine. The results shown high acceptability that the machine could produce coconut flour. The study concludes that the automated machine coconut flour maker is user-friendly, and anybody can operate this machine without any technical knowledge that can produce acceptable coconut flour consistently with its adequate production time. It requires less monitoring and human labor.

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Introduction

Trees are the world's largest plants, and their importance to the environment and human well-being cannot be underestimated. These plants produce oxygen, absorb carbon, keep soil healthy, and help to preserve the world's biodiversity. The products made from these plants highlight the relevance of trees in the lives of many people; it includes construction materials, fibers, and fuels.

Furthermore, trees can produce a variety of nutritious food such as fruits, leafy vegetables, nuts, seeds, and edible oils, which can help to diversify diets and mitigate seasonal food and nutritional shortages. Agroforestry employs hundreds of tree species to improve food sustainability and nutritional security (Jamnadass *et al.*, 2020). Among all the species of trees available on the planet, only the Coconut Palm is referred to as "The Tree of Life." The coconut tree is recognized as one of the world's most significant fruit trees (Lapina & Andal, 2017). FAO says Asia-Pacific generates 90% of the world's coconut products, including water, oil, milk, and construction timbers. In 2019, Southeast Asian islands, especially the Philippines, were the leading producers and exporters of coconuts. Davao Region was the leading producer of coconuts, contributing 455.45 thousand metric tons, or 13.8 percent of overall coconut production. (Philippine Statistics Authority (PSA)).

The coconut tree makes relatively little trash because every part of it is useful. Coconut tree cultivation is entirely sustainable, and it is a remarkable natural resource that yields interesting coconut goods. Throughout decades, the coconut has been a healthy supply of meats, milk, and oils that have sustained and nurtured individuals all over the world. This crop is classified as a "functional food" because, in regard to its vitamins, it provides a variety of possible health benefits (Ramaswamy, 2013). Coconut's main products include virgin coconut oil, desiccated coconut, coconut water, as well as coconut flour.

According to Masa, D., coconut milk/cream powder goods generate approximately 3,463 MT of coco residue each year, of which 40% is being used as a food ingredient as well as the other 60% is utilized as feedstuff or discarded. Coconut flour is a one-of-a-kind substance manufactured from the waste of coconut milk production. It is relatively low in digestible carbohydrates, involves no gluten, is much less costly than any of the other nut flours, contains high fiber as well as essential vitamins, and tastes great. (Ramaswamy, 2013). Its nutritional advantages may drive the industry to generate functional food components that may conduce to the appropriate treatment and management of chronic diseases, which opens the possibility of using coconut flour as a food supplement for people with diabetes (Tamil Nadu Agricultural University).

The shredded meat, also known as the pulp, is dried after emptying and extracting the milk. The pressed coconut pulp is heated or dried before being pulverized to make coconut flour. Traditionally, coconut pulp is dried by spreading thin layers of it in the open sun. This approach has drawbacks, such as no control over the rate of drying and non-uniform drying (Kumar *et al.*, 2015). After drying, a milling machine is used to produce pulverized coconut pulp.

According to Majeedullah (2022), drying requires heat and mass transmission. Heat must be transmitted to the material's surface to evaporate moisture latently. Mass transfer involves water diffusion through a substance to an evaporating surface and vapor diffusion into passing air. This theory was related to how air and contact drying worked. Heat is transferred through foodstuffs from either heated air or heated surfaces. The water vapor of pressed coconut pulp is removed with the air.

The grinder works at the point where an abrasive wheel and a piece of work come into direct contact. According to Urbaniak (2021), the same energy is needed to grind a very fine material and a very coarse material. Therefore, the same total volume of the substance is the only condition that should be met. It aims to establish a link between radial feed, force on particular grits, grinding wheel speed, work speed, and diameters. This process is the same as any other cutting method. It must be possible for the abrasive

grains on the wheel to wear and self-sharpen at the same rate for it to grind. Otherwise, problems with the wheels, such as loading and glazing, could happen. This can be done by straightening and dressing the wheels and by using grinding fluids. This theory explained how the sharp blades would break down the material into smaller pieces—related to how the machine will use the blade for the pressed coconut pulps will be made into tiny coconut flour.

