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Research Article

Design and Performance Evaluation of Grain Feed Grinding Machine

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ABSTRACT

The importance of milling grains into fine flours has a full advantage for homogeneity and size reduction for feed suitability. The grinding technology was made with locally available and affordable materials. Milling technology is promised technology mainly proposed for fish feed and can be used for any animals feed production that has been made with the factors considered in design standard and material properties. The hammer mill blades are replaceable or can regrind easily if they were worn out. This machine was designed and constructed for crushing locally available grains of maize, sorghum, wheat, barley, and other gains mainly for fish. And the parameters have been analyzed using statistix 8.0 software tool with different sieve hole-sizes (1 mm, 2 mm, and 3 mm) with corresponding independent variables; mass before and after grinding, grinding time, actual capacity, and crushing efficiency. The coefficient of variation of maize, wheat, and sorghum in respective sieve sizes for the grinding time and crushing efficiency was within the range of acceptable value of less than 7%. The power required for the milling has been determined 3000 W and the rotor speed was stepped up to 1800 rpm. The maximum capacity and crushing efficiency of this mill machine for different grains range from 65-78 kg h^{-1} and 90-95% respectively.

REVIEW ARTICLE

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Keywords:

- Hammer mill,
- Blade shape,
- Sieve size,
- Efficiency

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INTRODUCTION

Ethiopia is a country blessed with immense livestock and fishery resources. Obviously, the nation has an enormous livestock population in Africa and is ranked fifth in the world. The livestock industry continues to be one of income generation and subsidizes over 40% of the nation's agricultural GDP regardless of receiving modest state investments over the years. Ministry of livestock and fishery stated that industries are essential to the country's socio-economic development goals as it works toward its goal to become a middle-income country by the end of 2025 (Gashaw, 2018).

In the country of Ethiopia, it contains about 7000 km of rivers and 7400 km^2 of ponds. Ethiopia has a volume of capacity 51.500 tones of fish annually, however approximately 30-38% percent of this volume is present used. The issue varies by location but is most significantly affected by infrastructure, marketplace, and feedstuff (Tesfahun *et al*., 2018). Food for fish could contain a protein combination of 30-40% with substantial amount of lipids to provide a high level of fish production (Admasu *et al*., 2019).

The general algorism and algebraic mathematical formulations were used in equivalent to different proportion of easily accessible ingredients such as wheat bran, sorghum, and barley. The constituents were then considered as protein & vigor basis materials. These formulae have allowed for the achievement of the target crude protein and energy stages (Admasu *et al*., 2019).

Fish weight can be varying by using different feed nutrients. Majorly the diets were made from various protein-rich compositions of wheat, barley, and oats with a protein range from 11–14%. Efforts were made especially for feeding classes that are elevated and which make up unevenly 60% of the fish meal eat in fish industry (Suresh *et al*., 2018).

Today, the most of milling technology is designed for large scale productions of feed and particle mills. However, anyone operating on a small-scale faces difficulty in growing their own business. As a result, there is a significant need for small-scale milling equipment (Adekomaya *et al*., 2014).

Most of the conventional grain mill machines are used to convey grain and then re-circulate the uncrushed grain material, re-grinding it. But the machine that has a curved end screen hammer. Though, there no conveyance of un-milled particles that was used in the study when rectangular with serrated tip screen hammers mills to allow for entry. The research proves the efficiency of hammer mills with curved ends and serrated flat screens (Ajaka *et al*., 2104).

Milling is the process of converting large size grain materials into fine particle sizes. Materials are reserved in a crushing chamber until sieve allows entering the ingredients and lowered. The quantity of crushing on the rotating shaft unit, the dimension, structural arrangement, end shapes/sharpness, the rotational speed, wearing effect, and the available clearance between the tips with respect to the screen are the significance factors on the grinding capacity (Higgs *et al*., 2011).

The main objective of this study is to design and performance evaluation of grain grinder machine with efficiency greater than 89% with minimum costs and simple repair. This is to modify the most familiar hammer blades with a curved end (semi-circle) hammer mill tip, to a two-sided shape and tip serrated screen beat mill allocated as a major feature factor.

MATERIALS and METHODS

Sources of experiment

The investigation was conducted at the Melkassa Agricultural Research Center in Ethiopia's Oromia regional state. Its geographical coordinates are 8° 24' 985 N and 39° 19' 529 E, and its elevation is 1550 meters above sea level.

