Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Development and Performance Evaluation of Sugarcane (Saccharum officinarum L.) Peeling Machine

Shashank Verma[1*], Vijay Kumar Singh[2], Vipul Chaudhary[2], Pramod Kumar Mishra[2], Harsh Prakash Sharma[3], Amisha Singh[4]

[1]Department of Processing and Food Engineering, MCAET, ANDUAT, Kumarganj, Ayodhya- 224 229, Uttar Pradesh, India

[2]Mahamaya College of Agricultural Engineering and Technology, Ambedkar Nagar, ANDUAT, Kumarganj, Ayodhya-224122, Uttar Pradesh, India

[3] Department of Food and Nutrition, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, Uttar Pradesh, India

[4]Department of Mathematics, Chaudhary Charan Singh University, Meerut, Uttar Pradesh 250004, Uttar Pradesh, India

Corresponding author email Id: shashankagril7881@gmail.com

ARTICLE INFO

Received: 17 June 2023

Revised:04 Nov 2023

Accepted: 19 Nov 2023

Published : 20 Jan 2024

ABSTRACT

Sugarcane juice is a widely consumed refreshing beverage, particularly during the summer season, across many countries. The present study aimed to design, develop, and evaluate a sugarcane peeling machine using a CAD-based approach. The prototype was fabricated at the workshop of the Faculty of Agricultural Engineering, Mahamaya College of Agricultural Engineering and Technology, Ambedkar Nagar, with materials selected based on their mechanical strength and physical suitability for efficient operation. The developed machine incorporates a two-stage peeling mechanism, wherein the first stage employs an adjustable blade assembly to remove extraneous materials and nodal shoots, while the second stage utilizes the abrasive action of a wire wheel brush to achieve uniform peeling of the sugarcane surface. The performance of the machine was evaluated under varying operational parameters, including motor speed and sugarcane length, and the results indicated that an increase in these parameters led to a decline in peeling efficiency. In comparison to conventional manual peeling, the developed machine demonstrated improved hygiene, reduced labor requirement, and enhanced operational safety. The optimal performance was achieved at a motor speed of 1000 rpm with sugarcane lengths less than 200 cm, where the machine recorded a maximum peeling efficiency of 83.6% and a throughput capacity of 109.4 kg/h (approximately 113 canes per hour). Under these conditions, the minimum microbial load of 6.4×10^5 CFU/ml and a high consumer acceptability score of 8.2 were observed. The findings indicate that the developed sugarcane peeling machine is an efficient, hygienic, and practical solution for small-scale juice vendors, offering improved performance and product quality compared to traditional manual peeling methods.

Keywords: Sugarcane, Peeling efficiency, Through put capacity, Microbial load, Sensory evaluation, CAD etc.

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

Introduction

Sugarcane is one of the most important commercial crops cultivated worldwide, recognized for its high productivity and its significant contribution to both the food and bio-energy sectors (Cane growers, 2012). It serves as the primary raw material for sugar production and is also widely utilized for the preparation of fresh sugarcane juice, which is highly popular as a natural and refreshing beverage, especially in tropical and subtropical regions. The juice is valued not only for its sweet taste but also for its nutritional composition, including carbohydrates, minerals, and bioactive compounds that contribute to its health benefits. With the increasing demand for hygienic and high-quality beverages, the processing methods involved in sugarcane juice extraction have gained considerable attention in recent years.

One of the most critical operations in the preparation of sugarcane juice is the peeling of the cane (Chiawchanwattana et al., 2024). The outer layer of sugarcane contains impurities such as soil, wax, microbial contaminants, and fibrous materials, which can adversely affect the quality, taste, and safety of the extracted juice. Therefore, the peeling process plays a fundamental role in removing these unwanted materials and ensuring the production of clean, safe, and high-quality juice (Anon.,). The primary objective of peeling is to enhance the sweetness, improve the appearance, and increase the overall acceptability of the juice while also minimizing health risks to consumers. Proper peeling also contributes to improved shelf life and reduced microbial load in the final product.

Traditionally, sugarcane peeling has been carried out manually using knives, which is a labor-intensive, time-consuming, and skill-dependent process. This method not only leads to inconsistent peeling quality but also poses significant safety hazards to workers due to the risk of injuries. Moreover, manual peeling is inefficient for large-scale or continuous operations, making it unsuitable for meeting the growing demand for sugarcane juice in urban markets. In addition, the unhygienic conditions often associated with manual handling can lead to contamination of the juice, thereby affecting its safety and consumer acceptance. These limitations have created a strong need for the development of mechanized sugarcane peeling systems that can improve efficiency, consistency, and hygiene while reducing labor dependency.

In response to these challenges, various researchers have made significant contributions toward the design and development of sugarcane peeling machines. Tagare et al. (2013) conducted an important study on the design and fabrication of a sugarcane peeling machine. Their machine utilized a rotating hollow shaft equipped with blades and brushes, which facilitated the peeling process as the sugarcane passed through it. The peeled cane was then discharged through rollers positioned at the outlet. The study evaluated the machine performance using sugarcane samples of different diameters and reported peeling efficiencies of 67%, 51%, and 61% for three samples, with an average efficiency of 59.66%. The results highlighted the influence of cane diameter on peeling efficiency and demonstrated the potential of mechanical systems in replacing manual methods.

Further advancements were made by Xinfeng (2015), who developed an automated sugarcane peeling machine based on a slider-crank mechanism. In this design, a blade mounted on a reciprocating slider moves along a rail, and peeling is achieved through the relative motion between the blade and the sugarcane. This mechanism significantly reduces manual effort and improves operational efficiency. The automated nature of the system also ensures uniform peeling and reduces variability in output quality. Similarly, Dehui (2015) introduced a motion controller-based sugarcane peeling machine that integrates automated feeding, peeling, and discharge processes. The study emphasized that unpeeled sugarcane can introduce suspended solids into the juice, thereby affecting its quality. By incorporating automation, the developed system enhances productivity and ensures better control over the peeling process.

