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Development of Sugarcane Peeler and Juice Extracting Machine

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Abstract: *This research paper aims to find a solution for vendors' issues as well as designing and building a device that meets customer needs by giving them freshly squeezed sugarcane juice with high nutritional value. The main goal of this research paper is to develop and design a machine that can peel the sugarcane as well as extract the juice from it, and it must be available at an affordable price to all vendors, whether they are small or large. The study focuses on the two tasks: solving every vendor's problem and making machines available to all vendors, regardless of size. Another consideration that must be made during the design and development of a machine is its price. This machine must be made available in the market at a lower cost than other machines and must also satisfy all of the demands of customers and suppliers. Since the equipment is inexpensive, everyone should be able to launch their business with very little capital. Apart from the nutritional qualities of sugarcane juice, the extracted juice contains a lot of suspended solids and impurities, which affects the quality, taste and color due to the presence of wax and other plant impurities. In today's market, various models of peeling machines are available, including fully automatic and semi-automatic peelers, which are more expensive and out of reach for small-scale vendors. As a result, this paper focuses on the development of low-cost sugarcane peeling machines, particularly for small venders.This low-cost sugarcane juice extractor and peeling machine is made to be easily accessible at a cheap cost with the maximum level of efficiency. As it's combination of both peeling and juice extraction processes, the vendor doesn't need to buy a separate machine.*

Keywords: Sugarcane, sugarcane peeler, vendors, machine efficiency

I. INTRODUCTION

Sugarcane is the fifth-most productive crop in the world, after wheat, rice, maize, and corn. When we discuss the variation around the world, there are a total of 30 unique varieties of sugarcane. Sugarcane is a multipurpose crop that serves as source of sugar, juices, jaggery and various products. Fresh sugarcanejuice is a popular beverage in many countries particularly in India.The sugarcane juice is served in many eateries from roadside stalls to five-star hotel dininghalls. The largest sugarcane producing state in India is Uttar Pradesh, which has a 38.61% share in overall sugarcaneproduction. Maharashtra and Karnataka are the second and third largest producers. Before extracting the juice from sugarcane, peeling is done. The first step from harvest to processing is peeling, which is a crucial process. As we understand sugarcane is nutritious, so before the formation of sugar, juices are delicate to get rid of many unwanted impurities the usage of high dose of chemicals so, peeling is the first system from harvest to processing which is avery crucial procedure. Pilling is a process in which upper layer of sugarcane is removed in conjunction with black spots, mud and impurities. Manual peeling of sugarcane is time consuming and causes labor fatigue. There may be a risk of injury to the labours performing the peeling operation with the blades or knifes manually. Manual peeling with a conventional knife is used to extract sugarcane juice from small scale units, which results in uneven peeling, making the process more tedious and drudgery, and peeling efficiency is not satisfactory, leaving unpeeled portions, which may reduce juice quality.

All these problems which occur due to manual peeling and traditional way of juice extractioncan be eliminated by designing the machine which can reduce the efforts of workers and can be operated in less time. The main objective of

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this project is to design and fabricate the combination of both sugarcane peeler and juice extracting machine which will be cost efficient and will eliminate the problems of manually operated sugarcane peeling machine and traditional way of juice extraction.

II. LITERATURE REVIEW

Kehinde A. Adewole, Michael T. Adamolekun, Robinson Akinnusi, "Development of a Sugarcane Juice Extractor for Small Scale Industries", JMEST, Vol. 2, 5 May 2015

To help the small and medium sugarcane crushers extract juice from sugarcane, a motorized sugarcane juice extractor was created, built, and tested. In order to extract the juice from the wet bagasse, the machine macerates the sugarcane stem that is loaded vertically before pressing the macerated stem against the cylindrical cone. Housing, shaft, bearings, keys, pulleys, rollers, hopper, v-belt, adjusters, gears, electric motor, etc. make up the machine. The designed machine demonstrated a 65% efficiency in the performance testing. Instead of relying on imported ones, this machine might be manufactured in small machine shops in sugarcane growing regions.

