

Research Article

Design and Development of a Batter Mixing Machine for Khanom La to Preserve Local Wisdom and Enhance Community Sustainability

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Abstract

This research aimed to design and develop a batter mixing machine for Khanom La production in order to reduce the time required for batter preparation, while preserving local wisdom and supporting sustainable community development. The designed machine consists of four main components: the machine frame, the power transmission system, the stirring unit, and the automatic timer control system. The paddle stirrer was selected because it is suitable for low-speed mixing. Open spaces were incorporated into the stirrer design to reduce batter viscosity during the mixing process. The study then compared the mixing time and mixing capacity of manual labor with those of the developed batter mixing machine based on three repeated trials. Manual mixing required an average of 40.00 minutes to mix 10 kilograms of batter, resulting in an average mixing capacity of 15.15 kilograms per hour. In contrast, the developed machine took an average of 13.33 minutes, with an average mixing capacity of 46.06 kilograms per hour. The difference in mixing capacity between manual labor and the machine was analyzed using a Independent Samples t-test at a significance level of 0.05. The results showed a p-value of 0.014, which was lower than the significance level of 0.05, indicating a significant difference between the two methods. The findings demonstrate that the batter mixing machine operated 3.04 times faster than manual labor at the 0.05 significance level, which reduced the production time of Khanom La for the community.

Keywords: Batter Mixing Machine, Khanom La, Paddle Stirrer, Local Wisdom Preservation

Introduction

The Tenth Lunar Month Festival (or Sart Ducean Sip) is a long-standing cultural tradition in southern Thailand, particularly in Nakhon Si Thammarat Province, where cultural heritage has been continuously preserved and passed down through generations. One important practice during the festival is the preparation of traditional desserts known as “Mmu Rub.” Popular items included in the Mmu Rub are Khanom La, Khanom Pong, Khanom Dee Sum, Khanom Ba, and Khanom Kong. These traditional desserts reflect local wisdom and also serve as a form of soft power that adds economic value through the promotion of long-held cultural beliefs and regional identity. Each dessert carries its own symbolic meaning. Khanom La represents clothing and textiles offered to ancestors, Khanom Pong symbolizes rafts or boats used by ancestors to cross the great ocean, Khanom Dee Sum represents money for daily use, Khanom Ba symbolizes the traditional game balls used during the Songkran festival, and Khanom Kong represents decorative jewelry and ornaments for the body [1].

Khanom La is one of the traditional desserts prepared for the Tenth Lunar Month Festival. One of the most well-known production areas is Ban Hoi Rak Community. At present, the community has approximately 15–20 groups that produce Khanom La. Each package is sold for around 30–50 baht, while La sheets are priced at approximately 120 baht per kilogram, depending on size and quality. The production of Khanom La generates an average monthly income of 15,000–30,000 baht per household. As a result, Khanom La production has become both a primary occupation and an important source of income for the Ban Hoi Rak Community. The production process begins with raw material preparation. Fine and clean rice flour is selected and mixed with palm sugar and water in appropriate proportions. Rice grains are then soaked in water for approximately 3–4 days until softened. After that, the soaked rice is processed in a grinding machine to produce rice batter. The batter is filtered through a thin white cloth to obtain a smooth texture. Once the batter settles, it is wrapped in cheesecloth and pressed to remove excess moisture. The dried flour is then transferred to a mixing machine, where honey is added to improve the flavor. Before the batter can be used, it must be stirred thoroughly each time to prevent the ingredients from separating or forming lumps. This process takes approximately 40 minutes per cycle before the batter is further processed into Khanom La.



Figure 1 Traditional Khanom La batter mixing by manual labor

Based on the production conditions of Khanom La in Ban Hoi Rak Community, manual batter mixing has been identified as a key issue affecting both production efficiency and the quality of life of producers. Hand

mixing requires considerable physical effort and takes a long continuous period of about 40 minutes per 10 kilograms of batter. The daily production volume varies depending on customer demand, while orders increase significantly during the Tenth Lunar Month Festival. This leads to fatigue among producers, limits production capacity, and prevents them from meeting rising market demand. As a result, income opportunities are reduced. At present, there is also no suitable batter mixing machine for Khanom La production that fits the community context while maintaining product quality.