There are a lot of projects, whether small or large-scale, the Arduino had been the backbone behind the design by inventors and students. It is intended to make electronic technology more accessible to artists, designers, hobbyists, and anybody else interested in making an interactive gadget using it. A single-board microcontroller offers an Integrated Development Environment for writing or uploading codes to the physical programmable circuit board. "Arduino" was named after King Arduin, who ruled Italy in 1002. Its wiring is inspired by Hernando Barragan's thesis at the Interaction Design Institute Ivrea. Olivetti, the computer company, was the original manufacturer. Arduino was used to automate the system.

Object Oriented Programming with C++. C++ is a general-purpose objectoriented programming language that Bjarne Stroustrup had been developed at Bell Labs since 1979 but was not standardized until 1998. Additionally, it is a C language extension. He was inspired to create this programming language while working on his Ph.D. thesis using the language Simula 67, which is credited with being the first programming language to support object-oriented programming. The researcher used C++ programming languages to program in Arduino Microcontroller.

Coconut farming is one of the main sources of jobs in the Philippines. Coconut sap produces sapal. After extracting the milk, the coconut meat remains. These are still trashed. According to the Food and Nutrition Research Institute of the Department of Science and Technology (FNRI-DOST), coconut flour made from sapal has health benefits beyond basic nutrition. Coconut flour is a healthy source of fiber. It prevents colon cancer, thus it's healthy. It effectively manages and controls diabetes mellitus and obesity by regulating the body's glucose release. Sapal production has become an attractive venture for the coconut industry since the discovery of coconut flour. It is nourishing. It is a viable source of revenue. The researcher utilized pressed coconut pulp as the primary ingredient in the production of coconut flour and the medium used in the testing process.

The workpiece is usually secured in a vise and moved in three perpendicular directions on a milling machine. Disk- or barrel-shaped cutters are clamped to arbors (shafts) via holes in their centers; they have teeth on their rims or faces. End mills have a tapered shank that fits into the machine spindle, cutting teeth on the face, and spiral blades on the side. This is crucial in the researcher's study since one of the machines main features is to grind the pressed coconut pulp into smaller pieces to achieve the correct sizes and texture.

According to a study by Pascua (2018), the arrowroot processing machine could encourage and motivate arrowroot farmers to raise farm size while enhancing productivity and processing efficiency. Agricultural literature has a wealth of facts.

Almost nothing is known about how well arrowroot grinding machines extract flour or how they were developed or designed. The province-wide demand for arrowroot can be sustained by a motorized mobile arrowroot grinding mill made of food-grade materials, which can increase flour production. In this study, a machine powered by a 1 hp electric engine generated 200 kg per hour. 425 rpm processed data in 7.47 minutes as opposed to 8.38 minutes for 225rpm. The model is cost-effective because it only costs P65,000. The method is workable for small-scale arrowroot processing, according to an economic assessment. In 0.343 years, or 4 months and 3 days, the machine heals. For processing, the permanent machine cannot be moved to farms without electricity.

According to Jongyingcharoen *et al.* (2019), coconut milk residue continually and rapidly degrades and poses a tremendous disposal problem for processing

coconut milk, but the coconut milk residues are nutrient-dense due to their high moisture and nutritional content put in waste. Fresh coconut residue holds between 50% and 55% moisture and should be dried immediately to avoid microbiological deterioration. Safe preservation of coconut milk residue is particularly critical during the drying process, as it improvesthe dried product's quality, enabling it to be used as a high-fiber food ingredient and added value.