Kadam et al. (2018) proposed an innovative approach to sugarcane peeling by developing a machine based on orbital motion. In this system, sugarcane is fed into the machine through rollers and guided into an orbital drive equipped with brushes along its inner periphery. As the cane moves through the system, the brushes remove the outer layer through abrasive action. Additionally, horizontal brushes are provided at the outlet to further clean the surface, resulting in multi-stage cleaning in a single pass. This design not only improves peeling efficiency but also reduces operator fatigue and processing time, making it suitable for continuous operation.

Pandraju et al. (2021) focused on developing a low-cost sugarcane peeling machine for small-scale vendors, addressing the need for affordable and accessible technology. The machine utilized grooved stainless steel wire brushes to achieve effective peeling. The performance evaluation considered parameters such as peeling efficiency, power consumption, and juice quality characteristics including pH, total soluble solids (TSS), and color. The study reported a maximum peeling efficiency of 77% at a clearance of 2 cm and a minimum efficiency of 36% at 4 cm clearance, indicating the importance of optimizing machine parameters for improved performance. This work demonstrated that cost-effective solutions can significantly enhance the quality and hygiene of sugarcane juice production in small-scale operations.

Chai et al. (2022) further contributed to the development of sugarcane peeling technology by designing and fabricating a modified peeler aimed at reducing manual effort and processing time. The machine incorporated adjustable cutting mechanisms using flexible components such as rubber bands, allowing it to accommodate sugarcane of varying diameters. It also included storage compartments for waste materials and tools, enhancing its practicality and ease of use. The design ensured that peeling could occur uniformly across the entire surface of the cane, thereby improving efficiency and output quality.

In addition to mechanical design advancements, studies have also highlighted the importance of preprocessing techniques in improving juice quality. Karmakar (2011) investigated the effects of pretreatment on the physicochemical characteristics of sugarcane juice and found that proper preprocessing, including peeling, significantly influences parameters such as clarity, microbial load, and shelf life. This emphasizes that peeling is not only a mechanical operation but also a critical step in ensuring the overall quality and safety of the final product.

Despite these advancements, several challenges remain in the development of sugarcane peeling machines. These include achieving high peeling efficiency across different cane sizes, minimizing losses of edible material, reducing energy consumption, and ensuring ease of operation and maintenance. Additionally, there is a need to design machines that are compact, cost-effective, and suitable for use by small-scale vendors, who constitute a major segment of the sugarcane juice market. The integration of hygienic design principles and food safety standards is also essential to ensure that the machines meet modern consumer expectations.

Overall, the existing literature indicates substantial progress in the mechanization of sugarcane peeling; however, there remains a need for further research and development to address existing limitations. The development and performance evaluation of improved sugarcane peeling machines can play a crucial role in enhancing processing efficiency, ensuring product quality, and promoting hygienic practices in sugarcane juice production. Such advancements will not only benefit small-scale vendors but also contribute to the modernization and sustainability of the sugarcane processing industry.

Materials and Methods

In this research work, the sugarcane was collected from the farmer's field and local sugarcane juice vendors available near to the college campus for the testing and performance evaluation of the

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

sugarcane peeling machine. The sugarcane variety CO-0238 and CO-8436 which is widely grown in Ambedkar Nagar district was selected for the study. The length, diameter, weight of sugarcane were crucial for developing a peeling machine for sugarcane in terms of blade adjustment to remove the shoots presents over the nodes of sugarcane, clearance between the brushes and feeding roller adjustment. The physiological characteristics of the cane like length, mean diameter and weight of sugarcane are measured with help of measuring tape, vernier calliper and electronic weighing balance. The details of the used instrument are depicted in table 1.

Table 1 Details of instrument used to determine physical properties of sugarcane

S. No.	Name of instrument	Description	Range	Accuracy
1.	**Vernier Caliper**	To measure the diameter of sugarcane	0 to 200 mm	0.02 mm
2.	**Measuring Tape**	For measuring the length of sugarcane	0 to 10 feet	0.79 mm
3.	**Electronic Weighing Balance**	To weigh the sugarcane	0 to 50 kg	1 gram

2.1 Development of sugarcane peeling machine

A sugarcane peeling machine was designed and developed for peeling the sugarcane. The mechanical peeler is mainly for (peeling the sugarcane) small scale cane crushing units. It consists of main frame, blade section, wire wheel brush section and power transmitting unit. The main frame of the machine divided into different sub-section as the support required to other components such as rollers, main shaft, block bearings, pulleys, motor and blade assembly etc. The frame columns are put at a square section rubber covers to increase the ground contact area in terms to stabilizing the whole machine while machine in working condition. A motor is main source of power transmission to required units of the machine. In this present study, six copper zigzag wire wheel brushes were taken and these were procured from OM automation Rajkot, Gujarat. Four stud rods are fixed between the frames to adjust the clearance between two brushes which is suitable for peeling various sizes of sugarcane. V-belt type transmission was adopted because it is less critical to misalignment than other types of drives and there is no need to maintain exact speed ratio and does not require lubrication (Kepner et al., 1985). In this machine two pulleys (Motor, main shaft) are selected for facilitating the speed variation between the pulleys.

Table 2 Specification of fabricated sugarcane peeling machine

S. No.	Components	Dimensions	Selected/Fabricated
1.	Main frame	Length = 370 mm Width = 320 mm Height = 510 mm	Fabricated
2.	Feed roller	Centre diameter = 38 mm Outer diameter = 60 mm Length = 120 mm	Selected

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

3.	Main shaft	Diameter = 18 mm	Fabricated
4.	Counter shaft	Diameter = 50 mm	Fabricated
5.	Block bearing	Bore diameter = 50 mm	Selected
6.	Gear mechanism assembly	**Gear** / **N** A / 56 B / 31 C / 10	Selected
7.	Blades	Cutting angle = 22.36° Back rake angle = 18.43°	Fabricated
8.	Wire wheel brush	OD = 100 mm ID = 20 mm	Selected
9.	Motor pulley	Diameter = 2 inch	Selected
10.	Shaft pulley	Diameter = 6 inch	Selected
11.	Overall dimensions	545×530×390 mm.	-

1.2 Performance evaluation of sugarcane peeling machine

2.2.1 Dependent and Independent Parameters

For conducting experiment, the machine parameters i.e. RPM of motor and length of sugarcane were taken as variable parameters whereas peeling efficiency (%), through put capacity (canes/day (8h)) and microbial load (CFU/ml) taken as dependent variable. The experimental design for the performance evaluation of the sugarcane peeling machine Table 3 illustrated the research plan in brief for achieving the objective of this research.