Fish feeds with wheat ingredients kinds are considered appropriate for the suspending of feeds. As alternatives, maize could be suitable for flour grinder with correct screen will be preferred or if it has made based on the present design. Moreover, the grain crusher machine has been tested on representative feed substances like wheat, sorghum, brewery waste, nug-cake, maize, and wheat bran that as a fish research center recommended (Admasu *et al.*, 2019). According to (Zhou, 2018) the particle size for animal feed of plate size holes were between the ranges of 1 mm-5 mm.

Statistix 8.0 design software was used for data analysis as long as RCBD design has been considered for the experimental design. During testing, the machine performance was determined by varying the sieve size with a constant weight for each ingredient initial sample items (2 kg) with variation grinding time, the overall capacity and efficiency of the machine was determined. The test was conducted on maize, wheat and sorghum grain ingredients.

The main parts of the grain feed grinder machine consist of;

- ✓ Hopper
- ✓ Driving beat hammers
- ✓ Driving unit holder to hold the hammer beaters
- ✓ Driver and driven pulleys'
- ✓ Motor with belt
- ✓ Bearing, bearing and other housings and frames.
- ✓ Different sieves to separate the ingredient particle size

Machine component design

In the design mill machine components, some parameters have been considered such as ease of maintenance, affordable, and locally available materials within the capacity of medium scale farmers.

Hopper unit

This unit is configured by considering the overall capacity of the machine. The hopper must be capable to provide adequate grains in order to achieve all through the capacity. This has pyramidal shape and prepares with a sheet metal 2 mm thick. The hopper size was 50 * 50 cm on the top sides, 15 * 15 cm on the bottom opening, and 30 cm depth.

Frame and support

The frame part was manufactured using mild steel material with square pipe cross-sections (50*50*3) mm. The overall dimensions are 68 cm length, 50 cm width, and 80 cm height.

Determining of shaft speed

One must first choose the rotating speed and overall capacity while designing a hammer mill. According to (Stephens *et al.* 2005), it has been decided that a beat mill with an output speed of about 1800 rpm will result in better competence. Based on this, pulley drives could be used to raise the output speed of the majority of commercially accessible motors, which have an output speed of 1440 rpm.

Starting with the assumption that the motor pulley diameter is around 160 mm, one can use the relation provided in Equation (1) using the theory of (Mohamed *et al.*, 2015).

$$\frac{D_1}{D_2} = \frac{N_2}{N_1} \quad (1)$$

Where: D_1, driver pulley diameter, m; D_2, driven pulley diameter, m; N_1, rotational speed of motor, N_2, driven rotational speed. This gives the result to step up the speed to about 1800 rpm and driven pulley diameter can be used as 128 mm. And the results are $D_1 = 0.16$ m, $D_2 = 0.128$ m, and $N_1 = 1440$ rpm.

Determining of belt length and contact angle

The belt contact length can be calculated by considering driver, driven pulley diameter, and center distance between them. It was calculated in the Equation (2) using (Ezurike *et al.*, 2018).

$$L = 2C + \frac{\pi}{2}(D_1 + D_2) + \left(\frac{D_1 - D_2}{4C}\right)^2 \quad (2)$$

Where, L is belt length, mm; C, distance between smaller and larger pulley's (directly measured from the final fabricated technology) as 400 mm.

Substitute all the required values gives,

$$\mathrm{L} = 2(400) + \frac{\pi}{2}(160 + 128) + \left(\frac{160 - 120}{4\,(400)}\right)^2 = 1252\ mm$$

The contact angle of belt can be calculated in considered to the pulley's using relations of (Ezurike *et al.*, 2018).

$$\beta = sin^{-1}\left(\frac{R - r}{2C}\right) \quad (3)$$

Where, R, larger pulley radius, r is smaller pulley diameter, mm; β, contact angle.

$$\beta = sin^{-1}\left(\frac{84 - 60}{400}\right) = 3.4^{\circ}$$

The angle of wrap is gives,

$$\alpha_1 = \pi + 2\beta \quad \text{for diver pulley} \quad (4)$$
$$\alpha_2 = \pi + 2\beta \quad \text{for driven pulley} \quad (5)$$

Therefore, $\alpha_1 = 180 + 2 \times 3.44^{\circ} = 188.8°$ and $\alpha_2 = 180 + 2 \times 3.44^{\circ} = 173.1°$

Where, θ_d, smaller pulley contact angle in deg, θ_D larger pulley contact angle in deg *D*, larger pulley diameter, mm; *d*, smaller pulley diameter, mm; α_1, angle of wrap for driven pulley, α_2, angle of pulley for driver pulley.