The drying characteristics of coconut residue were investigated using hot air drying with layer thicknesses of 5, 10, and 15mm. The study found that for coconut residue to have a shelf life of more than 140 days, the moisture content must be less than 0.03g water/g dry matter. The thin-layer drying of coconut residue took between 70 and 565 minutes, depending on the drying temperature and layer thickness. Higher drying temperatures and thinner layer thicknesses reduce the drying time. The drying time was considerably impacted more by the layer thickness than by the drying temperature. Fresh coconut was more white than dried coconut residue dried for less than 200 minutes.

As per the findings of the above study, safe shell life is essential for drying pressed coconut pulp. Also, the study revealed the drying characteristics and effects of thin-layer drying of coconut residue at different layer thicknesses and drying temperatures. Jongyingcharoen *et al.* (2019) claim that the right thickness and temperature are crucial for drying the pressed coconut pulp. However, the layer thickness and moisture level of pressed coconut pulp to know the shelf life of coconut flour will not be included in the Cocoflour maker machine. Similarly, this study used coconut milk residue as the main input in common with the Cocoflour machine.

Bučányova (2020), stated that there are numerous factors to consider when constructing a milling machine. One is that the machine's quality must be excellent because it will be used to process food. In contrast, a milling machine is very expensive to build because it contains many expensive components such as sensors, food-grade lubricants, and food-grade stainless steel materials. The study outlines the specifications and characteristics of a milling machine, including its design and the requirements for quality. The basic principles of milling machine design, including spindle speed (the spindle speed decreases as cutter diameter increases), cutting force (based on milling technology parameters and material properties of machined material), and performance calculation (based on cutting force and milling technology parameters).

The research was carried out by Samuel (2018), titled, Valorization Strategies of Coconut Flour" is research that examines how coconut flour is processed. The coconuts that will be utilized to make coconut flour must be gathered once they are fully developed. It can be seen if the skin has mostly turned brown. This will improve maximum oil as well as coconut residue extraction during this point. The coconut fruits are deshelled to acquire accessibility toward the coconut meat or kernels in the making of coconut flour. The brown covering that has formed around the kernel is then gently removed with a knife. The peeled nuts are next cleaned and chopped into 10 mm portions. This will be accompanied by cooling and drying. These will be pulverized with a strong electric grinder before the oil extraction procedure is performed by using the screw press method. Upon completing this process, the residue is re-dried in an oven at 60 °C for 30 minutes. From that, the flour is milled and packaged. This creates high-protein coconut flour that can replace wheat in baked items.

According to this study, a drying machine will help to dry the products much faster and more efficiently. Kumar (2015), stated that the best way to increase shelf life is by drying vegetables or fruit. Drying in the open sun, on the other hand, will result in a non-uniform dried product, resulting in unequal dryness inside the product if not properly dried. Removing the water moisture inside the product is extremely difficult. Temperature and fruit or vegetable thickness affect the drying process. However, using a machine will necessitate the expenditure of money to obtain the machine. In addition, electricity is used, as

opposed to the natural method of sun drying. The researcher used this research to fig. out which drying procedure is perhaps the most efficient.

The investigation by Ramya, H. and Pattan, N. (2019), "Development and quality evaluation of ready-to-use coconut flour" (2019). The study considers characteristics including color, flavor, taste, particle size, and high water absorption capacity in order to consistently gather coconut flour. In addition to its nutritional value, coconut is recognized as a "functional food" since it has a number of positive health effects. According to Hossain *et al.*, the coconut was dehusked, split in half, the meat was collected, the milk was drained using a hand crusher, and the kernel was dried for six hours at 60 degrees Celsius in a hot air dryer. The dried coconut was pulverized to create flour. High-density polyethylene was used to bag and seal the coconut flour.

