Design and Development of Pedal Operated Grinder

Rohit Raut[1], Sunil Dhanjode[2], Rohit Suryavanshi[3], Sai Kartik Gunnisetti[4], Piyush Satokar[5]
[1,2,3,4,5] *Student, Department of Mechanical Engineering, Dr. Babasaheb Ambedkar College of Engineering and Research, Nagpur, Maharashtra, India*

Abstract- **Powdered food grains are a base of almost all foods in India. In ancient times, food grains are ground with the help of hand grain crushers. Today the electric motor driven grinders are used. But today there is a huge scarcity of electricity almost everywhere in India which results in six to twelve hours load shedding. In rural areas the load shedding is done daily from ten to twelve hours which badly affects their daily needs requiring electricity such as food grain crushing, water supply etc. To overcome this, we can replace the electric motor driven process units by manually driven process units such as Grinders driven by Gearless Transmission [Modak J]. i.e. manually driven food grinding machine. Also, we all know that hand muscles are weaker than the leg muscle [K.H.F. Murell]. We can operate the Pedal Operated Grinder without fatigue and smoothly for a longer period if we replace hand operated grinder by pedal operated grinder.**

1. INTRODUCTION

Pulses are part of the legume family, but the term "pulse" refers only to the dried seed. Dried peas, edible beans, lentils and chickpeas are the most common varieties of pulses. Pulses are very high in protein and fibre and are low in fat. Like their cousins in the legume family, pulses are nitrogen-fixing crops that improve the environmental sustainability of annual cropping systems. Pulses are a great tasting addition to any diet. They are rich in fibre and protein, and have high levels of minerals such as iron, zinc, and phosphorous as well as folate and other B-vitamins. In addition to their nutritional profile and links to improved health, pulses are unique foods in their ability to reduce the environmental footprint of our grocery carts. Put it all together and these sensational seeds are a powerful food ingredient that can be used to deliver the results of healthy people and a healthy planet.

Pulses come in a variety of shapes, sizes and colours and can be consumed in many forms including whole or split, ground in to flours or separated into fractions such as protein, fibre and starch. Pulses do not include fresh beans or peas. Although they are related to pulses because they are also edible seeds of podded plants, soybeans and peanuts differ because they have a much higher fat content, whereas pulses contain virtually no fat.

The main objective is to design & develop a machine which uses human power as source of energy to drive the machine. It basically consists of a simple bicycle mechanism. In many developing countries like India, the gap between the ever-increasing demand of power and its generation has prepared a daily busy schedule of load shedding (power cuts). There are millions of people in remote villages in India who lives day to day without reliable power supply. And thus, to fulfil their demand of flour there are conventional hand cranked grain mill without an easy way to power it. This process of hand cranking of stone wheels is characterized by slow operation, fatigue and low production rate. Pedal power is the transfer of energy from a human source through the use of a foot pedal and crank system (Kajogbola R,2010) Since the thigh or quadriceps is largest and most powerful muscles in the human body it makes sense to utilize it for generating as much as energy from human body. With the body in seat, the legs can provide a pedal work (Wikipedia 2008).

The person can generate four times more power (1/4 horsepower (hp)) by pedalling than by hand cranking. At the rate of 1/4 hp, continuous pedalling can be done for only short time, about 10 minutes. However, pedalling at half of this power (1/8 hp) can be sustained for around 60 minutes Maximum power produced with legs is generally limited by adaptions within the oxygen transportation system. On the other hand, the capacity for arm exercise is dependent upon the amounts of muscle mass engaged and that is why a person can generate more power by pedalling than hand cranking (Tiwari P.S.,2011). Pedal power enables a person to drive device at same rate as

achieved by hand cranking but with less efforts and fatigue. There are millions of people who live day to day without reliable power to complete daily work. Often these people are living in situations where manual labour allows them to sustain themselves, but mechanical devices can offer one way to ease the work load. The international labour organization (ILO) has reported that "The processed grain is one of the most important elements in the diet of low income groups in developing countries" The ILO found that appropriate technologies for grain milling keep the employment and local earnings. Further According to United states department of Agriculture, fresh grains as part of diet reduce the risk of several chronic diseases, including heart diseases and provide many vital nutrients. Thus, it was felt to have some machine which can be operated by common people without any electric power supply and the result is pedal operated flour mill.