The torque transmitted (pulley torque) can be the same as half of the total added forces *(F)* and the difference between F_1 and F_2 is related to the pulley torque *(T)* can be given the Equation (6), (7), and (8) using the mathematical formula of (Stephens *et al.*, 2005).

$$F1 - F2 = \frac{2T}{D} \tag{6}$$

Where, F_1 tight side tension, N, F_2 loose side tensional force, N, *Fc* centrifugal push force, N, *Fi* initial tension, N.

The centrifugal force could be determined as

$$Fc = mv^2 \tag{7}$$

From this, it is likely to calculate the belt's extreme tensional force as *(T=SA)*; where *S* is the maximum tolerable belt stress. For leather belting, the permitted tensile stress ranges between 2.4 MPa-2.45 MPa. Once more, the belt area might be expressed as,

$$A = bt \tag{8}$$

Where, p = density of belt (1000 kg m^{-3}) for the common belts, the selected width and belt thickness have 12.5, 8 mm respectively. For the calculated belt tension is *T* = 2304 N and the motor linear speed can be given as follows (Stephens *et al.*, 2005).

$$V = \frac{\pi dn}{60} = 12\ m\ s^{-1} \tag{9}$$

The centrifugal force (*Fc*) can be calculated using the hammer tip velocity (*v*) and mass per unit length, where *Fc*=129.6 N.

The equation is used to calculate the power and torque applied to the shaft as well as the intended power needed by the shaft will be calculated using (Gupta and Khurmi, 2005). Accordingly, to this statement, the tensional force (F_1) was three times of centrifugal force. Therefore, the tight side force will give, F_1 = 3Fc = 388.8 N.

$$P = (F_1 - F_2)\ V) \tag{10}$$

Again, the slack side force (F_2) can be calculated using the equation of

$$\frac{F_1}{F_2} = e^{\beta\mu} \tag{11}$$

Where, β, is angle of wrap in degree and μ, frictional coefficient between belt & pulley assumed to use as 0.3 and 3.44 respectively. Therefore, the slack side force (F_2) value will be 138.8 N. By adding the power Equation (7) the value of motor power will give 3 kW.

Determining weight of hammers

Hammers can be designed by considering the impact of centrifugal forces can be calculated using the formula of (Stephens *et al*., 2005).

$$F_h = N_h * M_h * r_h * \omega_h^2 \quad (12)$$

Where, F_h Centrifugal force, *Kn*, r_h radius of hammer blade, 0.125 m. ω_h angular velocity, 188.4 rad·sec, $\left(\frac{2\pi N}{60}\right)$, N_h, number of hammers, 16 N, velocity of hammer (1800 rpm).

The weight of hammer blades could be up to 0.2 kg (Euzrike *et al*., 2018)

$$W_h = M_h \cdot g \quad (13)$$

Where, W_h is weight of hammer blade, kg, M_h, mass of hammer blade, *g*, gravitational acceleration (9.81 m s^{-2}). This result gives the weight of blade has been 2 kg m^{-2}. For a better grinding efficiency, the quantitative number of hammers could be up to 16 The yield and tensile strength of the material is about 351 Pa and 421 Pa respectively. And, the mathematical formula utilizing for the density is about 7860 kg m^{-3} as well as the minimum width of the hammer mill (w_h) to withstand the impact of centrifugal force (Stephens *et al*., 2005).

$$M_h = \rho * V_h \quad (14)$$

Where, ρ is density of material (7860 for mild steel), kg m^{-3}, V_h is volume of hammer (0.125 m × 0.005 m × 0.05 m).

Determining the shaft sizes, calculating the shaft diameter using the general Equation (12) using the formula of (Nisbett *et al*., 2010).

$$\frac{1}{n} = \frac{16}{\pi d^3}\{\frac{1}{S_{ut}}[(4(k_b M_b)^2 + 3(k_t M_t)^2]\}^{\frac{1}{2}} \quad (15)$$

Where, *d*, diameter of shaft in m, M_b, bending moment N · m; M_t, torsional moment, N m; k_b and k_t are combined shock and fatigue factors for bending & torsion respectively using American Society of Mechanical Engineering (ASME). And the values for the combined shock bending and torsional moments were taken 1.5 & 1.0 for the gradually applied shaft stress.