This study focuses on terms of coconut characteristics such as color, flavor, taste, and particle size before proceeding into the drying and grinding stage. According to Hossain *et al.*, this study also stated that the coconut pulp was dried for 6 hours at a constant temperature of 60 degrees Celsius using mechanical drying or hot air drying before advancing to the next stage, which is the grinding stage. However, this study didn't mention the sensors or what kind of machine technology they used. The relevant information about the coconut flour from this study, such as the characteristics of the flour that must be considered as well as the process on how to produce coconut flour is useful for the researcher. It offers fundamental knowledge on how to design Coconut Flour Processing Machine and what is the expected product of the system.

The study conducted by V.Bharathi *et al.* (2018), entitled 'Smart Multi-Utility Spice Pulverizer Machine,' focuses on producing spices such as chili powder, dhal powder, coriander powder etc. using the Smart Multi-Utility Spice Pulverizer Machine (SMUSPM). It is designed to ease the difficulty of spice grinding for home cooks and hotel management. The Spice Pulverizer Machine is a device that can quickly and automatically select the ingredients to grind into the necessary spice powder. The automatic ingredient selection is managed by a programmed Arduino processor. The SMUSPM incorporates a blade that distributes fine-grained spice without heat and uses less energy while making less noise. A single-phase power supply can also be used to power it. SMUSPM is a straightforward machine that anyone with no technical knowledge can operate. This research's function is that it contains different hoppers for each component, such as chili, dhal, coriander, turmeric, and so on. The servo motors will be used to close and open hopper valves, and they will be connected to a microcontroller which is the Arduino. The software will control its performance. It also indicates the LCD display that will serve as the screen of the machine. The above-mentioned concepts and studies were used by researcher to conceptualize and design the machine. All of the study's parameters and features were taken into account and served as a guide for the researcher.

INPUT (Knowledge Requirements)	PROCESS	OUTPUT
Microcontroller Programming Language Circuit Design Grinding Principle Hot Air Dying	Hardware Development Software Development Hardware and Software Integration Testing and Debugging Evaluation	Flour Processing Machine for Pressed Coconut Pulp

Fig. 1. Conceptual Framework.

Fig. 2 shows the procedural guidelines followed by the researcher to attain the success of the study. The fig. is divided into three phases: input, process, and output. The input block contains different requirements that are essential in the development of the machine. It defined the specific knowledge and materials needed to perform the study. Next is the process, where the step-by-step procedure on how the machine will come into reality is defined. It starts with Planning, Software Development, Hardware Development, Hardware and Software Integration, Testing and Debugging, and lastly, Evaluation. For the last phase, showed the final output of the study, which is an Automated Flour Processing Machine for Pressed Coconut Pulp. Considering coconut (pulp) was not being used to its maximum potential despite its abundance, the researcher developed a Cocoflour

maker, which is a microcontroller-based flour processing machine for pressed coconut pulp, with the objective of reducing the drying period of pressed coconut pulps and enhancing the effectiveness of producing flour from pressed coconut pulp.

Materials and methods

This research used the developmental research process in building the Automated Flour Processing machine for Pressed Coconut Pulp. Developmental research, according to Richey and Klein (2005), is a means of establishing new procedures, strategies, and instruments based on a rigorous investigation of individual examples. It addresses not only product design and development, but evaluation as well. Developmental research is often structured in phases such as an analysis phase, design phase, development phase, try-out, and evaluation phase. This study approached the necessary requirements to improve the device's effectiveness and efficiency.

To show the development and procedures of the study, an iterative model was used to get a better understanding of the development of the system.

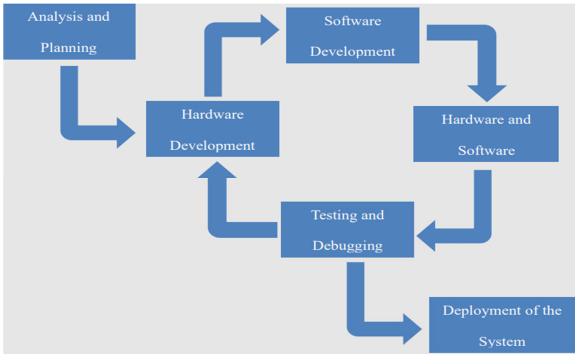

Fig. 2. Iterative Model of the Study.