Parameters	Levels	Replications
INDEPENDENT		
Motor rpm	1400	05
	1200	05
	1000	05

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

Length of sugarcane	>200cm	05
	<200cm	05
DEPENDENT		
Peeling efficiency (%)	-	05
Through put capacity(cane/ day(8h))	-	05
Microbial load (CFU/ml)	-	05

Table 3 Experimental layout for performance evaluation of the sugarcane peeling machine

a) Peeling efficiency

The peeling efficiency will be estimated using the ratio; (Tagare *et al.* 2013)

Thickness of sugarcane peeled by machine (t_a): ideal thickness to be peeled by machine (t_i)

Thus;

$$\textbf{Peeling efficiency} = \frac{t_a}{t_i} \times 100 \qquad \text{...Eq (1)}$$

b) Through put capacity

The throughput capacity of machine refers to the maximum amount of work or data that can be processed by the machine with in given time frame. It is typically measured in units per hour, units per day, or similar units of time. In general, the formula can be expressed as; (Stevenson *et al.* 2014)

$$\textbf{Throughput capacity} = \text{Processing Rate} \times \text{Available Time} \qquad \text{...Eq (2)}$$

c) Microbial load

The number and type of microorganisms contaminating an object or organism is known as microbial load. The data analysis of sugarcane juice is calculated by using formula; (Kohli *et al.* 2019)

$$\textbf{CFU/ml} = \frac{(\text{Number of colonies} \times \text{dilution factor})}{\text{volume of culture plate.}} \qquad \text{...Eq (3)}$$

2.2.2 Quality parameters for analysis of peeled sugarcane juice

a) Total soluble solid

Total soluble solids content of a solution is determined by the index of refraction. This is measured using a Refractometer and is referred to as the degrees Brix. This is the summation of all the dissolved solids in the water such as salts, sugar, protein, acids etc. The total solid contents in the extracted juice affect its quality. More will be the total solids in the juice; poor will be the quality of juice. % Brix scale expresses the concentration percentage of the soluble solids content of a sample with water solution taken as reference material. The total soluble solid content was measured by placing two drops of the sugarcane juice on the scale of hand Refractometer (0-32^{o}Brix). The averages of three readings were taken as TSS content of extracted juice and expressed in degree Brix in percent.

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

b) Microbial load

The number and type of microorganisms contaminating an object or organism is known as microbial load. The microbial load estimation is done using the serial dilution method.

c) Sensory evaluation of juice

The acceptability of the final products was judged by sensory evaluation based on 9 point Hedonic scale. This evaluation was done against manually peeled sugarcane juice. The product was evaluated by a panel of 10 judges, based on the taste, flavour and overall acceptability. A 9-point Hedonic scale was prepared for taste, colour and overall acceptability. The score 9 was termed as liked extremely whereas score 1 was termed as disliked extremely.

2.2.3 Statistical analysis

The statistical analysis of the data was done using the software SPSS. The data of the machine is optimized using the randomly block design (RBD).

Results and Discussion

The performance evaluation of the developed sugarcane peeling machine was conducted as per standard procedures. The length of sugarcane varied from 180 to 270 cm and the diameter of cane varied from 20 to 35 mm. The developed sugarcane peeling machine was measured and presented in Fig. 1 and developed machine was shown in figure 1.

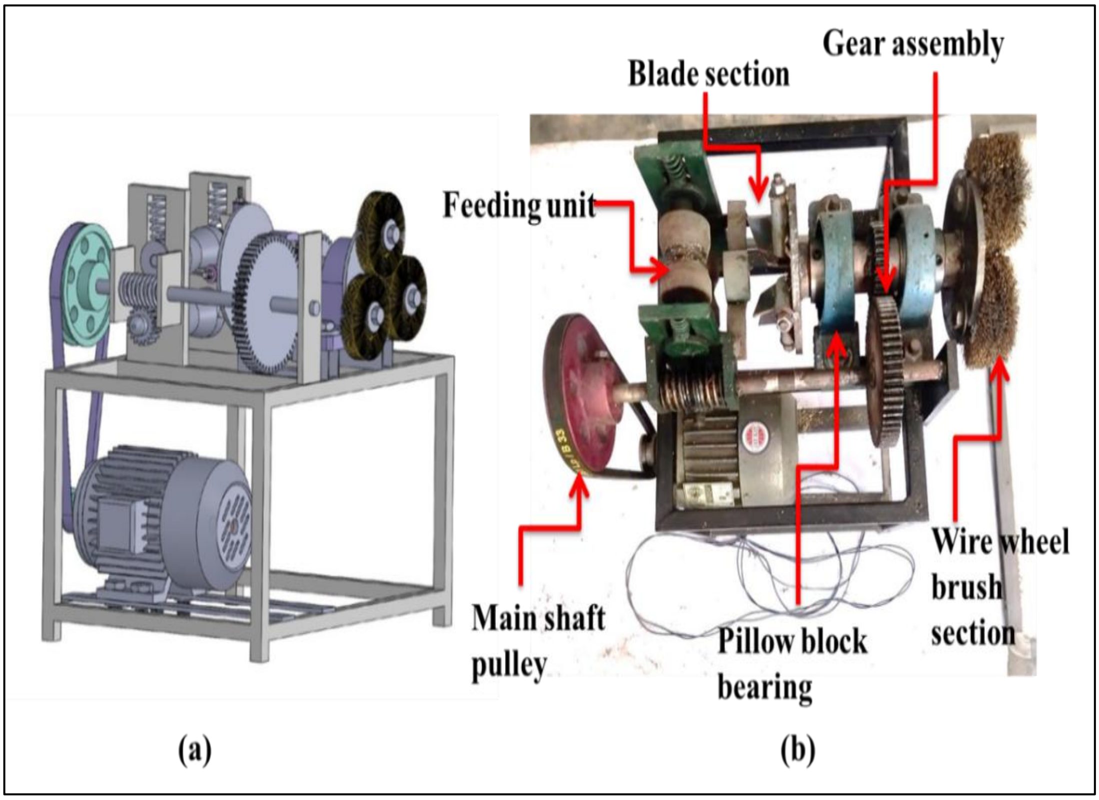


Fig. 1: (a) 3-D CAD view of sugarcane peeling machine, (b) Actual view of sugarcane peeling machine

