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Corn Peeling and Coarse Grinding Machine to Make Chicken Feed

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Abstract **- Nowadays, farmers employ machinery to crack and crush corn kernels for animal feed, especially broilers and pigs, causing farmers to increase production costs. The purpose of this research was to design and fabricate a corn peeler with coarse grinding for chicken feed and to reduce the process of peeling and coarse grinding in the same machine. The machine has a width of 32 cm, a length of 49 cm, and a height of 185 cm. The design is divided into two parts, consisting of a base and a body. The base is a rectangular table with a width of 32 cm, a length of 67 cm, and a height of 65 cm. The body is a cylinder, with a height of 80 cm. and a diameter of 38 cm. Corn and blades are used to coarsely beat corn kernels. The performance test was performed at 120, 150, and 180 rpm. It was found that using 180 rpm was for good performance because the percentage of weight after peeling was the highest (83.5–85.8%) and the percentage of weight loss was the lowest (1.0–1.7%). Using the speed of 120 rpm, the percentage of crushed corn kernel weight was the highest, 5.3–6.9%. The weight loss was 1.8–2.2%. It was also found that using 150 rpm had 82.2% weight after cracking, which was higher than using 120 rpm but less than using 180 rpm. There were 3.8–4.5% crushed corn weight and 1.6–1.8% loss weight, which were higher than using 180 rpm but less than using 120 rpm.**

Index Terms **- Corn, Peeler, Coarse grinder, Animal feed**

INTRODUCTION

Animal feeding corn (Scientific name *Zea Mays* L.) is in the Gramineae family, common name is corn [1]. It is an important economic crop of Thailand. Farmers prefer to cultivate it in 2 seasons: the rainy season and during the rainy season, March-October, and harvest the produce around June-January of the following year, and the dry season will start planting during November-February and harvest the produce during March-April of the following year. Thailand has important cultivation areas in Phetchabun and Nakhon Ratchasima provinces. Nowadays, corn is used as the main raw material in the animal feed production industry which is continuously expanding in line with the growth of the livestock sector, especially broilers and pigs. There are more than 376,000 households who grow corn for animal feed across the country and there are also groups of corn entrepreneurs at various levels, many more whether it is a group of traders in field crops, the central market, exporters. Animal feed factory and animal husbandry [2] where the amount of corn production in Thailand is approximately 4 million tons per year. In the past year of 2020, Thailand had a production volume of corn for animal feed 4,995,169 tons, with a total planting area of 7,088,945 rai [3].

Nowadays, farmers employ machinery to separate corn kernels from the corncob and sell the corn kernels to mills by employing people with corn peeling machines causing farmers to increase production costs. It also causes farmers to lose both the opportunity to add value to the broken corn cob left behind. Currently, corn cobs are worth 1-2.5 baht per kilogram. As a result, there is no value for farmers as well [4]. Currently, researchers have developed several types of corn peeler, for example, a prototype of a small corn peeler with 2 shells with a diameter of about 10 cm. The machine dimension is 120*100*80 centimeters with a maximum working rate of 960 kilograms per hour by using an electric motor of 2 horsepower, 220 volts, etc. The highest cracking efficiency was 94.94% and the amount of broken kernels was 1.96% [5].

The research team had a prototype for a corn peeling and coarse grinding machine that they developed from the previously studied garlic peeling machine. A garlic peeling machine with the dimensions of 50 cm in width, 50 cm in length, and 85 cm in height was constructed that comprised a base, a tank having a diameter of 26 cm and a height of 35 cm which was lined with a durable rubber sheet, and a garlic peeling propeller. Installed under the tank to drive the propeller was a 3-phase electric motor. Operation of the garlic peeling machine. Once the garlic peeling machine was started, the motor served to drive the garlic peeling propeller to both remove the skin and produce an upward wind blowing it out of the tank. After being run for predetermined period, the machine was switched off, and the material was brought out of the tank for separation into intact and damaged garlic as well as the identification and removal of the remaining skin [6].

In addition to having to hire machinery to crack corn kernels then to be used as chicken feed, coarse grinding is required firs causing farmers to hire machinery to grind again. It increases the cost even more. The research team therefore foresaw such issues and looked for ways to help farmers reduce the cost of producing corn for animal feed by designing and developing a corn kernel cracker machine with coarse grinding to make chicken feed.

OBJECTIVES

I. To design and build a corn peeler with coarse grinding for chicken feed.
II. To reduce the process of cracking and rough grinding.