Improving production efficiency through the design of appropriate machinery can enhance productivity, reduce processing time, and help maintain product quality. In the industrial sector, [2] designed a solar-powered palm sugar stirring machine and compared it with manual labor, finding that the machine reduced stirring time by up to 58 percent compared with traditional methods and also helped reduce worker fatigue. [3] developed a gas-fired filling stirring machine for curry puff production in community settings, which reduced mixing time and manual labor requirements, improved ingredient homogeneity, increased production capacity, and generated higher income for farmer groups. [4] developed a fruit processing stirring machine suitable for elderly users in a community enterprise in Ban Pa Suan, which reduced the workforce by one person, eased physical effort, and shortened working time, leading to lower gas consumption and reduced operating costs per production cycle. [5] designed a rice mixing machine and tested optimal speed and mixing time, which increased production capacity at the same labor level and reduced electricity consumption. [6] developed a dough kneading machine for small and medium enterprises to improve production efficiency by applying a bidirectional rotational system along a single axis, achieving a kneading efficiency of 90.65 percent. Similarly, [7] designed a dough mixing machine for bread production capable of processing 31.90 kilograms per hour at 280 rpm, with an efficiency of 94.70 percent, taking into account the properties of mixed dough. [8] designed and simulated a dough mixing machine to reduce cost and processing time, using Fusion 360 software to analyze structural performance. In the chemical industry, [9] designed and constructed a mixing machine for cosmetic and cleaning products to control product quality and increase production capacity to meet market demand. The system used a paddle impeller and produced 57.85 liters per hour, increasing output by 64.36 percent with a payback period of 0.6 years. In the agricultural sector, [10] developed a semi-automatic chitosan mixing machine for community use, which received the highest level of user satisfaction in terms of usability and safety. The machine could process 20 liters in 2 hours, operate continuously for 6–8 hours per day, reduce production costs, and allow easy mobility and use. [11] designed a horizontal compost mixing machine using a rotating ribbon-type blade system to improve mixing efficiency in community fertilizer production. The evaluation of dispersion performance showed a coefficient of variation below 5 percent, with 1.74 percent at 3 minutes and 3.5 percent at 4 minutes. [12] also studied the efficiency of fertilizer mixing blades for farmers. Overall, improving production processes through machinery reduces labor requirements, lowers production costs, and decreases work-related fatigue. However, the mixing blades used in commercially available mixers may not suit Khanom La batter, as the batter has a high level of viscosity. The project team studied, researched, and developed a batter mixing machine for Khanom La production that is suitable for the Ban Hoi Rak community. The objective was to improve efficiency in the Khanom La production process and reduce the risk of injury among producers, which would lead to increased output, higher income, and a sustainable improvement in the quality of life of Khanom La producers in the community.

Objectives

1. To design and build a batter mixing machine for Khanom La production.
2. To study the efficiency of the batter mixing machine for Khanom La.
3. To support the preservation of local knowledge and enhance the community economy in a sustainable way.