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Motor speed (rpm)	Peeling efficiency (%)			Through put capacity (cane/ day(8h))			Microbial Load (10^5 CFU/ml)		
	Length of sugarcane		Mean	Length of sugarcane		Mean	Length of sugarcane		Mean
	<200 cm	>200 cm		<200 cm	>200 cm		<200 cm	>200 cm	
1400	80.2	**74.4**	77.3^{a}± 1.169	**1167.09**	904.45	1035.77^{a}± 56.114	**10.78**	15.1	12.94^{a}± 11.322
1200	83.2	80.8	82^{b}± 1.169	993.83	732.93	863.38^{b}± 56.114	6.84	10.7	8.77^{b}± 11.322
1000	**83.6**	81.6	82.6^{b}± 1.169	904.23	**670.39**	787.31^{b}± 56.114	**6.04**	10.2	8.12^{b}± 11.322
Mean	82.33	78.93		1021.71	769.25		7.88	12.0	

Table 4.3 Effect of Sugarcane length and motor rpm on peeling efficiency, through put capacity and microbial load

3.1 Peeling efficiency

Fig. 1 illustrates that the peeling efficiency of the machine varied between 74.4 to 83.6 %. The maximum peeling efficiency was 83.6 % was obtained at the motor speed of 1000 rpm and less than 200 cm length of sugarcane while the minimum peeling efficiency 74.4 % was found at 1400 rpm having greater than 200 cm length of sugarcane. It was also observed that as the speed decreased from 1400 rpm to 1000 rpm the peeling efficiency was increased as shown in Fig. 2. It was also observed that the mean value of the maximum peeling efficiency i.e. 82.33 % was found for length of sugarcane less than 200 cm whereas the mean value of minimum peeling efficiency i.e. 78.93 % was found for greater than 200 cm length of sugarcane. Thus it can be concluded that length of sugarcane affecting the peeling efficiency of the machine so less is the length of sugarcane better will be peeling efficiency.

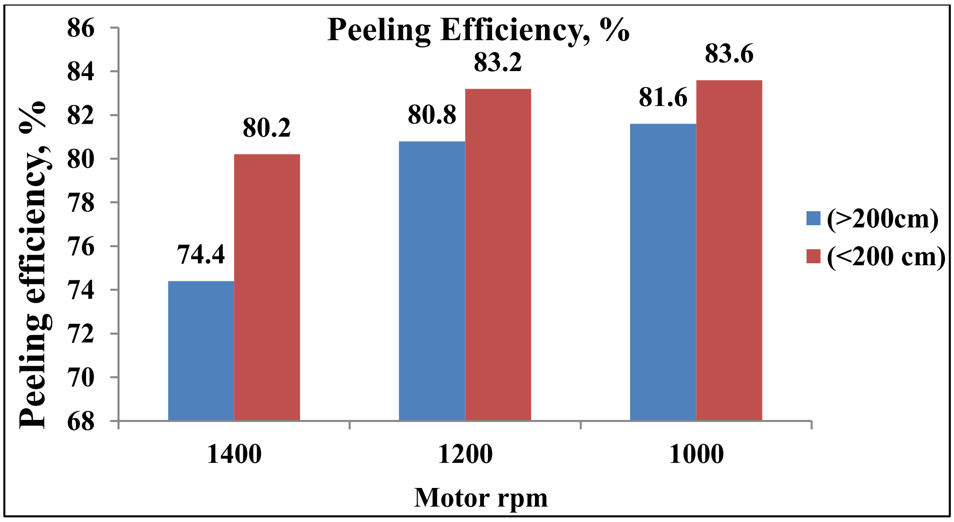


Fig. 2: Effect of independent parameters on peeling efficiency

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

Table 4 Peeling efficiency at different motor rpm

	Peeling efficiency at different motor rpm		
	1400	**1200**	**1000**
Average (%)	80.2	83.2	83.6

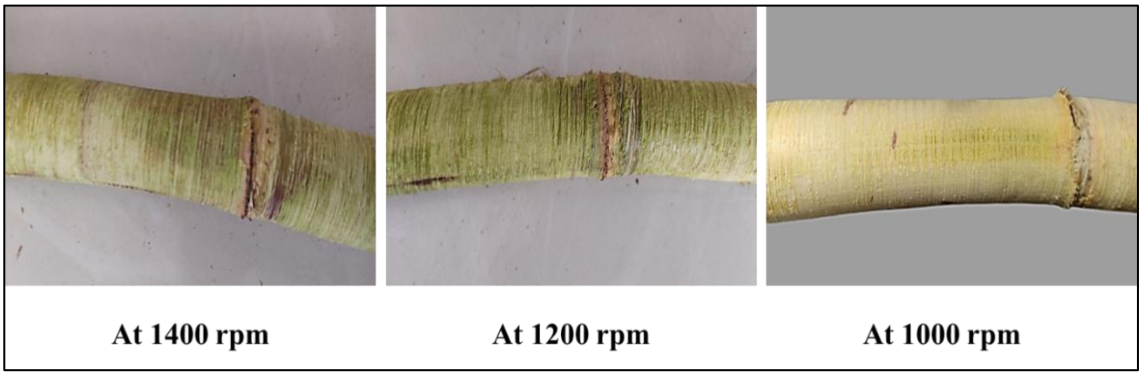


Fig. 3: Peeled cane at operation of 1400, 1200 and 1000 motor rpm

3.2 Through put capacity

Fig. 4 illustrates that the through put capacity of the machine varied between 670.39 canes/ day (8h) to 1167.09 canes/ day (8h). The minimum through put capacity i.e. 670.39 canes/ day(8h) was found at 1000 rpm and greater than 200 cm length of sugarcane whereas the maximum through put capacity i.e. 1167.09 canes/ day(8h) was found at 1400 rpm with length of sugarcane less than 200 cm as shown in fig 4. From the results, it was clear that as the length of sugarcane decreases the through put capacity of the machine increases whereas increase in length of sugarcane decreases the through put capacity. From figure it was also clear that as the speed decreased from 1400 to 1200 rpm, the through put capacity of the machine decreases and further decreasing the speed decreased the through put capacity of the machine. This might be due to the longer length of sugarcane takes higher time to push against the feeding rollers at lower speeds.