The iterative model of the Microcontroller based Flour Processing Machine for Pressed Coconut Pulp as presented in Fig. 2, analysis and planning are followed by hardware development, software development, hardware, and software component integration, testing and debugging, and lastly, evaluation.

To verify the validity and acceptability of the study, the researcher determined the corresponding number of respondents using the purposive sampling technique. Considering their technical competencies and knowledge about the device and its product, researcher gather five bakers, five coconut sellers, and five computer engineering professionals. The respondents of the study examined the machine and its product to ensure that sound objective judgment is used in judging the equipment's effectiveness.

The pandemic is still relevant in today's world, which is why researcher only have a limited means of collecting data. Since one of the main vital aspects of conducting research is having a reliable research instrument in collecting data, most relevantly for grinding machinery, that is why the researcher came up with the idea of using Likert scale with criteria adapted from the ISO 9126 Quality Model to assess the acceptability of the machine. In regards to machine functionality, reliability, efficiency, maintainability, and portability. The researcher utilized a questionnaire for pressed coconut pulp for vendors, bakers and professionals.

The researcher gathered all the information needed to evaluate this study through data collection. The researcher conducted five trials for each manual process, namely: pan dry, gas oven, microwave oven, and sundry, along with automated testing that evaluates the process duration of each operation. The process duration of all the trials was recorded, and the means are computed. The data gathered from this testing is used to compare the durations and to see if the automated process is comparable or much better than the manual processes. The researcher used the t-test in the process duration to analyze data acquired from several trials. The researcher also used the Pekar test to gather and interpret the color differences between each product produced from multiple processes; According to Simsek, D. S. (2020), the color differences in flour are determined when the samples are slicked and soaked together with a clear demarcation line on a level surface and then dried. Furthermore, Dr. Balázs, S. (2018) utilized the Pekar test to examine the color of flour samples in both the dry and wet states.

The researcher used a survey method in this study to collect responses from their respondents, whom

included a coconut vendor, bakers, and computer engineer professionals. The researcher conducted in-person surveys for the coconut vendor and online survey methods for the professionals, whereas for the bakers, the researcher performed in-person and online surveys to acquire data from the selected respondents. On the evaluation day, the researcher simply shown a video demonstration of the operating process but also ensured that the respondents understood and got the accurate information. Following the presentation, the researcher distributed the assessment form to respondents. After collecting the completed surveys, the researcher tally, compute, evaluate, and document the responses.

The information gathered throughout the investigation was handled as statistics and analyzed using mathematical equations. The mean of the recorded process duration of each manual method of coco flour production was compared with the mean of the automated process.

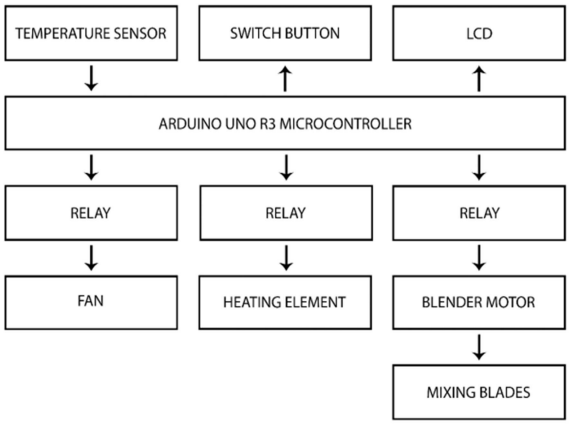

Fig. 3. Block Diagram of the Automated Cocoflour Maker.