Mild steel with the characteristics S_{ut} = 420 Mpa and S_y = 351 Mpa was utilized to create this design. The torque generated by a 3 kW motor is what exerts force on the shaft, and the weight of the blade-containing disc is what exerts force vertically.

Therefore, the bending moment can calculate by using the vertical bending moment diagrams of the shaft (M_t) calculated using the mathematical theory of (Gupta and Khurmi, 2005).

$$M_t = \frac{P*60}{2\pi N} \quad (16)$$

Using the transmitted power of 3000 W and rotational speed of 1800 rpm the bending moment gives,

$$M_t = \frac{3000\ W*60}{2\pi*1800\ rpm} = 15.9\ \text{N·m}$$

On the other hand, the vertical loading bending moment could be using the centrifugal force exerted by the hammer as 1300 N (upward). And the shaft is subjected to the vertical applied load. Therefore, the values of distributed vertical force will be per unit length of loaded shaft=$\frac{1300\ N}{0.28\ m}$ =4642.8 N · m^{-1}

Mass of each blade =0.2 kg and the quantity are 16 and the weight of each blade contains=2.0 kg, Again the vertical force can be obtained by considering the factor of safety=2.5, the minimum shaft length and diameter is determined as 280 mm and 30 mm respectively.

Figure 1 shows the diagram for free body and bending moment as well to determine the bending moment at point of bearing support, it is clear that the maximum bending moment is in the point of A with bending moment M_b=4642.8 × $\frac{0.28^2}{2}$=181 N · m

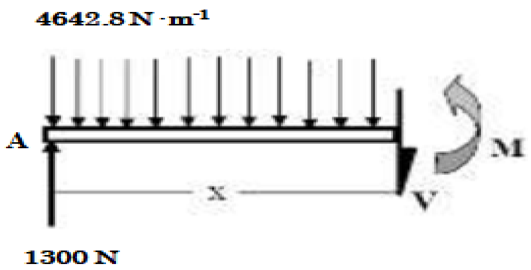

Figure 1. Free body diagram and bending moment.

By applying in Equation (15) both the maximum bending moment (M_b) and vertical applied load (M_t), the shaft diameter to carry out these forces should be greater than or equal to 30 mm.

Bearing selection

The function of bearing is to carry loads and to bring the auxiliary structure. The following material properties have been considered during bearing selection, corrosion resistant, resistant to damage during rotational speed, strong enough to carry loads, static friction, and optimum operating temperature. According to (Nisbett *et al.* 2010) for the medium operating machines like milling, it would have maximum speed up to 2000 rpm and the maximum load 15000 psi. Using manufacturing catalogue ball bearing type has been selected for this purpose.

Based on the design parameters the assembly, orthographic views, and part drawing of the prototype will be shown in the Figure 2 to 8.

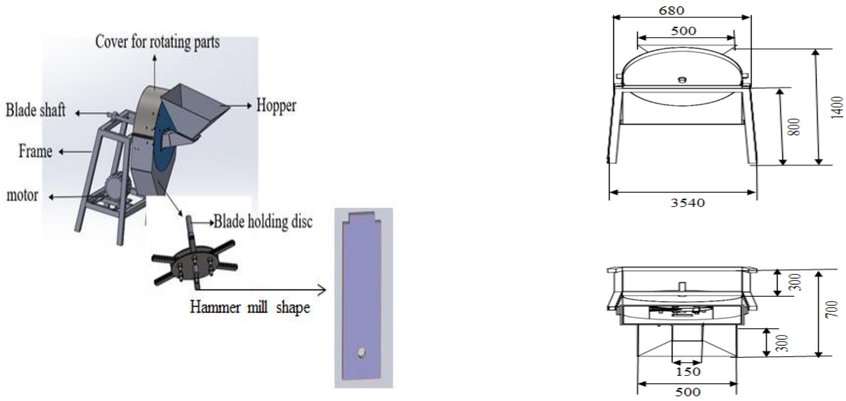

Figure 2. Assembly and engineering drawing views of hammer mill.