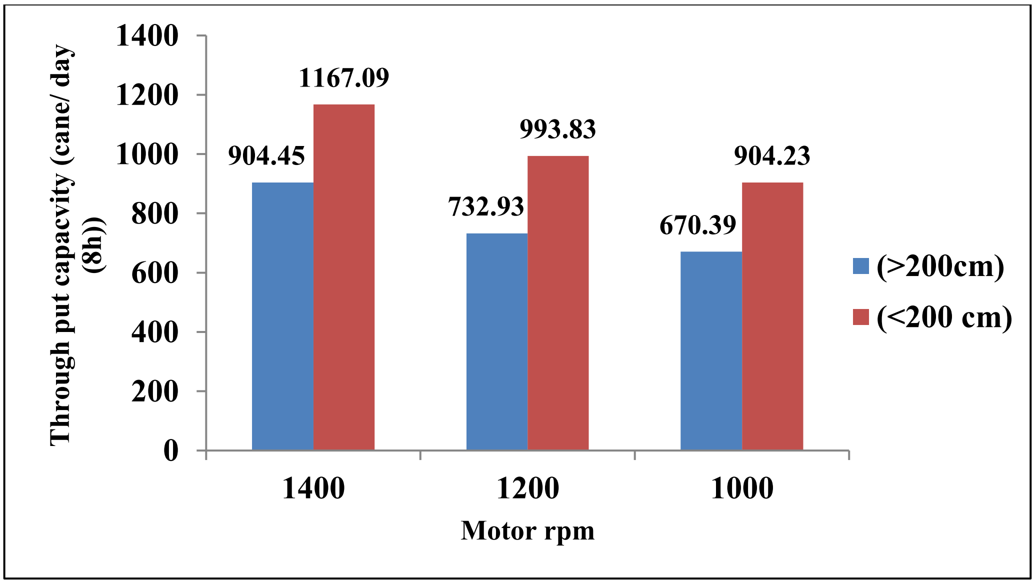


Fig. 4: Effect of independent parameters on through put capacity

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

3.3 Microbial load

Fig. 5 illustrates that the population of bacterial colonies varied from 6.04×10^5 to 15.1×10^5 CFU/ml. The colony forming units was obtained maximum 15.1×10^5 CFU/ml when the speed of the motor was 1400 rpm and length of the sugarcane greater than the 200 cm while the colony forming unit was obtained minimum 6.04×10^5 CFU/ml when the speed of the motor was 1000 and length of the sugarcane less than 200 cm. From fig. 5 it is clearly shown that when motor rpm was reduced from 1400 to 1200 rpm the population of bacterial colonies was also reducing with it and if the rpm of the motor decreased further the population of bacterial colonies is found to be decreased.

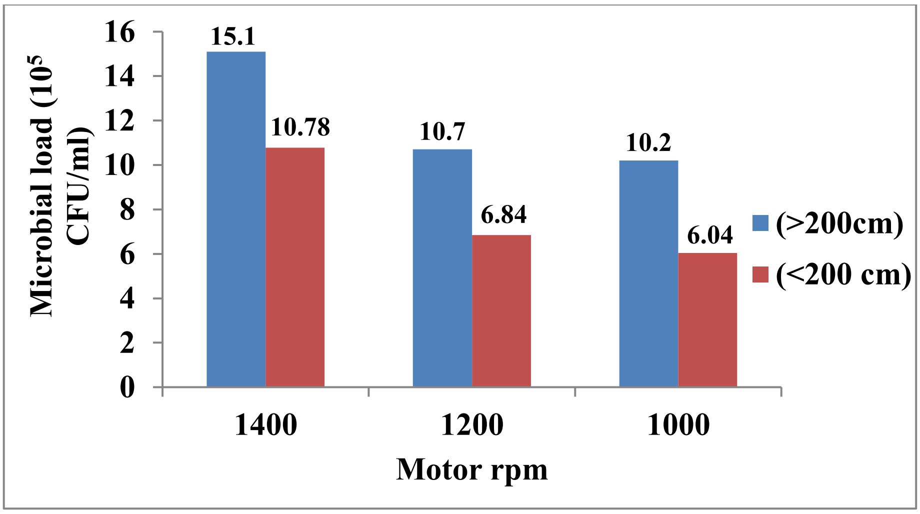


Fig. 5: Effect of length of sugarcane and motor rpm on microbial load

3.4 Effect of length of sugarcane on dependent parameter through Anova table

The statistical analysis of the data was done using SPSS software. From the Anova Table 5, it is clearly shown that there is a significant effect of length of sugarcane on peeling efficiency (%), microbial load (10^5 CFU/ ml), and through put capacity (cane/day(8h)) at 5% level of the significant the p value of all dependent parameter of less than 0.002 was observed.

Table 5 ANOVA Table for effect of sugarcane length on dependent parameter

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Length of sugarcane	Peeling efficiency (%)	86.700	1	86.700	12.688	.002
	Microbial load	12689.633	1	12689.633	19.800	<.001
	Through put capacity	478034.474	1	478034.474	30.363	<.001

3.5 Effect of motor rpm on dependent parameter through Anova table

From the ANOVA Table 6, it is indicated that there is significant effect of motor rpm on peeling efficiency (%), through put capacity (cane/day (8h)) and microbial load (10^5 CFU/ ml), at 5% level of the significant the p value of all dependent parameter of less than 0.001 was observed.

Table 6 ANOVA Table for effect of motor rpm on dependent parameter

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Motor rpm	Peeling efficiency (%)	168.467	2	84.233	12.327	<.001
	Microbial load	13681.267	2	6840.633	10.674	<.001
	Through put capacity	324109.783	2	162054.892	10.293	<.001

3.6 Comprehensive effect of sugarcane length and motor rpm on dependent parameter through Anova table

The comprehensive effect of length of sugarcane and motor rpm indicated in the Table 7, it was observing that the comprehensive effect of length of sugarcane and motor rpm on peeling efficiency (%), through put capacity (cane/day (8h)) and microbial load (10^5 CFU/ ml) significant at par. with p value of (0.224, 0.979 and 0.959), respectively.

