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International Journal of Engineering Technology Research & Management

AUTOMATIC MATURE COCONUTS BREAKING CUM COCONUT WATER EXTRACTION MACHINE

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ABSTRACT
Mature Coconut water is rich in carbohydrates and electrolytes such as potassium, sodium, and magnesium, but lot of coconut processing industries are wasting tons of coconut water because they did not have proper way of water collection system. And also, lots of copra industries are using manpower to break the coconut it is unhygienic and time-consuming process. To overcome such problems facing in copra industries we developing a coconut cutting cum water collection machine with cooling system. The main aim of this machine is to minimize the coconut water wastage, hygienic way of water collection, and cooling system maintains the coconut water in certain temperature to avoid fermentation. By collecting coconut water, we can produce lots of by-products like ready to drink coconut water, coconut water vinegar etc... Which is completely natural product containing lot of micro and macro nutrients. The primary goal of designing and developing such a machine is to automate the coconut splitting process, which will save time, require less effort, and assist avoid any potential accidents.

Keywords
Mature Coconut Water, Coconut Water, Existing Machines, Coconut Water Collector, Cooling System, Waste Utilization.

1. INTRODUCTION

Cocos nucifera (L.) is a critical family member Aceraceae (palm family) popularly referred as coconut. The plant is originally from Southeast Asia (Malaysia, Indonesia and the Philippines) and the island between the Indian and Pacific Oceans. The coconut are the fruits of the cocos tree, which is part of family of palm trees. The term "coconut" may refer to the entire coconut palm, its seed or its fruit, which is botanically a drupe rather than a nut.

The aqueous portion of coconut endocarp is known as coconut water (CW). Coconut water is used as a tropical beverage, an environment for growth for microbes, a medication and a ceremonial gift. About 25% of the overall weight of the nut is made up of coconut water. Its contents are translucent and colorless, with a flavor that is pleasantly sweet and tart. In its natural state, the liquid endosperm is sterile and housed in a hermetic container.

There are two primary types of coconut water: Mature Coconut Water (MCW) and Tender Coconut Water (TCW), each having unique flavors, appearance and nutritional profile. TCW is the liquid that can be found inside a young, green coconut. It has a translucent appearance, taste sweeter and is transparent. Mature Coconut water, on the other hand, is the liquid that may be found inside a fully matured, brown coconut. It has moderately nutty flavor and hazy, opaque appearance.

It is naturally isotonic beverage made primarily of components that are similar to those present in blood plasma and is considered nutritional and healthful when derived from palm trees. Coconut water is packed with nutrients, vitamins, minerals, ammino acids, antioxidant, growth hormones and enzyme.

Coconut water is seen as a natural functional drink because of its distinct qualities. It's a great refreshing and rehydrating beverage to have after physical activity because of its sugar content and mineral composition.

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Total phenolic and sugar content is greater in TCW compared to MCW. serine, cysteine, arginine, and alanine are among the ammino acids that are more abundant in TCW. Rich in arginine, coconut water supports the body's stress-response mechanisms.

Most of the soluble solids in coconut water are composed of sugars. Sucrose, Fructose, glucose and sorbitol are main sugars in MCW. The smaller sugar galactose, mannose and xylose come next. The predominant sugars present in coconut water are glucose, fructose and sucrose which also comprise the majority of the soluble solids.

Mature coconut water has historically been seen as waste products, particularly in plants that process coconuts (such as the ones that produce coconut milk and desiccated coconuts).

A desiccated coconut plant that breaks down roughly 300,000 coconuts a day produces 50 m^3 of effluent per day, consisting of 44m^3 of wash water and about 5.3 m^3 of pure coconut water. The biological oxygen demand (BOD) of wash water and pure coconut water combined is approximately 3000 and 29000 mgL^{-1} respectively. As a result, the factory's overall liquid waste contains 5800 mgL^{-1} of BOD, which needs to be lowered to the recommended amount of 50 mgL^{-1}.