2. LITERATURE SURVEY

In 21st century the world is going towards a new era of invention. Every rising day comes with new invention or discovery just to enhance the life of human being and to improve the living standard of human. Pedal power is the transfer of energy from a human source through the use of a foot pedal and crank system (Kajogbola R,2010) Since the thigh or quadriceps is largest and most powerful muscles in the human body it makes sense to utilize it for generating as much as energy from human body. With the body in seat, the legs can provide a pedal work (Wikipedia 2008).

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A manually driven brick-making machine has recently been developed without the benefit of any design data. The machine consists of three main units: a pedal-driven flywheel motor; the transmission between the flywheel shaft and the input shaft of the process machine; and the process unit, consisting of auger, cone and die. The machine was essentially developed on the basis of general mechanical design experience and intuition. In spite of this, it proved to be functional and economically viable. However, it was felt essential to develop it scientifically. (Modak J.P.) While there are solar powered laptops that will allow a computer to be powered without an energy source, not everyone may be able to afford them. There was always the hope that there would be an affordable way for people in poorer and very remote areas to be able to benefit from the uses of a computer and there finally is because of the pedal powered laptop in Afghanistan. Pedal power laptop is a pedal powered machine that uses nothing but pedal power to operate the laptop. The system is set up so that just about anyone with two legs would be able to power the laptop and they claim that even a third grader can step up to the pedal power laptop computer and get to work with no problems.

A dynapod is a stationary pedal-powered device. The word 'Dynapod' comes from the Greek words for power and foot. The dynapod can be attached to any kind of device or tool and used to generate power for a multitude of activities. The first design for this type

of unit was introduced in 1968.Although it was not built, Alex Weir (Edinburgh University) built one and two-person dynapod at Dar-es-Salaam in Tanzania. A cement-filled bicycle wheel was used as a flywheel. He developed and built many prototype units using square tubing for the framework. His prototype inventions were tested as corn grinders and a winnowing machine. The pedal powered generator from Windstream is perfect for emergencies, power failures, remote locations, and off-grid applications. It can be pedalled or cranked by hand to charge 12 volts batteries and run small appliances. The typical average continuous power that can be generated by pedalling the Human Power Generator is up to about 80 watts. The maximum power obtainable through hand cranking typically is about 50 watts. The pedals and optional hand-cranks are interchangeable. Re-engineered for more strength, easier adjustment, and smooth operation, the new Human Power Generator is the tool for energy education and self-reliant electrical production.

Remya Jose hailing from Malappuram, Kerala has created an innovative idea of a pedal-powered washing machine for helping her family with her daily washing chores. She used a simple technique for making the mechanical washing machine as compared an electric one. Her idea was modelled into a manual washing machine costing just about INR3,000, which is quite affordable for many Indians. The pedal-powered machine not only helps in washing clothes but also helps in staying fit through pedalling. A rust-proof iron mesh cylinder is placed inside an aluminium cabin. This cylinder is connected to a pedal system with a chain, pedals and a seat. Another innovative work that grabbed attention is the 'Noor Bicycle' by Mohammad Saidullah, a resident of Motihari District, Bihar. He has many developed many innovative devices at a low cost, which have been recognized by the Indian government too. Noor Bicycle is an amphibious vehicle innovation developed by Saidullah with the intention of helping his village people to commute during the floods. This bicycle has the capacity to float in water and it can also be driven on land. It is a conventional bike with a few extra attachments—four rectangular air floats and fan blades attached radially to the spokes of the rear wheel. The floats keep the bicycle from sinking and the blades allow forward movement while pedalling. Saidullah has made this amphibious bicycle at an affordable rate.