Table 7 ANOVA Table for comprehensive effect of sugarcane length and motor rpm on dependent parameter

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Length × Motor rpm	Peeling efficiency (%)	21.800	2	10.900	1.595	.224
	Microbial load	27.267	2	13.633	.021	.979
	Through put capacity	1304.454	2	652.227	.041	.959

3.7 Analysis of quality parameters for extracted sugarcane juice

3.7.1 Total soluble solid

The table 8 compares manually peeled sugarcane juice with machine peeled sugarcane juice. On average, manually peeled juice yielded higher values (23.75) compared to machine peeled juice (22.01).

Table 8 TSS content of sugarcane juice

S.No.	Manually peeled sugarcane juice	Machine peeled sugarcane juice
1	26	24
2	25.4	22.8
3	19.85	19.25
Mean	**23.75**	**22.01**

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

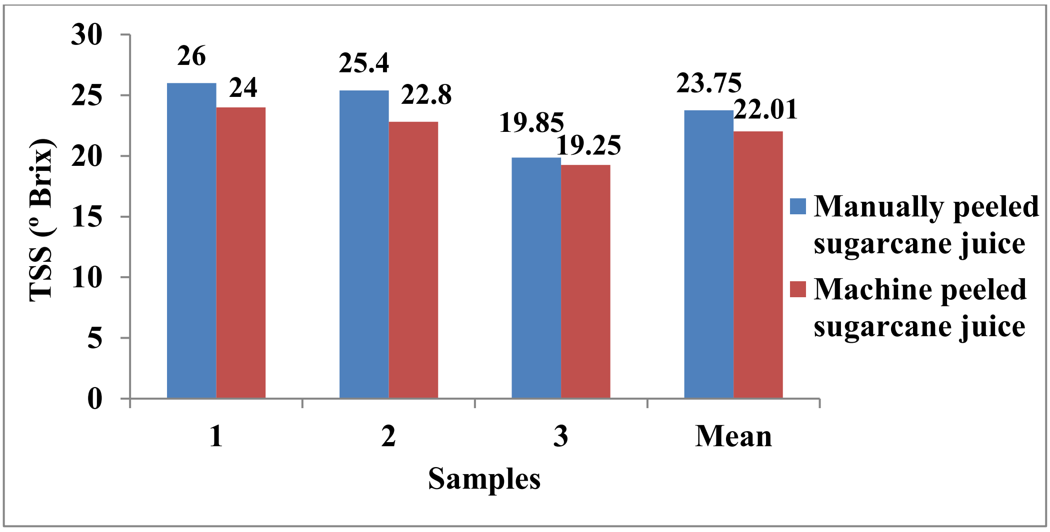


Fig. 6: Relation between manually peeled and machine peeled sugarcane juice (TSS)

3.7.2 Microbial load

The samples of manually peeled and machine peeled sugarcane juice were packed in sterile low density zip lock polythene bag. The bacterial colonies of collected samples were calculated using serial dilution method. After inoculation, dishes were incubated at 37°C for 48h and colony forming units per ml of sugarcane juice were calculated. Fig. 6 illustrates that the population of bacterial colonies in sample I were found 16 x 10^5 and 1.2x10^5 CFU/ml for type of sample R_1 and R_2 respectively. For sample II population of bacterial colonies were found 12.3 x 10^5 and 2.5x10^5 CFU/ml for type of sample R_1 and R_2 respectively. Similarly, population of sample III bacterial colonies were found 15 x 10^5 and 3.2x10^5 CFU/ml for type of sample R_1 and R_2 respectively. The variation in bacterial colonies were found due to the manually and machine peeled sugarcane juice because the machine peeled the sugarcane uniformly and the efficiency of the machine is also high whereas manually peeled sugarcane is not uniformly peeled and less efficient as compare to the machine method.

Table 9 Data of microbial load in manually and machine peeled sugarcane juice

Type of juice	**SAMPLES**		
	Sample I	**Sample II**	**Sample III**
Manually peeled (R1)	16 x 10^5	12.3 x 10^5	15 x 10^5
Machine Peeled (R2)	1.2x10^5	2.5x10^5	3.3x 10^5