The Pekar test was conducted to determine the physical appearance in the color of manual and automated methods using commercial flour. The researcher weighed 10 grams of all processed flour, then aligned commercial flour, pan dry flour, gas oven flour, microwave oven flour, sundry flour, and automated flour, then soaked it in water and let it dry. The researcher compared whether the manual and automated flours were lighter than commercial flour after drying. The acceptability of the system is analyzed using the data based on the respondent's assessment of the overall experience while using the machine. The Five-Point Likert Scale is utilized to evaluate the device.

The researcher started identifying the key components of the machine. Fig.3. shows the block diagram of the designed system. This diagram provides a high-level overview of major system components along with their relationships.

Results and discussions

Planning

The Iterative model was used as a basis and guidance to produce the desired output, namely the voltage and current, and the capability of the heating element to hot air dry the pressed coconut pulp relative to the model design of the machine. The method began with an implementation based on testing of subsets of the hardware and software requirements. As the system evolved, iterative improvements were made until the full system was completed and the output needed was achieved. The formulation of the stages and processes of automating the manual process of making coconut flour is straightforward and should not require a high-powered microcontroller.

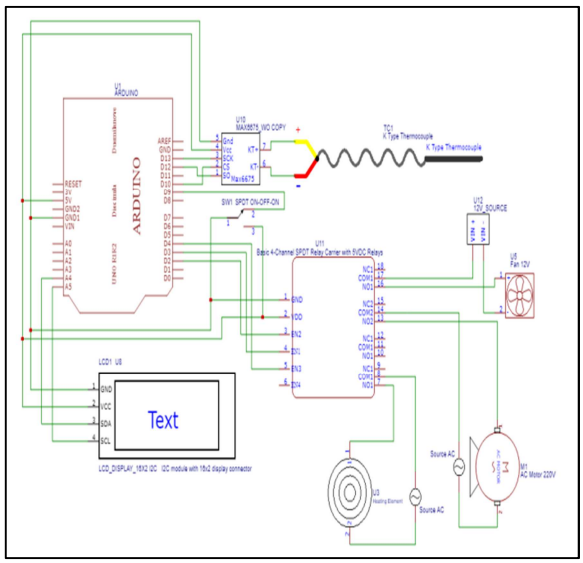

Fig. 4. Schematic Diagram.

The researcher used the Arduino UNO R3 and its programming language, C++. The researcher designed the circuit dependent on the capability of a

relay to close and open a circuit. The Arduino is installed with the max6675 and K-type thermocouple to gather and measure the temperature to operate the codes uploaded. The heating element, blender motor, and the DC fan that process the pressed coconut pulp are connected to the 5V 4-channel relay to control each stage and process of coconut flour making. A latch button switch is used in the machine because the software periodically checks the status of the switch and lets it manipulate which argument it should proceed with until completion.

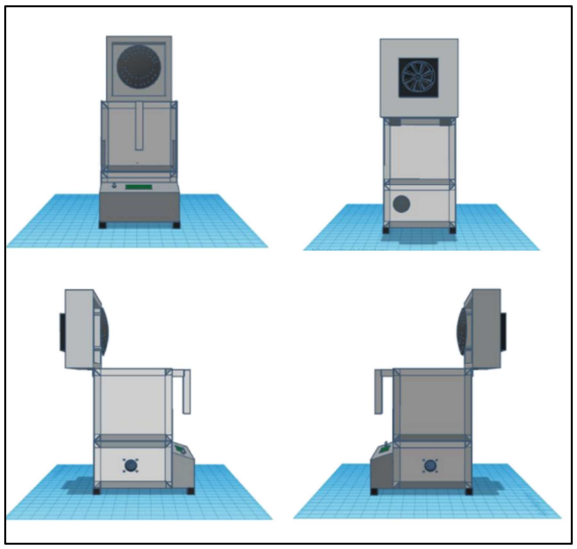

Fig. 5. 3D illustrations of the Project.

Fig. 6. Actual Picture of the Project.