Research conceptual framework

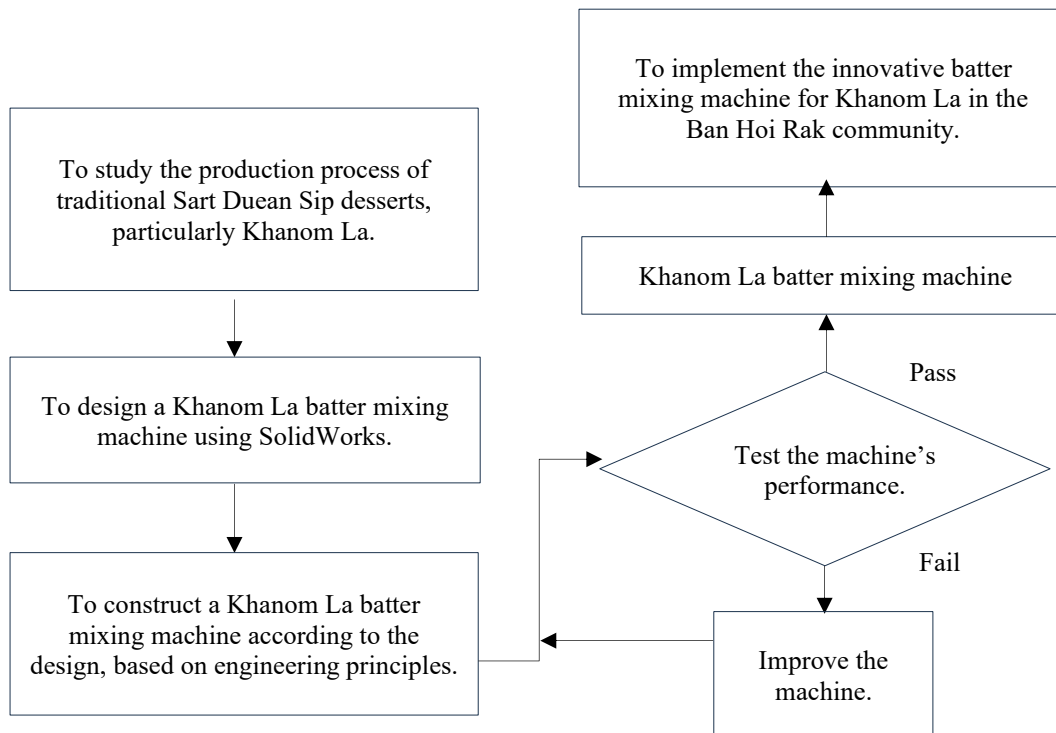


Figure 2 Conceptual framework of the research

Research methodology

1. Study relevant theories and research related to the chemical and food properties of flour, the production process of Khanom La batter, electric motors, stirring blades, and related studies.
2. Design a Khanom La batter mixing machine using SolidWorks software.
3. Plan the manufacturing steps of the Khanom La batter mixing machine using an operation process chart (OPC).
4. Construct the Khanom La batter mixing machine based on engineering principles.
5. Test the performance of the machine by measuring the mixing time for Khanom La batter in three trials, each using 10 kilograms of batter, and then calculate the mean and standard deviation of the mixing time.
6. Compare the mixing efficiency between manual labor and the machine using statistical analysis with Independent Samples t-test at a 0.05 level of significance.
7. Summarize the experimental results and submit them for innovation registration.

8. Transfer knowledge and provide instructions on how to use the Khanom La batter mixing machine to the Ban Hoi Rak community.

Results

1. Results from the design and construction of the Khanom La batter mixing machine

The Khanom La batter mixing machine was designed using software and then constructed based on engineering principles, as shown in Figure 3. The designed machine consists of four main components: the structural frame, the power and transmission system, the mixing blade assembly, and the automatic timing control unit. The details of the machine design are presented below.



Figure 3 Khanom La batter mixing machine

The structural frame was designed using stainless steel. It has a height of 100 cm and a width of 86 cm. A single 70 cm round steel pipe was used and formed into the frame structure of the mixing machine.

The power unit serves as the energy source for the machine operation. It uses a 0.5 horsepower electric motor, and the rotational speed of the mixing blade can be calculated using Equation 1. A control box regulates the electrical voltage at 220 volts. The transmission system transfers power from the motor to the mixing shaft. Its main components include a belt, pulleys, a shaft, and pillow block bearings.

The mixing blade assembly was designed as a paddle stirrer, which is suitable for low-speed mixing. Gaps were added within the blade structure to reduce the viscosity of the batter and improve heat transfer during mixing. The blades were made from stainless steel 304 and ensured that the Khanom La batter mixed evenly throughout the process. The main component is the stirring shaft, which has a width of 20 cm and a length of 20 cm.

The automatic timer control unit regulates the operating time of the motor. Users can set the desired time, up to a maximum of 60 minutes. Once the system starts, the timer counts down and keeps the motor running continuously until the set time has elapsed. The system then automatically cuts off the power, stopping the motor. This helps ensure consistent mixing and reduces user error.

The rotational speed of the mixing blade assembly is calculated using Equation 1. The system uses a 0.5 horsepower motor with a speed of 1,450 rpm. The driving pulley had diameters of 2.0 inches (d_1) and 2.5 inches (d_3), while the driven pulley had diameters of 12.0 inches (d_2) and 12.0 inches (d_4). The speed of the driving pulley (n_1) is 1,450 rpm. The rotational speed of the mixing blade assembly (n_4) can then be determined, as illustrated in Figure 4.