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

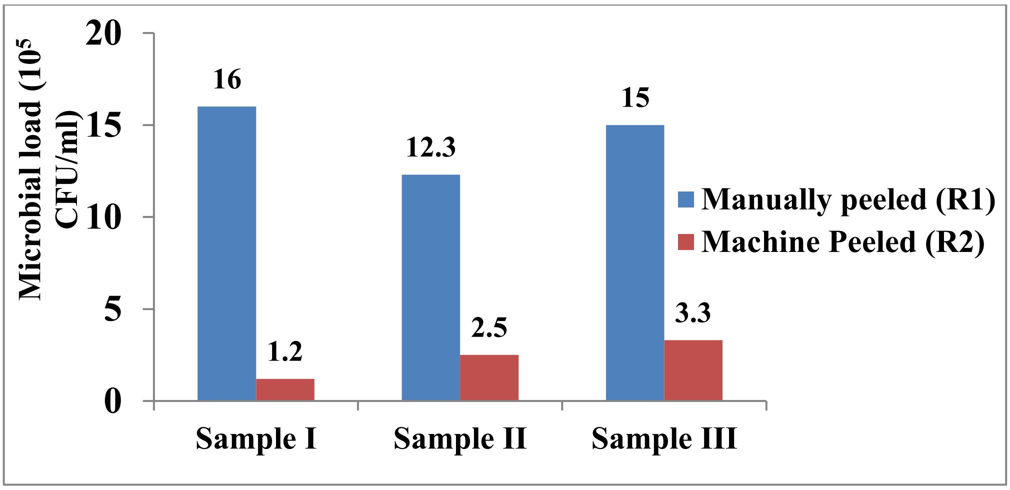
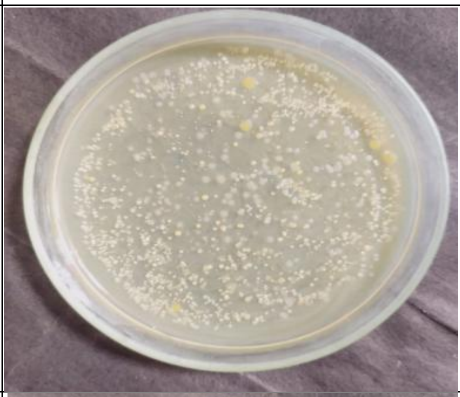
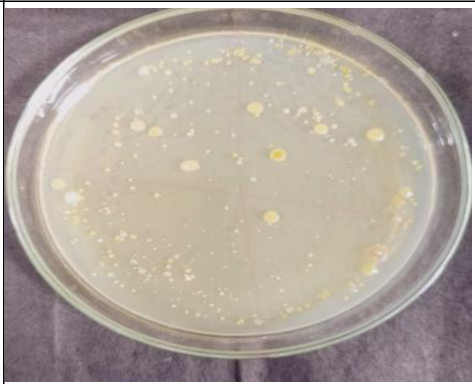
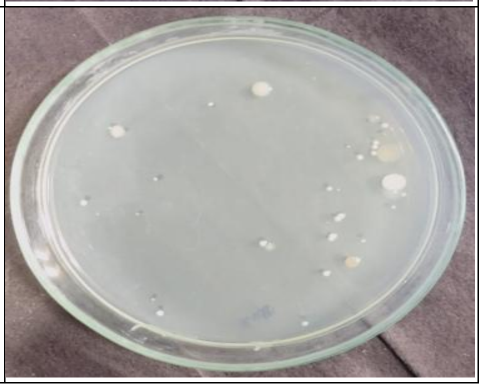
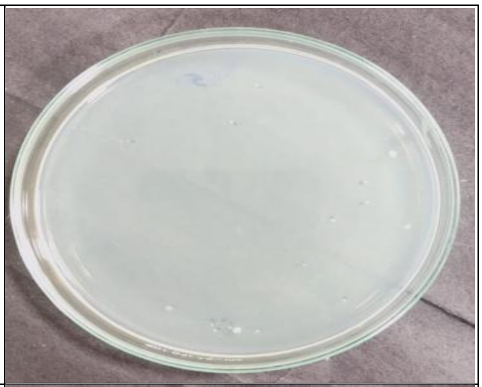
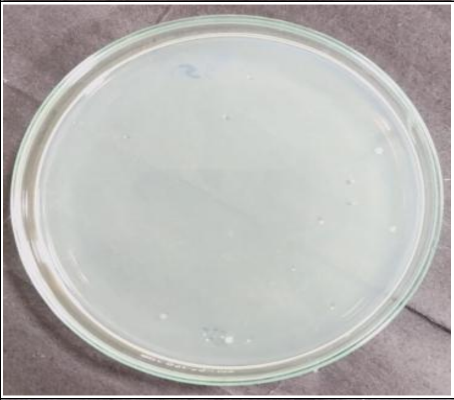
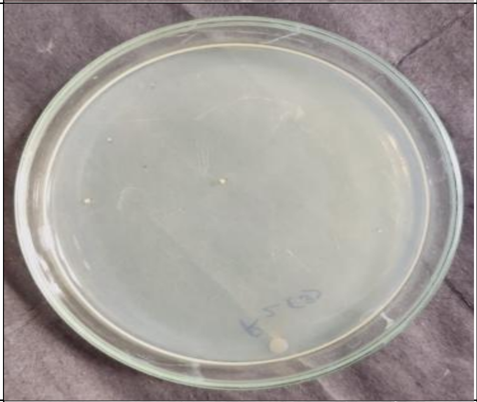
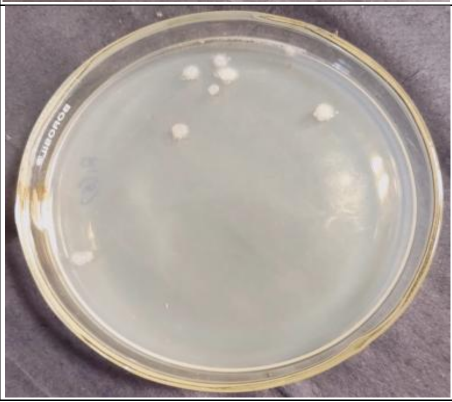


Fig. 7: Relation between manually peeled and machine peeled sugarcane juice (Microbial load)

Table 10 Comparison of bacterial population (CFU/ml) between manually peeled and machine sugarcane juice

Dilution No.	Serial dilution plating of manually peeled sugarcane juice sample	Dilution No.	Serial dilution plating of machine peeled sugarcane juice sample
C R1		C R2	
10^3		10^3	

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

10^4		**10^4**	
10^5		**10^5**	
10^6		**10^6**	

3.7.3 Sensory evaluation of the juice

Sensory evaluation of the samples between two treatments was done against sugarcane juice. The selection of both the treatments was done based on the method of the peeling operation of the sugarcane. The first sample of juice collected which was extracted by manually peeled sugarcane and the second sample of juice collected which was extracted by machine peeled sugarcane. The two samples were compared by panel of 10 judges. The sample were served to judges who recorded their observations on the average acceptability score card with coded and encoded samples as shown in table 10. The similar method was adopted by **(Sivakumar, *et al.* 2007)**.

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ Research Article

Table 11 Sensory evaluation scores of samples

Sensory attributes	Coded samples	
	R1	**R2**
Taste	6.10	8.30
Color	5.80	8.10
Overall acceptability	5.95	8.20

Encoded samples: R1= Manually peeled sugarcane juice, R2= Machine peeled sugarcane juice

The best sample was adjudged to be code-R2, which is highly significant over the sample code-R1. Based on the sensory evaluation the sugarcane juice peeled by the machine was considered to the best.