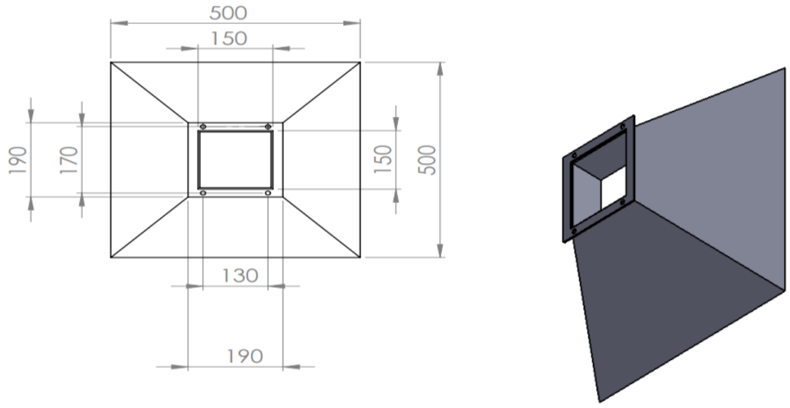

Figure 3. Orthographic and isometric drawing of hopper.

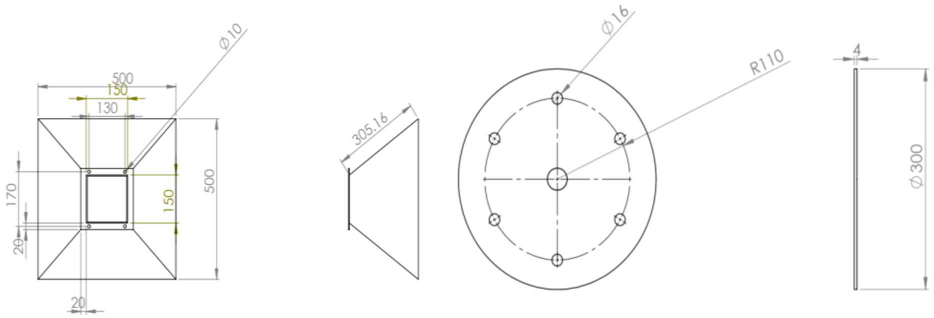

Figure 4. Top and side views of hopper and rotor disc respectively.

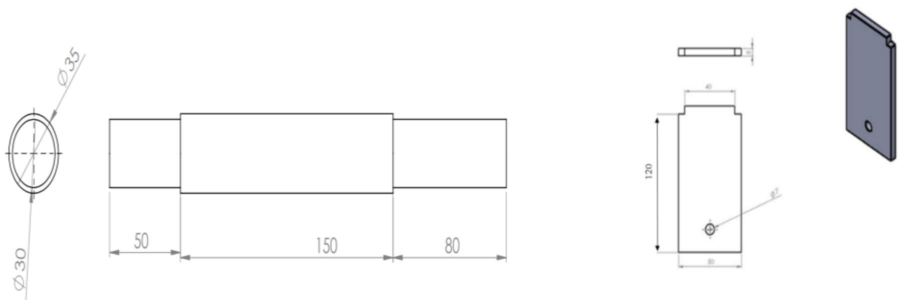

Figure 5. Top and side views of shaft and hammer mill respectively.

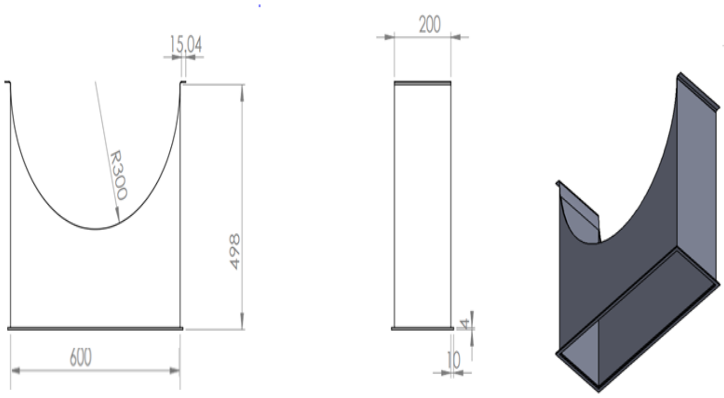

Figure 6. Orthograpic and isometric views of grain discharge.

The machine was designed using solid-works design software tool and proper material selection was done before the real assembling and construction of parts.

Figure 7. Pictures of fabricated hammer mill machine.

Figure 8. Picture during separation on different sieve sizes of sample flour.

Measuring tools

i. Weighing balance: in order to measure the mass of ingredients (before and after milling)
ii. Stopwatch: for the purpose of recoding for the time of milling
iii. Tachometer: in order to measure the speed of the rotor hammer mill.
iv. Different sieves sizes: (1 mm, 2 mm, and 3 mm)

The mathematical Equation (17) & (18) crushing efficiency and losses has calculated by using (Mohamed *et al*., 2015).