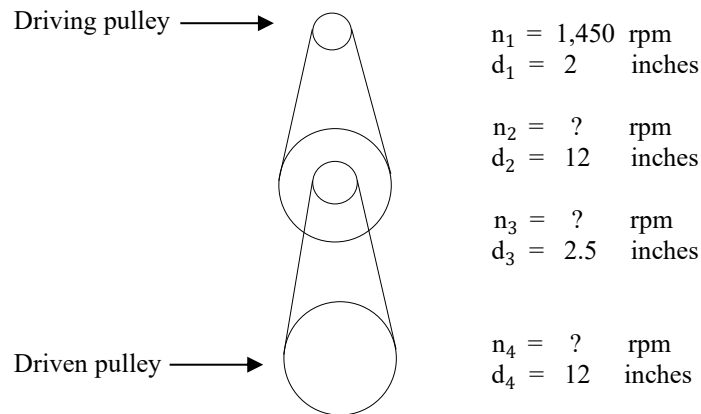


Figure 4 Calculation of the rotational speed of the mixing blade assembly

$$n d_{\text{driving pulley}} = n d_{\text{driven pulley}} \quad \dots (1)$$

Where:

$d_{1,3}$ = diameter of the driving pulley (inches)

$d_{2,4}$ = diameter of the driven pulley (inches)

n_1 = the speed motor of the driving pulley (revolutions per minute)

n_2 = the speed motor of the driven pulley (revolutions per minute)

n_3 = the speed mixing blades of the driving pulley (revolutions per minute)

n_4 = the speed mixing blades of the driven pulley (revolutions per minute)

Substituting the values:

$$\begin{aligned}
 n_1 d_1 &= n_2 d_2 \\
 n_2 &= \frac{n_1 d_1}{d_2} \\
 n_2 &= \frac{1450 \times 2}{12} \\
 n_2 &= 242 \text{ rpm} \\
 n_3 d_3 &= n_4 d_4 \\
 n_4 &= \frac{n_3 d_3}{d_4} \\
 n_4 &= \frac{242 \times 2.5}{12} \\
 n_4 &= 50 \text{ rpm}
 \end{aligned}$$

Therefore, the rotational speed mixing blades of the driven pulley (n_2) is 50 rpm, using a 0.5 horsepower motor.

2. Operation Process Chart (OPC) and Engineering Principles Applied in the Construction of a Khanom La Batter Mixing Machine

The operation process chart for the Khanom La batter mixing machine begins with defining the scope of the production process, from the design stage to the assembly of the machine structure. The process is then analyzed and divided into sequential operations, such as cutting, turning, welding, and assembly. Standard symbols are used to represent each type of activity, allowing the overall process to be presented clearly and supporting improvements in production efficiency. In addition, the chart assists in the systematic analysis of waste reduction and product quality enhancement, as shown in Figure 5.

3. Performance Evaluation Results of the Khanom La Batter Mixing Machine

The researchers evaluated the performance of the Khanom La batter mixing machine by examining the time required for batter mixing and comparing its mixing efficiency with manual labor. Electrical energy consumption was also taken into consideration during the evaluation.

3.1 Mixing Time and Performance of the Khanom La Batter Mixing Machine

The mixing time of Khanom La batter was tested using two methods: manual labor and the batter mixing machine developed through the design process. Each trial used 10 kilograms of batter and was conducted in three repetitions. The results were then analyzed to determine the mean and standard deviation, as presented in Table 1. After the design and development of the batter mixing machine, the operational procedure was carried out as outlined in the process chart.