METHODOLOGY

I. Design and Fabrication of Corn Peeler with Coarse Grinding for Chicken Feed.

The corn peeler designed for coarse grinding for chicken feed measures 32 cm in width, 49 cm in length, and stands at a height of 185 cm. It comprises two main sections: the base and the body. Constructed from 1 ½ * 1 ½ inch angle steel, the base forms a rectangular table measuring 32 cm in width, 67 cm in length, and standing 65 cm high. The machine itself is fashioned from a 3 mm thick steel sheet, rolled into a specific configuration. A cylindrical component towers at 80 cm in height with a diameter of 38 cm. Positioned atop the machine is the corn compartment, designed in a trapezoidal shape, 40 cm in height and 35 cm in width. This compartment is intended to roughly pound corn kernels. It's affixed to a 1-inch shaft, connected to a belt pulley and a 2 hp motor situated beneath the body, serving as the power source to rotate the shaft. This rotation drives the blade to crack corn ears and roughen corn grains. To facilitate the process, holes measuring 25 cm in height and 30 cm in width are drilled into the side of the tank, providing space for the cracked corn cob. Furthermore, a 5 mm sieve is installed to allow the crushed corn to pass through, directing it downwards into a designated container. Figure 1 illustrates the components of the corn peeling and coarse grinding machine, while Figure 2 depicts the fabricated corn peeling and coarse grinding machine.

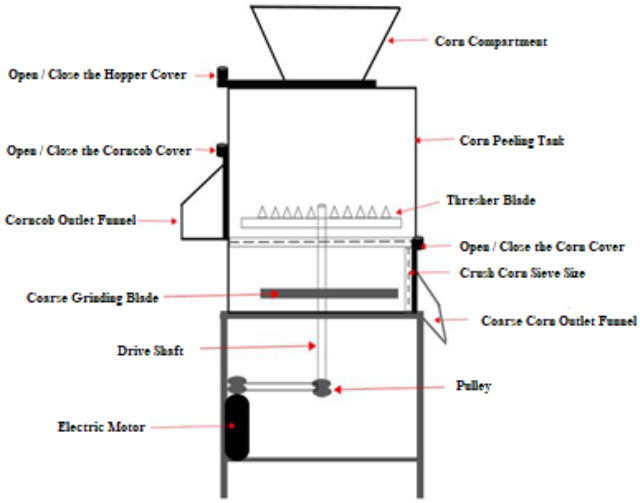

FIGURE 1 COMPONENTS OF THE CORN PEELING AND COARSE GRINDING MACHINE

Figure 2 The Corn Peeling And Coarse Grinding Machine

II. Working Principle of the Machine

First, place the corn ear in the corn ear compartment on top of the machine, and turn on the machine. After that, pull out the lid that covers the corn pod compartment. When the corn falls into the peeler, the blade will remove the corn from the cob. The shelled corn kernels pass through a sieve down to a blade that beats and coarsely grinds the kernels. The crushed kernels pass through the sieve one more time before flowing out through the pulverized cornhole into the test vessel, and the rest of the corn cob will flow into the corn cob compartment.

III. Functional Testing of the Machine

The corn peeler designed for coarse grinding for chicken feed underwent testing at speeds of 120, 150, and 180 rpm. Each speed setting involved conducting 2 sets of tests, with 3 replicates per set. The Golden Lion corn was used, maintaining consistent weights, to measure various parameters such as the weight before and after cracking, the corn cob weight, crushed corn kernel weight, and weight loss. Figure 3 illustrates the resulting corn kernels after the process of peeling and coarse grinding.

Figure 3 Corn Kernels After Peeling And Coarse Grinding

RESULTS

During the efficiency assessment of the corn peeler machine, which performs coarse milling for chicken feed, trials were conducted at different rotations per minute (rpm) settings: 120, 150, and 180, with varying operation times of 1.0, 1.3, and 2.0 minutes. The outcomes revealed that running the machine at 180 rpm for one minute resulted in the highest weight percentage after cracking, ranging between 83.0% to 87.9%. Following this, the 150 rpm setting displayed a weight percentage after hulling of 81.0% to 83.9%, while the 120 rpm setting showed a weight percentage after hulling of 78.1% to 83.5%.

Furthermore, it was observed that the machine operating at 120 rpm exhibited the highest proportion of milled corn kernels, measuring between 4.8% to 8.1%. Notably, 8.1% was the highest observed rate of grinding. When comparing the average percentage of crushed corn kernels, the 120 rpm speed yielded results higher by 1.7% to 2.4% compared to the 150 rpm speed, and up to 3.4% to 4.8% compared to the 180 rpm speed.

However, in terms of weight loss percentage, the machine running at 180 rpm showcased a weight loss of 0.5% to 0.8% less than that at 120 rpm, and 0.1% to 0.6% less than that at 150 rpm. (Table I)

TABLE I
TESTING OF CORN PEELER WITH COARSE GRINDING FOR CHICKEN FEED.