Crushing efficiency

Crushing efficiency can be computed using the expression given,

$$Crushing\ efficiency = \frac{mass\ of\ recovered\ material}{mass\ of\ input\ material} x100 \qquad (17)$$

Loss

$$Loss = \frac{Mb - Ma}{Mb} \qquad (18)$$

Where, M_b= Mass before grinding, and M_a= mass after grinding

RESULTS and DISCUSSION

The milling technology can be used for multipurpose of animal feed mixing as well as milling. Specifically, this research has been conducted only on fish feed sample ingredients of wheat, maize, and sorghum. The prototype of the machine has been produced and most of the machine parts use locally accessible materials. Preliminary testing of the milling is targeted at evaluating its ability to grind different size ingredients, duration of milling, capacity, and crushing efficiency have been considered. Figures 9, 10, and 11 illustrates the relationship between machine grinding efficiency and time of crushing for wheat, maize, and sorghum ingredients respectively. Different efficiency values have been gained according to the ingredient type to be crushed.

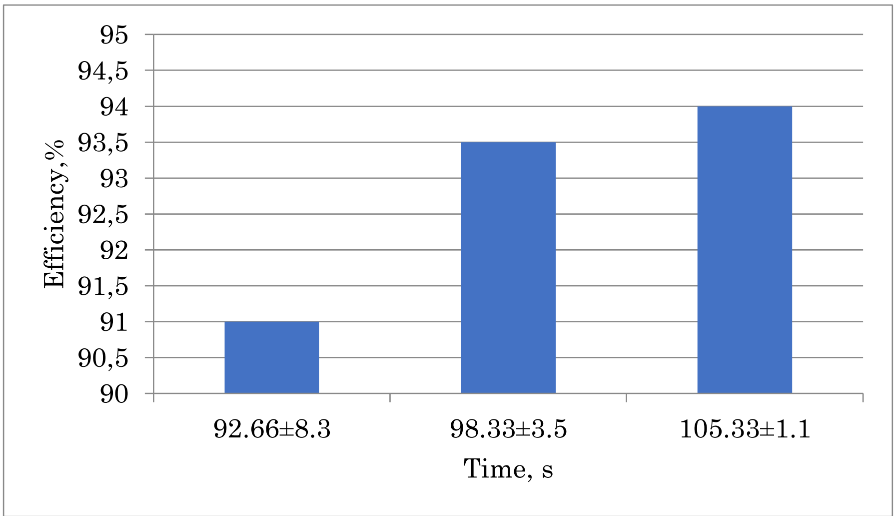

Figure 8. Average crushing efficiency versus time for wheat.

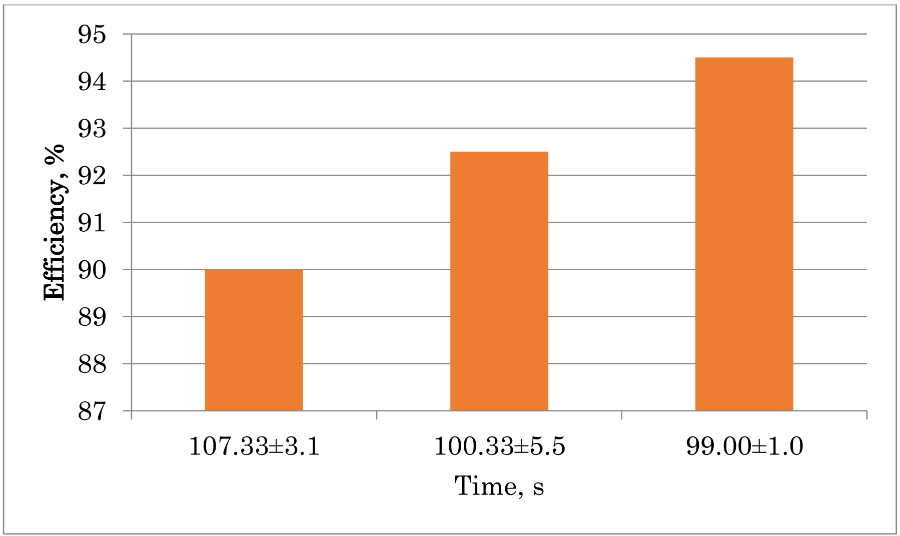

Figure 9. Average grinding efficiency versus time for maize.