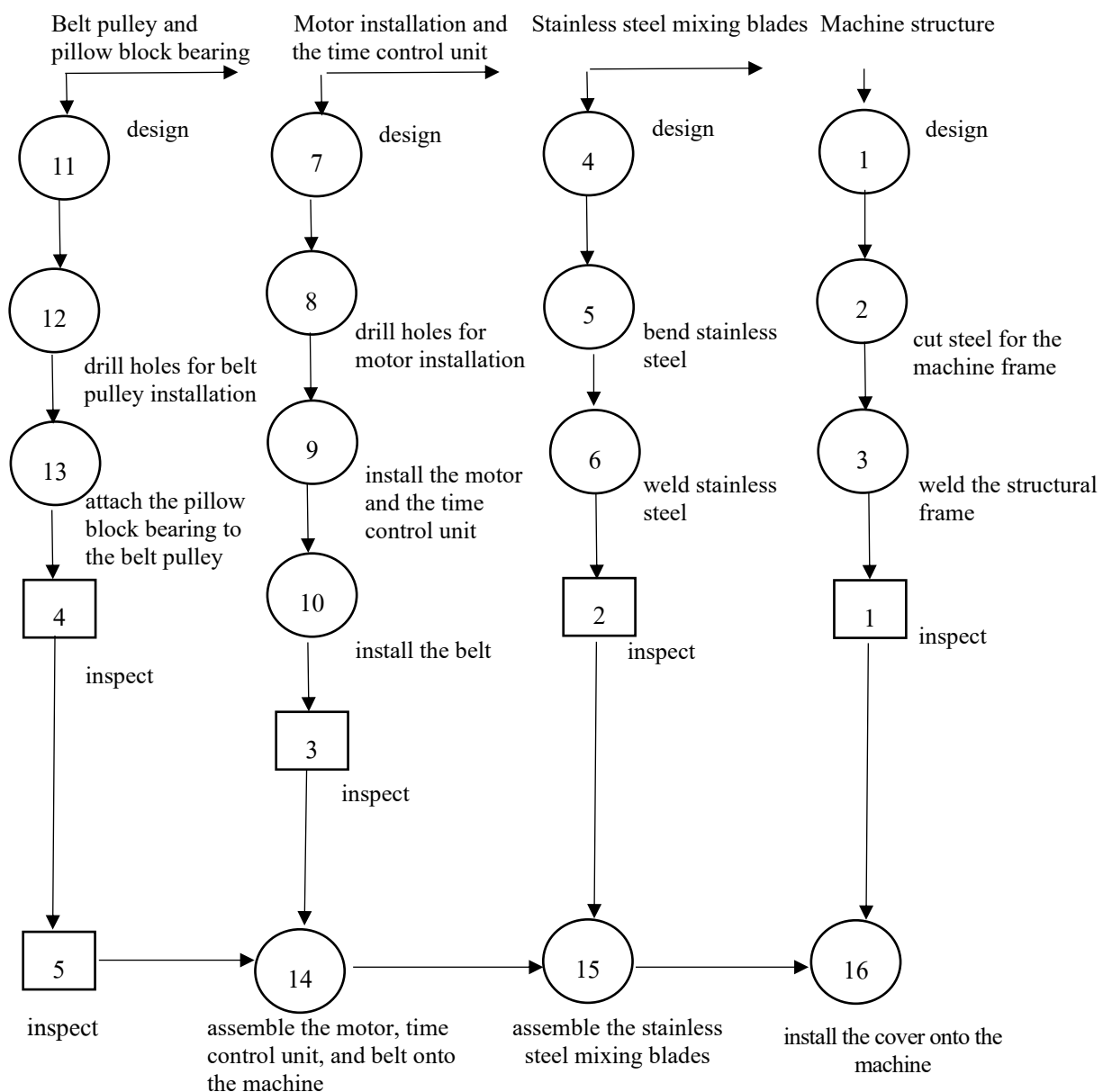


Figure 5 Operation Process Chart of the Khanom La Batter Mixing Machine

Table 1 Mixing Time and Performance of the Khanom La Batter Mixing Process

Trial	Manual labor		Khanom La batter mixing machine	
	Mixing time (minutes)	Mixing capacity (kg/h)	Mixing time (minutes)	Mixing capacity (kg/h)
1	35.00	17.14	16.00	37.50
2	40.00	15.00	13.00	46.15
3	45.00	13.33	11.00	54.54
Mean	40.00	15.15	13.33	46.06

Based on Table 1, the mixing time and capacity of Khanom La batter were tested using two methods: manual labor and the designed batter mixing machine. For manual labor, the average time required to mix 10 kilograms of batter was 40.00 minutes, resulting in an average mixing capacity of 15.15 kg/h. In contrast, the designed machine took an average mixing time of 13.33 minutes, with an average capacity of 46.06 kg/h. The machine therefore operated 3.04 times faster than manual labor. The viscosity was then measured with a DV2T Brookfield viscometer, and it was found that the batter's viscosity decreased from 14,213 cP to 2,847 cP, which was within the acceptable range set by the community requirements. This improvement helps the Ban Hoi Rak community, Hu Long Subdistrict, Pak Phanang District, Nakhon Si Thammarat Province, reduce production time in Khanom La processing. The machine also provides continuous and consistent mixing, leading to better batter quality and a finer texture, while also contributing to energy savings in the production process.