Azeez, N.A, Okpara, I.N and Ologunye, O.B, "Design and Fabrication of Sugarcane Juice Extractor," AJER, Vol. 8, 2019

Over time, small-scale farmers have helped Nigerian sugar cane production, which has since stopped chewing the inner tissues and biting the rind to sweeten the liquid. The juice is extracted at the concentration level. We have accepted a project to increase the output of sugar cane and its product. Referred to as a SUGARCANE JUICE EXTRACTOR. Evaluation of the sugar cane extractor's performance in terms of efficiency in the juice extraction. The goal of this project is to create a machine with a 2.0 horsepower gear motor and a crush mechanism made up of three rollers, latches, and gears that is attached on the frame along with the juicer and input and outlet.

Prakruthi N Raj Gangadkar, M. Chowde Gowda and N.B.L. Prasad, "A Research on Traditionally Available Sugarcane Crushers," International Journal of Engineering and Manufacturing Science, Vol 7, 2017

Based on the performance assessment of the number of rollers present in the crushers, the traditionally available sugarcane crushers—two roller power operated sugarcane crusher, three roller traditional sugarcane juice extractor, and three roller gear box type sugarcane crushers—were used to analyze the various parameters of sugarcane juice extracted from the four varieties of traditionally available sugarcanes. These three sugarcane crushers were used to study and evaluate the amount of juice extracted (gm/kg), bagasse weight (gm/kg), Brix content (%), Sucrose content (%), reducing sugars, and purity percent. According to the study, as the number of rollers in sugarcane crushers grows, the amount of juice extracted (in grammes per kilogramme) increases and bagasse weight (in grammes per kilogramme) drops.

Rachel Ugye and Oladele Ayodeji Kolade," Design Parameters for a Sugar Cane Extractor" American Journal of Engineering Research (AJER), Volume-8, 8 Jun 2019

This paper Discussed the design and constructing a portable and cost-effective juice extraction machine to expand sugarcane production in Nigeria. It will help to reduce the total cost of sugarcane production process and to avail farmers the opportunity of sugarcane business and to increase local production of sugar, the design procedures is carefully described. The need for this design became necessary because the currently available sugarcane juice extractors require high energy and sophisticated mills, driven mechanically. These are out of the reach of small scale and rural farmers that are presently involved in processing of cane juice into ethanol, brown sugar, and other related products in Nigeria.

III. PROBLEM STATEMENT

In the off-season, particularly in the rainy and winter months, bacteria and black patches develop on the sugarcane's outer layer. Impurities including dirt, dust, sludge, and other contaminants are also present in the sugarcane's outer layer. Most of the sugarcane juice is sold by small businesses that use a traditional manual peeling machine to prepare the sugarcane for juice extraction. Peeling sugarcane by hand requires a lot of time. The process of removing the sugarcane's outer covering takes a long time. Manual peeling can result in significant losses of usable sugarcane. There is too much wastage from the hand peeling procedure of sugarcane's outer layer, flesh, and uneven removal. Strong human hands are needed for manual operations. Additionally, the workers doing the peeling operation have a risk of

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getting injured. Because of the contaminants on the sugarcane, it is impossible to extract nutritious juice without peeling it, and the juice's quality would suffer. The hard nodes of the sugarcane may damage the juice extracting machine when the sugarcane is placed in it to extract juice without being peeled, which would lower the equipment's performance and efficiency. When sugarcane juice is extracted traditionally, which also consumes a lot of energy and puts human teeth at risk of damage, the gums of the teeth may be affected. The usual extraction procedure cannot provide as much juice as needed. Additionally, the market's commercial sugarcane peeling and juice extraction machines are extremely costly and out of reach for vendors.