The researcher conceptualized the hardware to imitate and combine two machines, an air fryer, and a blender. The researcher designed a circuit diagram that shows the connection and identities of the components to the Arduino and relay. Then, the researcher created a 3D model design of the machine to visualize the size of the machine, the covered spaces of different components, ventilation, and how the user can use or interact with the machine.

Software Development

The researcher programmed and designed the Arduino code with the influence of the manual process. At each iteration, the modified design, and hardware components, the software system is developed through repeated testing and cycles until the desired output is met. There are two main variables that are changed or constantly measured to create a viable automated procedure for the machine: temperature and process duration. The Ktype Thermocouple with Max6675 module uses its own Arduino library to interpret raw data into quantifiable data. On the other hand, the process duration uses for-loops to decrease the constant duration by a second per second. The program code also uses the library of the I2C LCD display to lessen the wiring of the LCD with the Arduino. The relay used in the machine is, somehow, defective; when the Arduino signals the normally closed relay input "LOW," the open circuit lets the electricity pass through and viceversa. The researcher iterated three versions of the code: 15 cycles, 17 cycles, and 19 cycles.

Fig. 7. Arduino Code and Compiler.

Hardware Development

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1. Heating Element (Pancake Machine)
2. The component used for the drying process of this study. The infrared heater converts electricity into radiated heat and transfers it into areas with lower temperatures; this device can reach operating temperature fast.
3. *AC Motor:* An AC (Alternating Current) brush motor uses 220V AC. The motor is connected to the blades that is warranted in processing of the pressed coconut pulps into flour.
4. *DC fan:* The fan assists the heating element in the drying process (air fry) of this study. Two 12v fans are also used for the exhaust of the machine.
5. *Arduino:* Arduino Uno R3 is the microcontroller used for the embedded system of the machine. It is user-friendly and able to handle multiple inputs and outputs required for this study.
6. *5V 4-Channel relay:* Relay is an electrically operated switch that connects the small current circuit to the larger current circuit of the machine. This is used to control the operation switch of the AC and DC devices such as the heating element, DC fan, and motor blender.
7. *K-type Thermocouple with Max6675 module:* The Thermocouple sensor can function at high temperatures, which are necessary for the design of the machine. It is placed inside the processing area and continuously functions and gathers data to trigger an argument.
8. *Switching Power supply:* The Power supply is an electronic device that supplies and maintains stable DC voltage input to the electrical equipment of the machine.
9. *16x2 LCD with I2C Display:* The LCD can display 2 lines with 16 characters. It is used to display the temperature and the duration of the machine for each loop.
10. *Blade:* The sharp blades cut the pressed coconut pulp into smaller particles.
11. *Switch:* SPDT switch is used to turn on or off the process of the machine.
12. *Casing:* Used to house all the electronic components.

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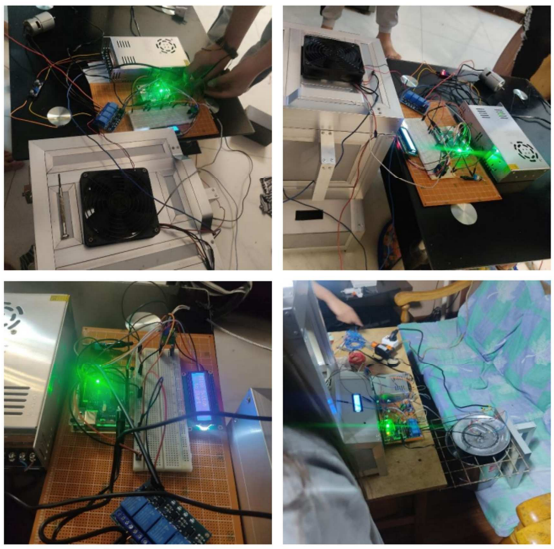

Fig. 8. Actual Picture of the Project in Operation.