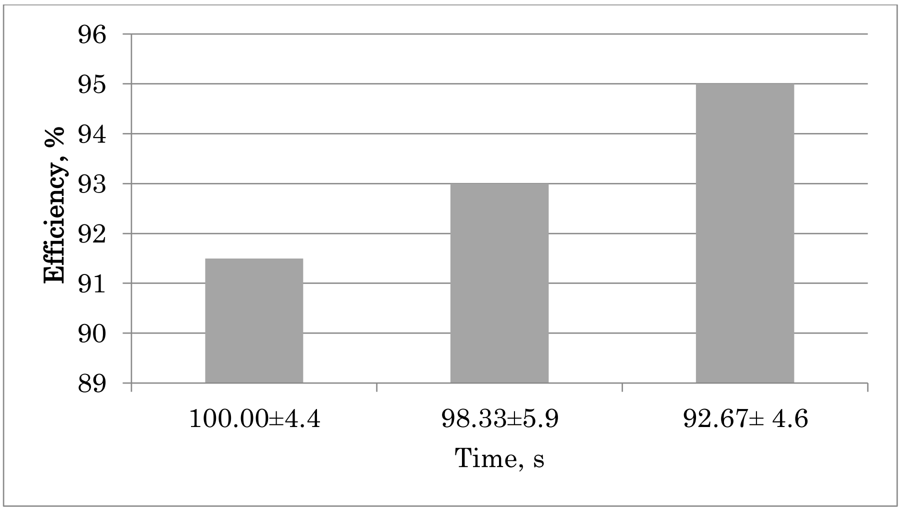

Figure 10. Average grinding efficiency versus time for sorghum.

Table 1. Sample test result for maize

Parameters				
Sample sieve	Sieve # 1 (1 mm)	Sieve # 2 (1.5 mm)	Sieve # 3 (2 mm)	CV
Mass (kg)	2	2	2	
Mass after grind, kg	1.8±0.05	1.85±0.04	1.89±0.02	
Capacity, kg $\cdot$ h^{-1}	67.13±1.88A	71.90±3.95A	72.73±0.75A	3.72
Crushing efficiency, %	90	92.5	94.5	
Loss, %	10	7.5	5.5	

Letter "A" indicates that the level of average mean followed by the same letters is not significantly different.

Table 2. Sample test result for wheat

Parameters				
Sample sieve	Sieve # 1 (1 mm)	Sieve # 2 (1.5 mm)	Sieve # 3 (2 mm)	CV
Mass, kg	2	2	2	
Mass after grind, kg	1.82±0.06	1.87±0.05	1.88±0.04	
Capacity, kg h^{-1}	73.300±2.60A	78.100±6.75A	68.40±0.69A	6.49
Crushing efficiency, %	91	93.5	94	
Loss, %	10	7.5	5.5	

Letter "A" indicates that the level of average mean followed by the same letters is not significantly different.

Table 3. Sample test result for sorghum

Parameters				
Sample sieve	Sieve # 1 (1 mm)	Sieve # 2 (1.5 mm)	Sieve # 3 (2 mm)	CV
Mass, kg	2	2	2	
Mass after grind, kg	1.83±0.06	1.86±0.04	1.9±0.02	
Average capacity, kg h^{-1}	72.100±3.05A	73.400±4.23A	77.83±3.75A	4.46
Crushing efficiency, %	91.5	93	95	
Loss, %	8.5	7	5	

Letter "A" indicates that the level of average mean followed by the same letters is not significantly different.

According to (Aboud, 2012) study has conducted to see the effect of drilled sieve holes ranges 1 to 3.5 mm for maize, wheat, and barley ingredients. Discussed about the result, as increase in sieve size diameter from 1 to 3.5 mm has significance increment in particle size, specific capacity, and lower the specific energy. The study by Ezurike *et al.*, 2018 results found to have for the ingredient milling machine with a capacity of 31 kg h^{-1} and 90% efficiency with 10% losses.