Due to technological issues in gathering coconut water and separating the oil from the coconut water, the initial attempts to use the liquid waste by food industry were unsuccessful. Therefore, we are building a machine that will mechanically breaking the coconut and collect the water by filtering through the filters.

2. REVIEW OF LITERATURE

A. . Nutritional Characteristics of Coconut water

Coconut water is a nutritious clear liquid inside coconut fruit, which is rich in vitamins and minerals. The soft coconut water, technically liquid endosperm is the most nutritious health drink than nature provided the inhabitants of the tropics with fighting strains heat with a calorific value of 17.4 per 100$gm^{3.}$

Coconut water contains plant hormones namely auxins, cytokinin's, gibberellins and abscises acid (ABA), which act as plant growth regulators addition, it is rich in minerals such as potassium, calcium, magnesium, iron, sodium, phosphorus, zinc, manganese, copper, Sulphur, aluminum, boron, selenium and chlorine. Among these minerals, potassium is dominant, followed by sodium as the next visible element. Coconut water contains several B vitamins, especially thiamine(B1), riboflavin(B2), niacin(B3), pantothenic acid (B5), pyridoxine (B6), biotin (B7) and folate(B9).

Coconut is known as a functional food which gives health benefits other than basic nutrients. Lauric acid is a main ingredient of coconut product; about 50% The fatty acids in coconut oil are lauric acid. (Percent arginine, alanine, cystine and Sestos sensitivity protein coconut water is higher. The green dwarf variety contains the highest in total phenols and vitamin C24. Amino acid important not only as a building material for the body, but it is another important characteristic, as an energy source (the body transforms amino acids to glucose), helps produce lymphocytes that there are cells in the human lymph nodes and bloodstream that are vital immune system It can help regulate blood sugar; help reduce symptoms of prostate enlargement in men, helps the adrenal gland function.

a. Nutritional Chart

- Calories: 22 Kcal
- Carbs: 3.7 grams
- Protein: 0.7 grams
- Fat: 0.2 grams
- Fiber: 1.1 grams
- Iron: 1% of the Reference DailyIntake (RDI)
- Calcium: 2% of RDI
- Magnesium: 6% of RDI
- Vitamin C: 4% of RDI

B. Composition of Coconut Water

The majority of the soluble solids in coconut water are sugars. The main sugar in mature coconut water includes glucose, fructose, sucrose and sorbitol. Lesser sugar like mannose, galactose and xylose comes next. The primary sugars in coconut water are glucose, fructose and sucrose which also makes up majority of the soluble solids. But as a plant reaches maturity, its non-reducing sugar content increases while its reducing sugar content increases while its reducing sugar content decreases with fructose and glucose. The synthesis of sucrose at the expense of the glucose-fructose bond is responsible for these changes. Among the components of coconut water, minerals come in second terms of quantity.

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Based on available data, their composition ranges from 0.4 % to 1% of the constituents in coconut water, which is adequate to provide isotonicity. The six main minerals that were discovered were magnesium, potassium, sodium, calcium, zinc and iron. In coconut water, potassium is followed in abundance by sodium, calcium, magnesium and calcium. Zinc and iron, however, are only present in extremely minute levels.

Table 1 : Mineral Composition of Coconut Water

Vitamins	Tender Coconut Water	Mature Coconut Water
Calcium	0.47	0.57
Magnesium	0.11	0.11
Potassium	3.50	4.64
Sodium	0.03	0.29
Phosphorous	0.08	0.23
Sulphur	0.01	0.07
Manganese	20.3	14.4
Iron	4.06	2.94
Zinc	11.3	3.51
Copper	0.96	5.32
Boron	12.8	14.3

A single cup of coconut water contains 600-700 mg of potassium, 60mg of magnesium, 40 mg of calcium. When added to a balanced diet, coconut water can be great method to increases mineral composition and improve overall health and wellbeing