3. DESIGN REPORT

Serial No.	Materials	Dimensions (in cm)
1.	Cycle	Length-140, Width-20
2.	Handle	Height-119, Width-47
3.	Chain	No. of teeth-183, Length-200
4.	Sprocket	No. of teeth-48, Diameter-18
5.	Catcher	Diameter-5
6.	Stone	Diameter-25
7.	Gearless Mechanism	Diameter of wheel-15, Length of shaft and Diamter-58,3
8.	Table	Length-40, Width-40
9.	Bearings	No. of Bearings-3, Size-25 mm

4. CONSTRUCTION DETAILS

4.1 Drive unit:

The transmission of power from human to processing unit is carried out in two stages namely chain drive and belt drive. The operators use his feet & legs to rotate pedal around the crank axel. The pedals, in turn, are fixed to a chain ring (sprocket) with teeth that engages the bicycle's continuous chain. The chain then transmits the pedalling action to a cog on the hub of the front wheel causing the front sprocket to rotate and then drive the shaft on which pulley is mounted. (Kajogbola R,2010) This is first stage of transmission. In second stage this power is transmitted to stone wheels from pulley with the help of cross belt drive.

4.2 Processing Unit

Process unit is the one where actual crushing of wheat kernels take place. This process unit basically consists of stone wheel, hopper & the hemispherical collector. Stone wheels are the two rigid chiselled emery stones placed one above the other. The bottom wheel is fixed one &the upper one can rotate about vertical axis. The selection of stone wheels is made in such a way that it should not be too heavy to cause early fatigue to operator but it should be capable of delivering the required finess of flour at optimum production rate. The provision is also made to enter

the wheat kernels inside through the hole at centre of upper stone. Hopper is mounted exactly above the stone wheels, in which the wheat to be crushed is collected. Since the intermittent flow is required from hopper to stone wheels the provision is also made to control the flow of wheat kernels. The hemispherical collector is fixed below the stone wheels where the flour is collected.

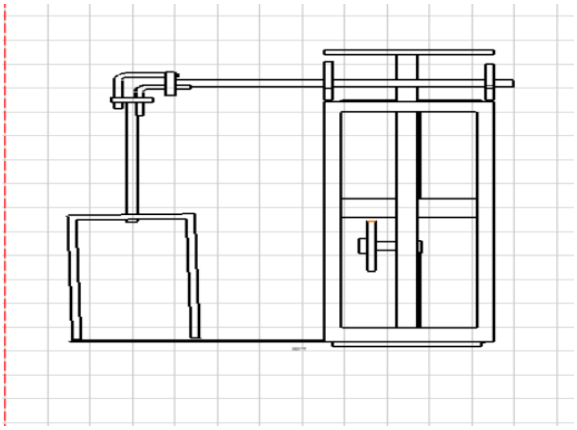

Fig. Front View

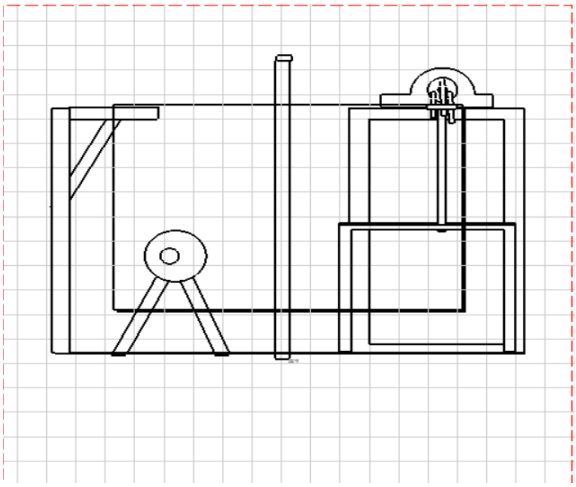

Fig. Side View

5. WORKING PRINICPLE

5.1 Drive unit

The transmission of power from human to processing unit is carried out with pedalling and gearless transmission system. The operator uses his feet & legs to rotate pedal. A shaft is mounted which is then used to transmit power to the process unit. The operator uses his feet & legs to rotate pedal around the crank axel. This is first stage of transmission. In second stage, this power is transmitted to stone wheels with the help of gearless transmission system.

5.2 Transmission unit

The transmission unit consists of gearless transmission system which provides the transfer of power at any desired angles. Gears are costly to manufacture and there is a need to increase the efficiency which cannot be done using geared transmission. The rotation of input shaft converts the rotational motion into sliding motion. The sliding motion of links is the converted to rotational motion of output shaft. Gearless transmission mechanism is capable of transmitting power at any angles without use of gears.