This study shows results, the variability (CV) of parameter effects for the average capacity of the respective ingredients has been for maize (3.72), wheat (6.49), and sorghum (4.46). The hammer mill has been tested with variable crops like maize, wheat, and sorghum with different sieve hole sizes (1 mm, 1.5 mm, and 2 mm). The machine was tested using 2 kg of dry maize, 2 kg of dry wheat, and 2 kg of dry sorghum at 13% moisture content for each sieve size with its respective replication, and the analysis was displayed in the above tables. From the results the average crushing efficiency, losses, and capacity of the machine were 93%, 7%, and 71.5 kg h^{-1} depending on the ingredient type and different size sieve holes. Generally, for all ingredient types as the sieve size increases, again the capacity and efficiency of the machine increases. With this, the maximum power and the speed of hammer mill have been 3 kW and 1800 rpm respectively.

CONCLUSION

This study was conducted to design a grain grinder machine and experiment test based on locally available materials. Based on the experimental testing results of milling, it can be concluded that:

i. The designed prototype machine was fabricated based on locally available materials.
ii. The designed hammer mill machine was tested for grains of fish feed like; sorghum, maize, and wheat with a readiness of moisture content of 13% for each ingredient.
iii. The maximum crushing efficiency (%) of maize, sorghum, and wheat was (94.5, 94, and 94) respectively at 1800 rpm hammer mill speed.
iv. The average capacity, time of milling, and the average coefficient of variation (CV) for maize, sorghum, and wheat were (3.72, 6.49, 4.46 and 3.61, 6.06, 4.69) % has been obtained respectively.
v. For the same weight (2 kg) of maize, sorghum, and wheat feed ingredients; time, capacity, and crushing efficiency were significantly affected by different sieve sizes.
vi. Due to different losses the mass of the ingredient reduces accordingly.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no conflict of interest.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

The authors declare the contributions to the manuscript such as the following sections:
Maney Ayalew Desta: Design, methodology, writing orginal draft, review, and editing paper.
Ahmedie Oumer: Design, methodology, data collection during testing, and data analysis.

ETHICS COMMITTEE DECISION

This article does not require any ethical committee decision.

REFERENCES

Adekomaya O and Samuel O (2014). Design and development of a petrol-powered hammer mill for ruralnigerian farmers. *Journal of Energy Technologies and Policy, 4(4): 65-72.*

Admasu F, Getahun A and Wakjira M (2019). The process of tilapia feed formulation and implementation in pond aquaculture: low cost and locally available ingredients option for small-scale farmers. *Journal of Agriculture and Aquaculture, 1(2).*

Ajaka E and Adesina A (2014). Design, fabrication, and testing of a laboratory size hammer mill. *International Journal of Engineering and Advanced Technology Studies, 2(2): 11-21.*

Aboud BA (2012). The effect of sieve holes and types of grains on some performance indicators of hammer mill. *Diyala Agricultural Sciences Journal, 1(4): 181-188.*

Ebunilo PO, Obanor A.I and Ariave GO (2010). Design and preliminary testing of a hammer mill with end section lift capability suitable for a commercial processing of grains and solid minerals for in Nigeria. *International Journal of Engineering Science and Technology, 2(6): 1581-1593.*

Ezurike OB, Osazuwa JO, Okoronkwo AC and Okoji IK (2018). Design, construction and performance evaluation of a flat screen hammer mill machine. *African Journal of Science, Technology, Innovation and Development, 10(6): 683-690.*

Gashaw G (2018). Fisheries commitee for the West Centeral Gulf Guinea from Ethiopia: Attempt to up livestock, fishery sector: http://allafrica.com/stories/201801310946.htm (07/01/2022).

Gupta J and Khurmi R (2005). A text-book of machine design elements. Eurasia Publishing House, New Delhi.

Higgs D and Hasting W (2011). FAO-Food and Agricultural Organization. https://www.fao.org/3/x5738e/x5738e0j.htm#2.%20grinding

Mohamed T, Radwan H, Elashhab A and Adly M (2015). Design and evalute of small-scale hammer mill. *Egypt Journal of Agricultural Research, 93(5): 481-493.*

Nisbett K and Richard B (2010). Shigley's mechanical engineering design. United States: McGraw-Hill science, New York.

Stephens and Richard C (2005). Mechanics of machines. Edward Arnold, New York.

Suresh V (2018). Fish nutrition feed resaecrh: scope and challanges ahead. *ICAR-Central Marine Fisheries Research, 23(1): 78-81.*

Tesfahun A (2018). Review in current problems of Ethiopia fishery: In case of human and natural associated impacts on water bodies. *International Journal of Fisheries and aquatic Studies, 6(2): 94-99.*

Zhou K (2018). Feed processing technology Effect of grinding particle size on feed quality. https://www.viv.net