C. Physiochemical Properties

a) Volume of Coconut Water

A tender coconut typically has 200 to 300 ml of water; however, a mature coconut may only have 100 to 200ml. The reason for the decreases in water content is that as the coconut ages, more of the water is absorbed by the developing coconut meat. The water content might vary depending on its growing environment. The chemical composition of coconut water from several Indian states, including Kerela, Tamilnadu, Andhra Pradesh and Goa were reviewed. It was found that the quantity of coconut water varied significantly by location. Coconuts from Kerala had the highest average water content, at 271.3 mL per coconuts. The lowest water content was found in Tamilnadu coconuts, which had an average of 159.7mL per coconut. The average amount of water in the coconut from Andhra Pradesh and Goa was 201.6 mL and 220.2 mL respectively.

b) Total Soluble Sugar (TSS)

MCW was shown to have more total soluble solids than TCW which is a measure of sweetness. As the kernel develops, it takes up the soluble substances found in the coconut water. As a result, the TSS value of coconut decreased with age. From the review article by using the freeze concentrations method, the initial TSS values of the mature coconut and tender coconut could be enhanced by two-fold from 3.9 to 7.9^{o} Brix and from 6.0 to 12.1 ^{o}brix respectively.

c) Titrable Acidity (TA)

Due to its impact on food flavor and aroma, acidity is an important parameter that is used as a sensory indicator. Tender coconut water coming in second and third.

d) Preservation and Processing of Coconut Water

CW is safe and sterile as long as it remains inside the inner chamber of the coconut. After being extracted from the internal chamber of the nuts, it must first go through a complex and time-consuming procedure in order to preserve its quality before being taken from the nut for additional processing. After the coconut water is removed from the nuts, it is exposed to the external air. As a result of faster biochemical and enzymatic activities, CW changes in colour, turbidity, appearance, and numerous biological components.

In this field, several non-thermal, thermal, and Hurdle technologies with additional additives are employed. Among these techniques are infrared heating, ultrasonication, pulsed electric fields, plasma processing, microwaves, and dense phase carbon dioxide processing.

D. Value Added Products

Zero waste ideas provide the foundation of the mass production of value-added coconut goods. In the coconut plantation, the husk that is collected during dehusking is used for burial. Cashew nut processing uses the coconut shells that are removed during deshelling as a fuel source. The Testa extracted in order to produce virgin coconut

water is dried, combined with cow feed and fed to farm's diary animals. The defatted, desiccated coconut is marketed after being added value to other goods. As previously mentioned, coconut water collected during processing is used enhance the value of a variety of variety of goods. Nursery plants and vegetable are grown using the concentrated, nutrient-enriched coconut water and leftover kernel wash water, which have undergone microbiological processing. It is therefore kept as zero polluting unit.

a) Coconut water vinegar

A naturally occurring product made from coconut water and sugar, which is fermented by adding yeast or Acetobacter and the allowed to oxidize and become acidic and they are filtered out as vinegar. The drawbacks of synthetic vinegar made from industrial acetic acid, which is bad for your health are absent from natural vinegar.

Figure 1 : Coconut Vinegar

b) Coconut water syrup

Delicious beverage created by persevering the freshness of the mature nuts used to make the coconut water while making virgin coconut oil. Coconut water, ginger, sugar, natural coloring and citric acid as a preservative are combined in equal measure to produce it. After diluting four to five times with water, it can ingest.

c) Xanthum Gum

Xanthum gum forms a flocculent complex with coconut protein under acidic condition. Soy polysaccharides specifically binds to coconut protein. Under acidic conditions, this complex is stabilized through the steric hindrance of soy polysaccharides. Due to gelatine coconut protein interaction, the isoelectric point of this complex changes.

d) Nata-de-Coco

The cellulose white to creamy yellow substance known as "nata-de-coco" is produced on the surface of sugar enriched coconut water, coconut milk, plant extract and other sugar-rich waste product by acetobacter aceti subspecies Xylinium. It is frequently served as dessert. Additionally, it's a component of food items like fruit cocktails, ice cream and more. The Spanish term "Nata" comes from Latin word "nature" which means to "to float". Because there is increasing interest in producing in nata from coconut water, a plentiful byproduct of coconut processing facilities, Nata making from coconut water, a plentiful byproduct of coconut processing facilities, Nata making is critical to the growth of our coconut sector.