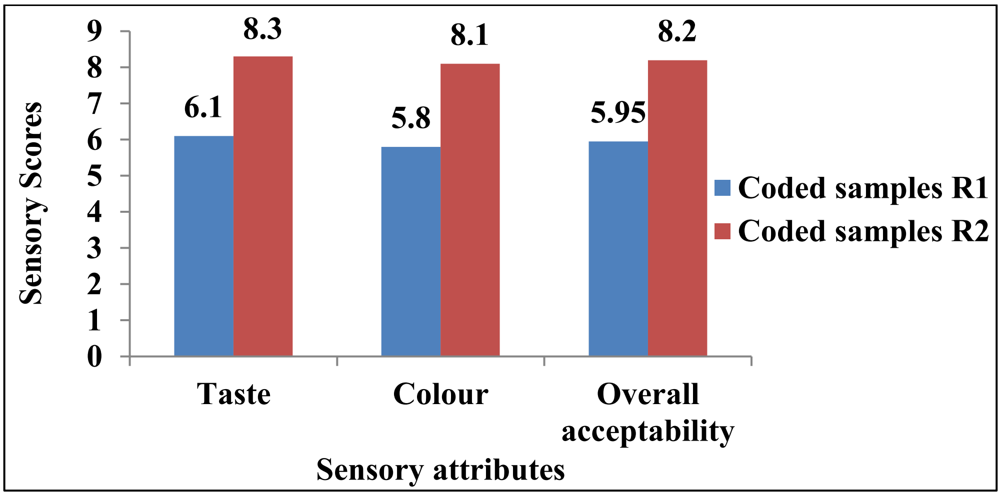


Fig. 8: Relation between manually peeled and machine peeled sugarcane juice (Sensory evaluation)

Table 12 Comparison of colour between manually and machine peeled sugarcane juice

Manually peeled sugarcane juice (R1)	Machine peeled sugarcane juice (R2)

Conclusion

A sugarcane peeling machine suitable for small-scale juice vendors was successfully developed and evaluated. The performance of the machine was assessed in terms of peeling efficiency, throughput capacity, and microbial load, and the results were compared with those obtained from manual peeling. Additionally, juice extracted from machine-peeled canes was analyzed for quality parameters including total soluble solids, microbial load, and sensory attributes.

The results indicated that peeling efficiency varied with operational conditions. The maximum peeling efficiency of 83.6% was achieved at a motor speed of 1000 rpm with sugarcane lengths less than 200 cm, while the minimum efficiency of 74.4% was observed at 1440 rpm with cane lengths greater than 200 cm. Throughput capacity was highest (1167.09 canes/day for 8 hours) at 1440 rpm and longer cane lengths, whereas the lowest capacity (670.39 canes/day for 8 hours) was recorded at 1000 rpm with shorter canes.

Microbial analysis revealed that bacterial load increased with higher motor speed and longer cane lengths, with a maximum count of 15.1×10^5 CFU/ml at 1440 rpm and a minimum of 6.04×10^5 CFU/ml at 1000 rpm. Overall evaluation demonstrated that the optimal operating condition for the developed machine was at 1000 rpm with sugarcane lengths below 200 cm. Under these conditions, the machine achieved a balanced performance with high peeling efficiency (83.6%), satisfactory throughput capacity (109.4 kg/h or 113 canes/h), minimal microbial load (6.4×10^5 CFU/ml), and high consumer acceptability (sensory score of 8.2).

Thus, the developed sugarcane peeling machine proves to be an efficient, hygienic, and practical solution for small-scale vendors, offering improved performance over traditional manual peeling methods.

Funding

This study was conducted without any specific financial support or external grant from public, commercial, or not-for-profit funding agencies. All experimental work, material procurement, and analyses were completed using available institutional facilities and resources.

Conflict of Interest

The authors declare that there are no conflicts of interest, financial or otherwise, that could have influenced the results, interpretation, or presentation of this research.

Data Availability

All data generated and analyzed during this study are included in this article. Additional supporting data or information may be obtained from the corresponding author upon reasonable request.

References

[1] Cane growers (2012). Cane growers Australia Annual Report 2011/2012. Tingalpa, QLD, Australia: Harding Colour.
[2] Chai, K.M., Xuan, A.Z., Yahya, M.S., Ismail, S., and Wagiman, A. (2022). Modified sugarcane peeler. *Multidisciplinary Applied Research and Innovation*, 3(1): pp. 664-671.
[3] Dehui, Z. (2015). Design of sugarcane peeling machine based on motion controller. *Advance Journal of Food Science and Technology,* 7(10): pp. 824-826.

Journal of Information Systems Engineering and Management
2024, 9(1)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

[4] Kadam, S.J., Sutar, S., Shinde, P., Shelke, and K., Patil, A. (2018). Design and fabrication of sugarcane peeling machine. *National Conference on 'Emerging Trends in Engineering and Technology'*. pp. 480-486.

[5] Kepner RA, Bainer R, Barger EL (1985). Principles of farm machinery. CBS Publishers and Distributors, New Delhi, India.

[6] Kohli, G., Jain, G., Bisht, A., Upadhyay, A., Kumar, A., and Dabir, S. (2019). Effect of non-thermal hurdles in shelf life enhancement of sugarcane juice. *Lwt*, 112: pp. 108-233.

[7] Pandraju, S., Madhava, M., Amith Padhi, G. G., Indira, M., Lavanya, T., Pavan Kalyan, K., and Subramanyam Sarma, A. (2021). Development of low cost sugarcane peeler for small vending's. *The pharma innovation journal,* 10(3): pp. 248-253.

[8] Sivakumar, P., Ray, R., Panda, S., and Naskar, S. (2007). Application of principal components analysis for sensory characterization of sweet potato curd. *Journal of Root Crops*, *33*(1): pp. 62-66.

[9] Stevenson, W. J., Hojati, M., and Cao, J. (2014). *Operations management* New York McGraw-Hill Education: pp. 182.

[10]Tagare, V.S., Patil, V.B., Talaskar, S.P., and Wadar, S.D. (2013). Design and manufacturing of sugar cane peeling machine. *International journal of advanced scientific and technical research,* 3(3): pp. 70-83.

[11] Xinfeng, G. (2015). Design of sugarcane peeling machine. *Advance Journal of Food Science and Technology*, 7(6): pp. 398-400.

[12]Chiawchanwattana, C., Laohavanich, J., Vipattanaporn, C., Senasuthum, R., & Yangyuen, S. (2024). Design and fabrication of a sugarcane abrasive peeling machine. *Agricultural and Biological Engineering*, *1*(1), 13-18.