Software and Hardware Integration

The integration of both hardware and software is straightforward. The program code is uploaded to the Arduino, and the processing components, motor, heating element, and DC fan, are connected to the 5V 4 channel relay. The Arduino code contains repetitive stages and cycles, adjustable based on the performance of the heating element and the motor for grinding. The integrated components function with little to no noise or trouble. However, the machine vibrates when the grinding process starts, it disrupts the wire of the LCD, and it sometimes malfunctions.

Project Evaluation

The machine was evaluated through its functionality, reliability, efficiency, maintainability, and portability. The results of the evaluation were examined and interpreted using the tables that followed. The machine was evaluated by five bakers, five coconut sellers, and five computer engineering professionals.

Table 1. Evaluation of the project.

Parameter	Mean	Interpretation
Functionality	4.60	Highly Acceptable
Reliability	4.20	Moderately Acceptable
Efficiency	4.69	Highly Acceptable
Maintainability	4.38	Highly Acceptable
Portability	4.40	Highly Acceptable
OVERALL	4.45	Highly Acceptable

Table 1 shows the overall performance of the machine based upon its functionality, reliability, efficiency, maintainability, and portability evaluation gathered an over-all average score of 4.45. According to the Likert scale the machine performance is in between the highly acceptable remarks.

Table 2. Summary of Physical Appearance (Color).

Trial	Manual				Automated
	Pan Dry	Gas Over	Microwave Oven	Sun Dry	
1	Lighter	Darker	Darker	Lighter	Lighter
2	Darker	Lighter	Darker	Lighter	Lighter
3	Darker	Darker	Lighter	Lighter	Lighter
4	Darker	Darker	Lighter	Lighter	Lighter
5	Lighter	Darker	Lighter	Darker	Lighter

The tables above show the physical appearance, color, of automated and manual procedures. The Pekar Test was used to compare standard commercial flour to manual and automated processes. The pan drying process produces lighter color in trials 1 and 5 and gets the darker color in trials 2, 3 and 4. The gas oven process produces the lighter color in trial 2, while trials 1, 3, 4, and 5 produce darker colors. The microwave oven gets a lighter color in trials 3 ,4 and 5, and produces the darker color in trials 1 and 2. The sundry produces lighter color in trials 1, 2, 3, and 4, and gets darker color in trial 5. The automated process is in the lighter color from trials 1, 2, 3, 4, and 5. As shown in table 2 the Automated process achieves greater consistency in providing lighter color than the Pan drying, Gas oven, Microwave oven, and Sun dry. This is a good indicator that the designed project was reliable in producing flour

Conclusion and future work

The machine was successfully designed a switch button for machine operation, a suitable heating element, and pulverizing of pressed coconut pulp. The project has also an LCD that shows specific information about the current process.

The automation of the process for the machine is user-friendly and anyone can use it. The procedures are taken to obtain the intended outcome in the developed Microcontroller Based Flour Processing Machine for Pressed Coconut Pulp including the planning, software development, hardware development, software, and hardware integration, project development model, and testing.

The data obtained show that the process duration of the machine and the physical characteristics of the produced coconut flour offset the disadvantages of the different manual processes. The automated machine can produce acceptable coconut flour consistently with its adequate production time. It requires less monitoring and human labour.

The researcher executed multiple trials and evaluated all experimental data from each trial to identify the accurate way to assess the machine's performance in terms of functionality, reliability, efficiency, maintainability, and portability. The researchers concluded that the prototype of the automated machine is alternatively viable against any manual process. The Pekar Test shows that the Automated process achieves greater consistency in providing lighter color than the Pan drying, Gas oven, Microwave oven, and Sundry which is a good indicator of reliability of the designed project.

To improve the developed project, the blade should be thinner in width. sharper, closer to the casserole, better chassis design to accommodate more pressed coconut flour and for ensuring that all the components are in the appropriate locations, a more suitable AC motor for grinding, and the use of different drying methods to speed up the dehydration process are recommended.

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