IV. CONSTRUCTION AND WORKING

A sugarcane peeler was design and developed for peeling of sugarcane it replaces the manual way of sugarcane peeling. The sugarcane peeler design in this project is semi-automatic which is design for both small venders as well as shops which peel sugarcane at high level. As shown in fig.1it consists of frame, 6-8 peeling blades, two sprockets (one smaller at motor and another at design blades), Chains, Bearing, 2-Semi Circular clamp, tyre rubber, Power capacitor. The frame is design to support all the internal component of the sugarcane peeler. During design of sugarcane peeler, the frame column is design at placed in such an angle that it make good contact with ground area. By design this at specific angle it makes good contact with surface as well as it also avoids maximum amount of vibration during sugarcane peeling while machine in working condition. The motor used in this peeler play an important role for power transmission from motor to the blades. In this present investigation total 6-8 peeling blades are used which is adjustable according to the size (diameter) of sugarcane. The four angles at upper and four angle at downward side are attached with the legs of stand with the help of electric welding. The angle in this investigation is made up of mild steel material. On the surface of blade marking on grooves are used for fine peeling of sugarcane. The chain is used to provide rotational motion to the sprocket for peeling. As when we supply power to the motor the motor start and as motor start it rotate the sprocket on motor and similarly these sprockets rotate another sprocket which is mounted on the peeling blade as it rotates the peeling of sugarcane take place with the help of blades. In this investigation the sugarcane move in horizontal direction and the blades are move in rotational motion. Sugarcane juice extractors are simple machines used to extract juice from sugarcane stalks. They are widely used in small-scale juice production and are operated manually by human labour. The basic components of a manual sugarcane juice extractor as shown in fig.2 include a metal frame, a set of rollers, a feeding chute, and a collection tray. The sugarcane stalks are first peeled with the help of design sugarcane peeler machine to remove dirt or debris. They are then fed into the feeding, which guides them towards the rollers. The rollers are the main components responsible for extracting the juice from the sugarcane stalks. The rollers are move with opposite to each other. They are typically made of metal and are designed to rotate in opposite directions. As the sugarcane stalks pass through the rollers, the pressure applied by the rollers crushes the stalks and extracts the juice. The juice flows out through the space between the rollers and is collected in a tray placed underneath the extractor. Combination of peeler and juice extractor section are highlighted in fig.3.

V. BILL OF MATERIAL

Table 1: Bill of material of sugarcane peeler

Sr. No.	Components	Material	Quantity	Specification
01	Blades	Low alloy Steel	06	L=80mm, B=30mm, W=4mm
02	Bearing	High carbon chromium steel	02	20-1022(Part number)
03	Stand	Mild Steel	01	h=860mm
04	Chain	Plain carbon steel	01	L=1397mm, w=8mm
05	ElectricMotor	Mild Steel	01	0.12HP, 1200RPM, AC Motor
06	Bigger Sprocket	High carbon steel	01	44 Teeth

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07	Smaller Sprocket	High carbon steel	01	14 Teeth
08	Pipe	Cast Iron	01	L=140mm, Dia=70mm,t=2mm
09	Gears	Cast Iron	04	T=68, 17, 20, 20
10	Rollers	Cast Iron	02	L=135 mm, Dia=85 mm
11	Handle Rod	Cast Iron	01	L=230 mm, Dia=24 mm
12	Frame	Cast Iron	01	L=665 mm, t=4mm, 50 mm
13	Plate	Stainless Steel	01	L=200 mm, t=1 mm,B= 135 mm