3.2 Electrical Energy Consumption of the Khanom La Batter Mixing Machine

In applying the Khanom La batter mixing machine to the production process, the research team calculated its electrical energy consumption by considering the total power usage of all electrical components in the machine, which amounted to 379 watts. The calculation also used the average electricity tariff of the Provincial Electricity Authority, approximately 3.98 baht per unit. The results of the electrical energy consumption are presented in Table 2.

Table 2 Electrical Energy Consumption of the Khanom La Batter Mixing Machine

Trial	Mixing time		Electrical energy consumption	
	minutes	hour	baht per cycle	baht per hour
1	16.00	0.27	0.41	1.51
2	13.00	0.22	0.33	
3	11.00	0.18	0.27	
Mean	13.33	0.22	0.34	

According to Table 2, the electrical energy consumption of the Khanom La batter mixing machine shows that the amount of batter used depends on customer demand during each production period. For each mixing cycle using 10 kilograms of batter, the average electricity cost is 0.34 baht per cycle, equivalent to 1.51 baht per hour. The results indicate that the use of the Khanom La batter mixing machine can improve production speed while maintaining a low electricity cost of 1.51 baht per hour.

3.3 Analysis of Differences in Batter Mixing Performance

The comparison of batter mixing performance between the machine and manual labor was conducted using statistical analysis based on Independent Samples t-test at a significance level of 0.05, with the statistical software. The results are shown in Figure 6, and the hypotheses for testing differences in mixing performance are presented as follows.

$$H_0: \mu_p = \mu_m$$

$$H_1: \mu_p \neq \mu_m$$

Where: μ_p Mean mixing capacity using manual labor (kg/h)

μ_m Mean mixing capacity using the mixing machine (kg/h)

Independent Samples t-test: Person, Machine				
Source	N	Mean	StDev	SE Mean
Person	3	40.00	5.00	2.90
Machine	3	13.33	2.52	1.50
T-Value	8.250			
P-Value	0.014			

Figure 6 Results of Statistical Analysis at a Significance Level of 0.05

As shown in Figure 6, the analysis of differences in mixing performance between the machine and manual labor was conducted using Independent Samples t-test at a significance level of 0.05. The results show a p-value of 0.014, which is lower than the significance level of 0.05. This indicates a statistically significant difference in mixing performance between the two methods, confirming that the mixing machine operates faster than manual labor at the 0.05 significance level.

Summary and Discussion of Research Findings

Ban Hoi Rak Community, Hu Long Subdistrict, Pak Phanang District, Nakhon Si Thammarat Province, is well known for producing Khanom La, a traditional dessert associated with the Sart Duean Sip festival. The production process relies heavily on manual labor, particularly during the batter mixing stage, which requires continuous stirring and considerable physical effort. This results in a long processing time and high labor demand. To address this issue, a Khanom La batter mixing machine was designed and developed. The machine reduces mixing time and produces a more consistent batter texture compared with manual mixing. This approach aligns with the concept of applying machinery in food production processes to improve efficiency and reduce production time [2] [3] [4] [5] [11]. The developed machine is capable of continuous and consistent mixing without the need for constant human labor. It shortens the mixing time, improves batter quality, and produces a finer texture. It also contributes to energy savings in the production process.

The Khanom La batter mixing machine consists of four main components: the machine frame, the power and transmission unit, the mixing blades, and the automatic time control unit. The results from testing the mixing time and capacity of Khanom La batter were compared between two methods: manual labor and the designed mixing machine. For manual labor, the average time required to mix 10 kilograms of batter was 40.00 minutes, resulting in an average

mixing capacity of 15.15 kg/h. In comparison, the designed machine required an average mixing time of 13.33 minutes, with an average capacity of 46.06 kg/h. The viscosity was then measured with a DV2T Brookfield viscometer, and it was found that the batter's viscosity decreased from 14,213 cP to 2,847 cP, which was within the acceptable range set by the community requirements. The average electrical energy cost was 0.34 baht per cycle, equivalent to 1.51 baht per hour. The results also show that the mixing machine operates 3.04 times faster than manual labor.