5.3 Process unit

Process unit is the one where actual crushing of pulses take place. This process unit basically consists of stone wheel, hopper &the hemispherical collector. The selection of stone wheels is made in such a way that it should not be too heavy to cause early fatigue to operator but it should be capable of delivering the required fineness of flour at optimum production rate. It also consists of a hopper in which pulses are stored. The pulses are then carried to the stone wheel mechanism. The pulses are grinded due to force applied by the stone wheel. The output of the stone wheel mechanism is collected between a hemispherical collector which is located below the stone wheel mechanism.

OBSERVATIONS AND RESULTS

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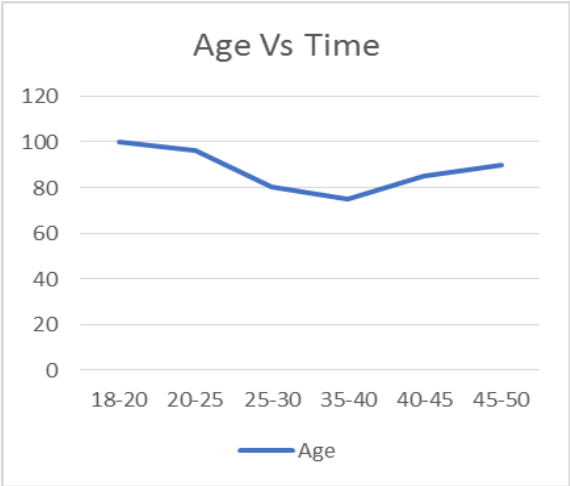

Fig. Age vs Time (in seconds) graph

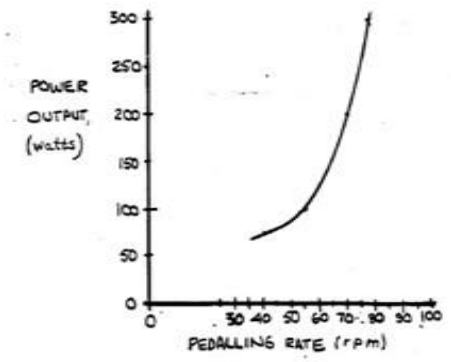

Fig. Variation of optimum pedalling rate with desired power output

A simple, easy to maintain and pedal operated grinder was developed, constructed and tested.

For conducting trials 8 personals from age group 20-50 were selected. The mean (± SD) of age, weight, height were 26.5± 3.5, years ,68.62±21 Kg ,176.8±3 cm respectively. All the trials started at 8 A.M.in the morning in the laboratory where the room temperature varied from 25-31˚C and relative humidity was 50-60% during experiment.

In order to find out most efficient, productive way operating the system, the input pedalling rate is set in three stages viz 30-50-rpm,50-70 rpm,70-90 rpm.

For 30-50 rpm, production rate observed was good but took time. The production rate found to be 100 seconds per Kg& average time that subject can maintain the pedalling is 15 mins.

For 70-80 rpm the production rate of dal was observed to be maximum. Further it was found difficult to maintain this pedalling rate more than 5 mins.

Thus, we can observe that the weight plays a role in the grinding process as more powerful person is able to produce more speed in the range of 50-70 rpm. This is turn is helpful in producing variety of different results that can be obtained. But this pedal operated grinder is producing and giving the output at a much smaller rate than the hand operated grinder. Therefore, we can say that the pedal operated grinder is a good way of producing output and grinding. We have seen that it takes 100 seconds maximum time for a person around the age of 18-20 to grind 1 kg of food grains. But a person at the age of 45-50 takes more time than person at the age of 25-30. Therefore, results obtained clearly suggests that the Pedal operated grinder performs the task which is given to him efficiently.

6. CONCLUSION

1. A new type of Pedal operated grinder can be fabricated which unlike other crushers will work on non-conventional energy source.
2. Apart from wheat grains, any type of food grains can be crushed using the given Pedal operated grinder.
3. In countries like India where ample human power is available, such human powered man machine systems will help in a great extend to improve the economic condition and employability of such countries in backward or remote areas.
4. Apart from use of such human powered man machine systems, those systems can be used for preparing poultry farm food which makes poultry farms in rural areas independent and such cheap poultry farm food will increase their profit margin.
5. Such systems are of utmost importance in Asian countries as almost all Asian countries are facing electricity scarcity which results in ten to twelve hours load shedding in rural areas.

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