No.	Speed (rpm)	Ordinal No.	Weight before peeling (grams)	Time used (minutes)	Weight after peeling (grams)	Weight of corn cob (grams)	Weight of crushed corn kernels (grams)	Weight loss (grams)
1	120	1	382.0	1.0	298.4 (78.1 %)	54.4 (14.2 %)	21.3 (5.6 %)	7.9 (2.1 %)
		2	391.4	1.3	307.3 (78.5 %)	43.5 (11.1 %)	31.8 (8.1 %)	8.8 (2.2 %)
		3	363.5	2.0	289.3 (79.6 %)	39.8 (10.9 %)	25.9 (7.1 %)	8.5 (2.3 %)
	Mean		379.0	1.4	298.3 (78.7 %)	45.9 (12.1 %)	26.3 (6.9 %)	8.4 (2.2 %)
	150	1	366.4	1.0	296.8 (81.0 %)	49.5 (13.5 %)	14.1 (3.8 %)	6.1 (1.7 %)
		2	374.9	1.3	306.2 (81.7 %)	42.9 (11.4 %)	19.4 (5.2 %)	6.4 (1.7 %)
		3	375.9	2.0	315.3 (83.9 %)	38.6 (10.3 %)	16.6 (4.4 %)	5.5 (1.5 %)
	Mean		372.4	1.4	306.1 (82.2 %)	43.6 (11.7 %)	16.7 (4.5 %)	6.0 (1.6 %)
	180	1	350.7	1.0	295.1 (84.1 %)	44.5 (12.7 %)	6.9 (2.0 %)	4.2 (1.2 %)
		2	358.3	1.3	305.1 (85.2 %)	42.3 (11.8 %)	6.9 (1.9 %)	4.0 (1.1 %)
		3	388.2	2.0	341.2 (87.9 %)	37.3 (9.6 %)	7.2 (1.9 %)	2.5 (0.6 %)
	Mean		365.7	1.4	313.8 (85.8 %)	41.4 (11.3 %)	7.0 (1.9 %)	3.6 (1.0 %)
2	120	1	392.7	1.0	308.6 (78.6 %)	56.3 (14.3 %)	22.9 (5.8 %)	4.9 (1.2 %)
		2	394.7	1.3	318.4 (80.7 %)	48.0 (12.2 %)	21.0 (5.3 %)	7.3 (1.8 %)
		3	389.5	2.0	325.3 (83.5 %)	36.3 (9.3 %)	18.8 (4.8 %)	9.1 (2.3 %)
	Mean		392.3	1.4	317.4 (80.9 %)	46.9 (11.9 %)	20.9 (5.3 %)	7.1 (1.8 %)
	150	1	371.3	1.0	301.8 (81.3 %)	51.2 (13.8 %)	13.8 (3.7 %)	4.6 (1.2 %)
		2	379.0	1.3	310.0 (81.8 %)	47.8 (12.6 %)	15.1 (4.0 %)	8.2 (2.2 %)
		3	386.0	2.0	321.8 (83.4 %)	43.0 (11.1 %)	13.9 (3.6 %)	7.4 (1.9 %)
	Mean		378.8	1.4	311.2 (82.2 %)	47.3 (12.5 %)	14.2 (3.8 %)	6.7 (1.8 %)
	180	1	349.9	1.0	295.0 (84.3 %)	46.1 (13.2 %)	4.6 (1.3 %)	4.2 (1.2 %)
		2	363.3	1.3	301.5 (83.0 %)	47.5 (13.1 %)	9.2 (2.5 %)	9.1 (2.5 %)
		3	382.4	2.0	318.2 (83.2 %)	49.7 (13.0 %)	8.9 (2.3 %)	5.6 (1.5 %)
	Mean		365.2	1.4	304.9 (83.5 %)	47.8 (13.1 %)	7.6 (2.1 %)	6.3 (1.7 %)

DISCUSSION

The corn peeler equipped for coarse grinding in chicken feed operated at speeds of 120, 150, and 180 rpm while processing approximately 350-390 grams of corn within a duration of about 1.4 minutes. However, when attempting to escalate the speed beyond 180 rpm, it was discovered that the inserted corn tended to rebound from the machine, rendering it unable to effectively crack the corn. Moreover, in relation to output time, the process remained too sluggish for large-scale production purposes. To enhance the production cycle, efforts were made to augment the machine's speed further. A speed of 360 revolutions per minute was achieved by introducing 20 kilograms of corn, resulting in an average processing time of 30.74 seconds and yielding an 85.80 percent output of corn kernels. However, it was noted that the original vertical shift blade's area of contact with the corn ear was insufficient. Therefore, modifications were contemplated, considering a shift to a horizontal axial flow type peeling system. This proposed design incorporates a crescent fin intended to compel the corn into repeated rotations, significantly expediting the peeling process—a reported 70 times faster than traditional cracking methods [7]. Additionally, this new design entails a coarse grinding blade, enhancing the refinement of corn kernels, and potentially involves resizing the grille to a smaller dimension.

CONCLUSION

When assessing the corn peeler's performance regarding chicken feed, the investigation into post-peeling weight highlighted that operating at 180 rpm resulted in the highest weight percentage after peeling, ranging between 83.5% to 85.8%. Notably, this speed also incurred the least weight loss percentage, measuring between 1.0% to 1.7%. On the other hand, regarding milled kernel weight, the use of 120 rpm demonstrated the highest percentage of crushed corn weight, ranging from 5.3% to 6.9%. However, it also exhibited the highest percentage of weight loss, ranging from 1.8% to 2.2%. Contrarily, the 150 rpm speed showcased a weight percentage after peeling of 82.2%, surpassing that of 120 rpm but falling short of the 180 rpm speed. The percentage of crushed corn kernels at 150 rpm stood between 3.8% to 4.5%, with a weight loss percentage ranging from 1.6% to 1.8%. These figures placed it higher than the 180 rpm speed but lower than the 120 rpm setting.

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