Research Recommendations

Future studies may place greater focus on energy consumption through the adoption of solar energy systems. This direction could also expand the scope of analysis to cover both economic and environmental impacts.

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References

1. Nakhon Si Thammarat Journal, Special Issue: "Duan Sip 51" Commemorating the Traditional Tenth Lunar Month Festival of Nakhon Si Thammarat Province. (2008). Nakhon Si Thammarat Provincial Administrative Organization; K.U. Quality Printing Co., Ltd., Songkhla.
<https://finearts.go.th/storage/contents/2023/05/file/dX4mBJJZtx0xJ9sL5y8FXXEZ0vmrFYHO8boJlZg.pdf>
2. Nutwarat K, Pranee T, Phinyapat S, Boonchub B. Case study and design the stirrer machine from solar energy for sugar jaggery. *Art and Architecture Journal Naresuan University*. 2021: 12(1): 121-132. <https://so01.tci-thaijo.org/index.php/ajnu/article/view/242126>
3. Ronnarit J, Athika C. The Development of a curry puff filling mixing machine using heat from liquefied petroleum gas (LPG) for community use. *Udon Thani Rajabhat University Journal of Sciences and Technology*. 2020: 8(1), 75-87.
<https://ph01.tci-thaijo.org/index.php/scudru/article/view/239973>
4. Pakin M, Weeraphat I, Sutthirat K, Thep K. The developments of fruit processing stirrer suitable machine for the elderly in Ban Pa Xuan fruit conserve community enterprise Group, Wang Hin, Mueang Tak District, Tak Province. *Proceedings of the National Academic Conference for Students, Kamphaeng Phet Rajabhat University, No. 1, 2021: 1053-1060*.
<https://research.kpru.ac.th/research2/pages/filere/11022021-03-06.pdf>
5. Amnad T, Pongtorn W. Design and test of horizontal rice mixer with ribbon stirring blade. *Academic Journal Uttaradit Rajabhat University*. 2022: 17(2): 37-54.
<https://ph01.tci-thaijo.org/index.php/uruj/article/view/248161>

6. Ojo O, Oyerinde A, Bamisaye O, Adewole J, Adepoju T. Development of dough kneading machine for small and medium-sized enterprises. *Journal of Applied Research in Technology & Engineering*. 2024; 5(1): 23-31.
<https://doi.org/10.4995/jarte.2024.20210>
7. Oni K, Akinmolayan O, Ige A M. Performance evaluation of dough mixing machine. *ABUAD Journal of Engineering Research and Development (AJERD)*. 2025: 8(2): 130-139.
<https://journals.abuad.edu.ng/ajer/article/view/926>
8. Fatah I Y A, Ramli N A, Rohimi R. Conceptual design and simulation analysis of dough mixer-maker machine. *Malaysian Journal of Applied Sciences*. 2022; 7(2): 93-102.
<https://doi.org/10.37231/myjas.2022.7.2.340>
9. Sittiboon S, Thunyatip S. Mixing machine for beauty product and liquid detergents. *Journal of Innovation Technology Research*. 2021: 5(2), 19-29.
<https://so04.tci-thaijo.org/index.php/JIT/article/view/253866>
10. Pakornkiat P, Nikom L, Asada W, Thiangtham S. Development of prototype semi-automatic chitosan stirrer for community. *Journal of Social Science and Cultural*. 2024: 8(7): 115-126.
<https://so06.tci-thaijo.org/index.php/JSC/article/view/275239/184347>
11. Supakanya K, Bhagavadi S. Design and Efficiency Assessment of Horizontal Fertilizer Mixing Machine. *UTK Research Journal*. 2025: 19(1): 100-105.
<https://ph02.tci-thaijo.org/index.php/rmutk/article/view/259072>
12. Pratama A T, Zuardi G. Performance enhancement of mixing impellers based on mixture ppm analysis. *Journal of Applied Agricultural Science and Technology*. 2025: 9(1): 70-84.
<https://doi.org/10.55043/jaast.v9i1.266>