e) Coconut Squash

It is hydrating and revitalizing healthy soft drink concentrate made by combining the sugar, coconut water and organic preservatives like ginger and lemon.it has few calories and is high in vitamins and minerals. Three months is product's shelf life in normal conditions.

f) Frozen Coconut Water

The spray evaporation method can be used to create coconut water concentrate. Fresh coconut water is used to create frozen coconut water. Fresh coconut water collected in a hygienic manner from recently opened shell. Prior to concentration, the suspended particles and oils were eliminated by centrifugation and the minerals were extracted from the coconut water by passing it through an ionic resin -packed column to give it as sweet flavor. the flavor.

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The concentrated ‘s shelf life ranged six to twenty-four months, depending on how concentrated it was. Approximately 800g of concentrate might be produced from ten liters of coconut water. After diluting the concentrate to the appropriate concentration, it can be refrigerated or kept in cans and used as a base to make both carbonated and non-carbonated coconut drinks.

3. DESIGN METHODOLOGY

A. Design Of Machine

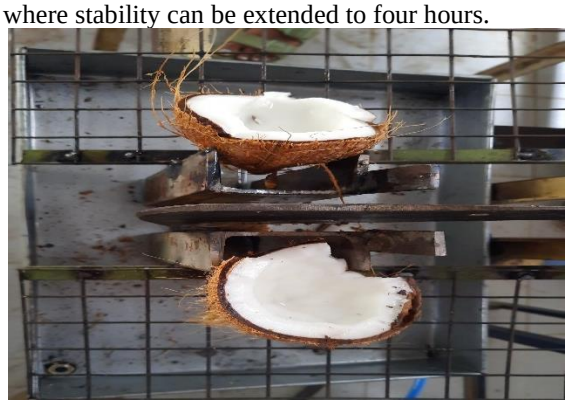
From a machine design perspective, the mature coconut’s proportion are very important. In order to understand the range of dimension involved in the mature coconut, several farms and location were visited. When compared to region of India like Tamil Nadu and Kerala where coconuts are abundant, certain coconuts from Andaman and Nicobar Islands are quite large.

This study ‘s primary goal is to develop a coconut cutting machine that incorporates with rotatory motion of cutting. This design will serve as the foundation for prototype creation and a source for commercial manufacture. The research will specifically look into following:

- Outline the disadvantages faced by the farmers while collecting coconut water and splitting of coconuts.
- List the data elements that call for the automation of the cutting of coconuts.
- Using the principles of rotatory motion as basics, create a three-dimensional design for an automated coconut cutting machine.
- Using machine shop technique, create a prototype for the machine design.
- Compare the data collected from manual operation with motorized coconut cutting machine’s effectiveness.

B. Benefits of Machine

- In order to effiency to cut the coconut in half and collects its fluids, a machine for cutting coconuts is designed.
- It helps to save time, labor and resources when compared to cutting a coconut by hand, however the physical handling and process of slicing a coconut causes several risks and inefficient.
- Sanitary hazards can exist since the seller may not have provided enough hygiene materials, which could lead to microbial growth.
- Freshly extracted coconut water is unstable they start to ferment within a hour, so our machine helps to stabilize the coconut water by cooling the water where stability can be extended to four hours.



4. MATERIALS AND METHODS

A. Compents of machine

The materials required for fabricating coconut water collection machine are of

3.3.1 Motor
3.3.2 Gear box
3.3.3 C Channel
3.3.4 Pully
3.3.5 Round Plate
3.3.6 Heavy Plate Knife
3.3.7 Belt

3.3.8 Peltier Coil
3.3.9 Instant Cooler
3.3.10 Collector
3.3.11 Filter Sheet

Motor

A 1 HP motor refers to an electric motor with a power output of approximately 1 horsepower. Horsepower is a unit of power commonly used to measure the rate at which work is done. In the case of motors, it indicates the amount of mechanical power they can produce. For practical purposes, a 1 HP motor can typically provide enough power to perform tasks such as driving small machinery, pumps, fans, and various other applications in both industrial and domestic settings. Motor characteristics such as torque, speed, voltage and current determine the efficiency and power output of a motor. Higher torque and speed result in greater power output, while higher efficiency is achieved with optimal voltage and current to minimise energy losses within the motor.