Figure 1: Sugarcane Peeler

Figure 2: Sugarcane Juice Extractor

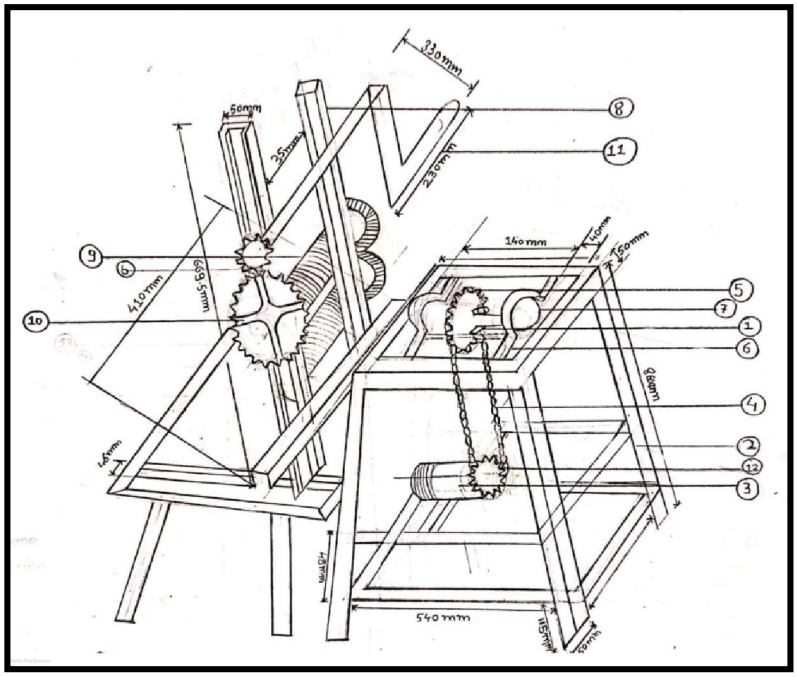

Figure 3: Assembly drawing of sugarcane peeler and juice extracting machine

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VI. CALCULATION

CALCULATION OF SUGARCANE PEELER

(a) Speed

Speed (m/s) = πDN/60 = 1200/60 = 20 m/s

Where, D = Diameter of the drive shaft, m and

N = number of revolutions, rpm

(b)Power of developed sugarcane peeler machine

Current, (I) = 0.46A

Supply Voltage, (V) = 230V

Speed of motor = 1200rpm

Power Calculated,

P = V*I

To calculate no. of poles of motor,

F = P*N/120

Were,

F – Frequency = 50Hz

N – Relative speed = 1200rpm

P – Number of poles

By putting all this value in above formulae, we get,

P = 5

Torque,

Torque on motor = Power in HP * 9550/Speed in rpm= 1.1286 Nm

Power required = Torque*Angular velocity= T*2πN/60

Power required = 141.82 watts

Time required to peel the 50cm sugarcane is 20sec.

CALCULATION OF CHAIN DRIVE

Given: T_1, T_2=44

N_1=1200 rpm

Power of motor=0.14 HP

Assume, Pitch(P)=12.7 mm (Ref. DDB Pg.152)

Pitch diameter of smaller sprocket, DP

D_{P1}=P/sin(180/T1)=57.073 mm (Ref. DDB Pg.150 T. XIV)

Pitch line velocity(v)

V=ΠD$_P$N$_1$/1000=215.16 m/min =3.586 m/sec

D_{P2}=P/sin(180/T2) =178.022 mm

V=ΠDP2N2/1000

N2=V*1000/ΠDP2=384.713 rpm

Velocity Ratio= N1/N2=1200/384.713=3.11

Power capacity of roller chain as per A.S.A. standards

PC=p^2[v/104 -$V^{1.41}$/526(26-25cos180/T_1)] *Kc (Ref. DDB Pg.150 T. XIV.1)

=2.5417 KW (Kc=1 for single strand)

The minimum center distance should be 30 to 50 times the pitch (Ref. A textbook of machine design pg.763)

C=40*P =508 mm

Number of chain links

K=T_1+T_2/2 + 2C/P +[T2-T1/2π]^2 P/C =110(Ref. A textbook of machine design pg.762)

Length of chain (Ref. A textbook of machine design pg.762)

L=K*P=1397 mm

Outside diameter of smaller sprocket D_{o1},

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D_{o1} =P[0.6+cot(180/T_1)]=63.262 mm (Ref. DDB pg.154 T.XIV.4)
Outside diameter of bigger sprocket D_{o2},
D_{02} =P[0.6+cot(180/T_2)]=185.189 mm
Root diameter of smaller sprocket Dr_1,
Dr_1=D_{P1}-0.625p=49.135 mm (Ref. DDB pg.154 T.XIV.4)
Root diameter of bigger sprocket Dr_2,
Dr_2=D_{P2}-0.625p =170.084 mm
Width of sprocket teetht_o=0.58p-0.15 =7.216 mm (Ref. DDB pg.154 T.XIV.4)
Roller diameterd_r=5/8p=7.937 mm (Refer DDB pg.151 T.XIV.3)
Chain width, W=5/8p =8 mm