Gearbox

A gearbox with a ratio of 20:1 means that the input shaft (usually connected to a motor or engine) must rotate 20 times to achieve one complete rotation of the output shaft. This ratio indicates the relationship between the rotational speeds of the input and output shafts. Gearboxes with different ratios are used in various applications to control speed, torque, and direction of rotation. In the case of a 20:1 gearbox, it would typically reduce speed while increasing torque.

C Channel

C Channel, also known as a C-beam or C-section, is a structural steel profile characterized by its cross-sectional shape resembling the letter "C". It features a vertical back, flanges extending outward from each side, and a flat base connecting the flanges. Typically made from materials like steel, aluminum, or stainless steel, C channels are produced through hot rolling or cold rolling processes to achieve desired dimensions and strength characteristics. They come in various standard sizes, catering to a wide range of applications in construction, manufacturing, and engineering. Common uses include providing structural support in buildings, framing systems for walls and roofs, support structures for equipment and machinery, and applications in the automotive industry. With their strength, versatility, and efficient load-bearing capabilities, C channels play a crucial role in numerous industrial and structural projects worldwide.

Pully

In a cutting machine, a pulley plays a crucial role in the movement and control of the cutting mechanism. By using a system of pulleys, the machine can efficiently transfer power from a motor or other power source to the cutting blade. The pulley helps to regulate the speed and torque of the blade, ensuring precise cuts and smooth operation. Additionally, pulleys allow for adjustments in the tension of the cutting mechanism, enabling the machine to accommodate different materials and cutting requirements.

Round Plate

A round plate typically refers to a circular flat object with a uniform thickness. It can be made from various materials such as metal, plastic, ceramic, or glass. Round plates are commonly used in culinary settings as serving dishes or dinnerware for meals. They come in various sizes and designs to accommodate different serving needs and aesthetic preferences. In industrial and engineering contexts, round plates may serve as components in machinery, equipment, or structures, providing support, reinforcement, or a mounting surface.

Heavy Plate Knife

A heavy plate knife is a type of kitchen knife designed specifically for cutting through thick and dense food items, such as meats, poultry, and large vegetables. Plate 6 : Heavy plate Knife It typically features a thick and sturdy blade with a broad surface area, allowing for greater force to be applied when slicing through tough ingredients. The heavy plate knife is ideal for tasks that require significant cutting power and precision, making it a valuable tool for professional chefs and home cooks alike. Its robust construction and sharp edge enable efficient and effortless cutting, even through the toughest of foods.

Peltier Coil

Peltier devices, also known as Peltier modules or thermoelectric coolers, are indeed used for refrigeration purposes in certain applications. These devices utilize the Peltier effect to create a temperature difference across their junctions when an electrical current is passed through them. In a refrigeration application, Peltier devices are typically sandwiched between two heat sinks. One side of the Peltier device is in contact with the area to be cooled (the cold side), while the other side is in contact with a heat sink to dissipate the absorbed heat (the hot side)