VII. RESULT AND DISCUSSION

The peeling efficiency of mechanical peeler is calculated at different clearances of 20 mm, 30 mm, and 40 mm between the six rotating blades. The results obtained by peeler at different clearances are presented in table 2. The maximum average value of peeling efficiency is 77% at 20 mm clearance and minimum average value of peeling efficiency is 36% at 40 mm clearance. This shows that increasing the clearance between the blades decreasing the peeling efficiency and vice versa. Hence, the optimum clearance between the blades is 20 mm.

Table 2: Peeling efficiency at different clearance between blades

Peeling efficiency at different clearance between blades									
	20 mm			30 mm			40 mm		
	Initial Dia.	Final Dia.	PE%	Initial Dia.	Final Dia.	PE%	Initial Dia.	Final Dia.	PE%
Average	24.11	23.34	77	25.53	24.85	68	24.21	23.87	34

Comparison of sugarcane Peeler

The peeling efficiency of manual peeling and mechanical peeler are compared with the parameters of thickness removed during peeling and time taken for peeling and the results of the peeling efficiency are calculated. The comparable data were tabulated in table 7.

Table 3: Comparison of peeling efficiency of developed peeler and manual peeling

Treatment	Initial dia. of cane	Final dia. of Cane	Thickness of removed bark	Time for peeling /cane	Peeling efficiency
Manual peeling	25.76	25.1	0.42	60	42%
Developed peeler	26.98	26.21	0.76	20	77%

results shows that the peeling efficiency of the mechanical peeler is more, values 77% in 20 seconds and the peeling efficiency of the manual peeling is comparatively less, values only 42% in 60 seconds so the above results shows that peeling efficiency was maximum by using mechanical peeler compared to manual peeling.

The sugarcane juice extractor rollers consist of grooves which help to hold the sugarcane when the sugarcane is inserted between the two rollers for extracting the juice.

The total weight of the extracted sugarcane juice is calculated to be 16053 g and total time required for the removal of process is 150 sec

16053/150 = 107.02 g/sec= 387.432 kg/hr

Extraction in liter = 0.108480 lit/sec

VIII. CONCLUSION

Using a 0.2 HP electric motor and 6 blades, a sugarcane peeling machine can peel cane faster than doing so by hand. It has been accomplished to reduce the time needed to manually peel sugarcane by designing and building a machine. Additionally, manual peeling has virtually all the drawbacks associated with it, like worker fatigue, time consumption,

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risk of worker injury, unsanitary sugarcane, etc. The machine has an excellent overall performance. The machine requires less maintenance, which saves money. Without dirt, dust, bacteria, or black spots, the sugarcane has been peeled in a hygienic manner and is ready to be utilized to extract juice.

The sugarcane juice extracting machine consisting of two rollers produces optimum juice which is fresh and hygienic. The sugarcane peeler and juice extraction machine are designed in such a way that it can peel and squeeze any sugarcane of diameter ranging 30-50 mm. The Peeling and Juice Extraction process is carried out by a single machine. The developed machine possess simplicity in operation and maintenance as well as being affordable with low running and maintenance costs and with reliable efficiency. The machine can be used for small scale in rural and urban communities

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[18]. Voice cloning is to keep the current semantic information, and only change the speaker's voice personality characteristics to make it sound like another speaker.

[19]. Through the study of voice cloning, we can further strengthen the study of speech- related parameters, explore the pronunciation medium of humans, control the personality characteristic parameters of speech signals. advantage is that the network and data set used in each model can be flexibly selected and changed, which is convenient for later optimization.