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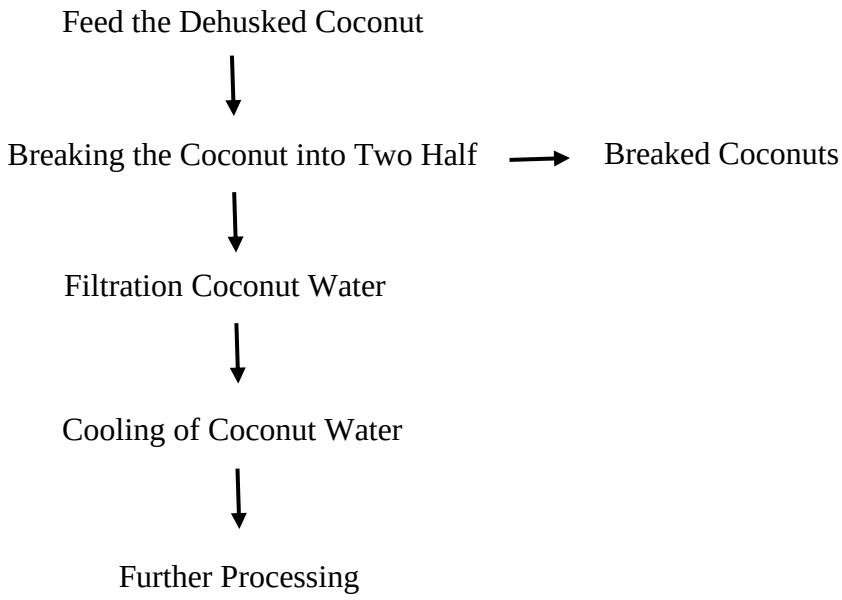
B.Working of Machine



Preparation :
The coconuts are dehusked, which involves removing the tough outer husk to reveal the inner shell or nut. This can be done manually or using specialized machinery depending on the scale of operations.
Feeding Mechanism:
The dehusked coconuts are then fed into the machine using a feeding mechanism. This could be a conveyor belt, chute, or any other system designed to guide the coconuts into the processing area of the machine.
Cracking Mechanism :
The machine employs a cracking mechanism, which could be a rotating blade, a hydraulic press, or a combination of both, depending on the design of the machine. This mechanism applies controlled force to the coconut to crack open its hard shell while minimizing damage to the inner coconut meat.
Collection:
Once cracked, the coconuts are directed to a collection area where the broken shells and the coconut water are separated from the coconut meat.
Filtration:
The coconut water is then pumped or gravity-fed through a filtration system. This system typically consists of one or more filters designed to capture suspended solids, impurities, and any remaining particles in the coconut water.
Cooling System:
Cooling coconut water using a Peltier cooling device, also known as a Peltier cooler, cooling coconut water using a Peltier cooling device involves employing the thermoelectric effect to transfer heat away from the coconut water, thereby lowering its temperature.
Peltier Device Integration:
A Peltier cooling device consists of semiconductor materials sandwiched between two ceramic plates. These devices are compact and can be integrated into a cooling system easily. The Peltier device is positioned in contact with the container holding the coconut water.

5. RESULT AND DISCUSSION

A. Capacity of Machine

Time taken to break one coconut = 3 seconds
Capacity of machine = 600 coconuts /hr

B. Efficiency of Machine

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Power = 1hp = 746 W
Efficiency = ((o/p power)/(i/p power))*100
= ((746/750))*100
= 99.4%

C. Force of Heavy Plate Knife

Force = Blade Spinning Speed x Blade Weight x No. of. Blade
Force = 28.8 x 14.715 x 1 = 423.7 N

The capacity of 1 hp motor 250 V at 50 hz frequency, they can break up to 600 coconuts /hour with 75 % of its efficiency under the force of 423 N.

6. CONCLUSION

The current paper summarizes the substantial research efforts and findings on the usage of mature coconut water and collection machines in order to make the material useful. We created the technologically advanced coconut breaking and water collection machine to address the issues that the copra industry was having. Our equipment not only helps to preserve aquatic life by lowering the biological oxygen demand (BOD) level, but it also minimizes the amount of coconut water wasted during the breaking process. Our machine's primary goal is to mechanically gather coconut water without the need for labor. It also maintains the cleanliness of the coconut water, increases breaking efficiency, and is equipped with a Peltier cooling system to stop the fermentation of the coconut water while it is being collected and stored for later use. Additionally, we computed the machine's efficiency, capacity, and cooling capacity to assess its overall functionality and running capability.

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