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Compact and Cost-Effective Oil Expeller

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Abstract: Oil has become an essential commodity in various fields, including cooking. In India, coconuts are produced abundantly, making it the third-largest coconut-producing nation worldwide. Despite the massive demand for coconut oil, there is a shortage of its production, & the majority of the entities producing the oil are large-scale industries, with only a few operating in local shops.

The solution to this problem lies in the "Compact & Cost-Effective Coconut Oil Expeller," which has the potential to increase oil production & address the current gaps. The machine can operate with low quantities of copra, allowing customers to produce oil based on their requirements. Furthermore, it is a zero-waste process that enables the sale of the leftover parts after oil extraction. By facilitating chemical-free oil extraction & reducing space & initial purchase costs, the expeller machine offers an opportunity for small-scale industries to set up a profitable business, similar to flour mills in the area. This project addresses the issues with the currently used oil extractors, leading to the design & fabrication of an automatic portable oil extractor that could enhance the life & functionality of the unit for small-scale industries.

The project also incorporates a solar panel for multipurpose use, making it functional even in the absence of electricity. Ultimately, this work contributes to reducing the running cost of an industry & prevents sudden breakdowns on the shop floor, making it a valuable addition to the oil extraction industry.

Keywords: Compact and cost effective, solar panel, renewable, Ansys

I. INTRODUCTION

The groundnut oil expelling machine is a crucial tool for extracting oil from groundnut seeds. The process involves a roller mill, direct firing of the barrel, and pressing using an engine-driven oil expeller. This need for oil extraction machines has existed for a long time, driven by the demand for oil in both domestic and commercial settings.

Groundnut seeds, also known as peanuts and earth nuts, are primarily grown for their protein-rich seeds and edible oil. The oil content of the seed's ranges between 45% and 55%, depending on the variety. To extract the oil, the process of oil extraction, expelling, or expressing is carried out.

Groundnut oil extraction technologies involve sub-processing operations, such as shelling, roasting, de-skinning, milling, and kneading, which are performed using specialized machines. There are also machines developed to extract groundnut oil directly from shelled seeds, such as hydraulic press and screw press machines.

The groundnut oil expelling machine is a critical tool for extracting oil from groundnut seeds using a horizontal rotating metal screw that feeds the oil-bearing seeds into a barrel-shaped outer casing with perforated walls. The expeller continuously grinds, crushes, and presses the oil out of the seeds as they pass through the machine. The pressure ruptures the oil cells in the product, and the oil flows through the perforations in the casing before being collected in an oil receiving container. The remaining material from which oil has been extracted is sent out through the cake outlet.

II. OBJECTIVES

This project seeks to thoroughly evaluate a groundnut oil expelling machine that boasts of locally-sourced materials and increased durability. The main purpose is to examine and present a comprehensive assessment of this innovative machine. The following are the primary goals that this project intends to achieve:

1) Develop an efficient machine that can extract oil from groundnuts in a minimal amount of time.
2) Design, build, and test an expeller that is affordable for small-scale oil millers.
3) Create a compact cold-pressed coconut oil expeller that is suitable for local shops and capable of producing oil in accordance with customer demands.
4) Ensure that the machine is affordable in terms of both initial purchasing cost and ongoing operating costs.

Implement renewable energy sources, such as solar panels, to make the machine more sustainable and environmentally friendly.

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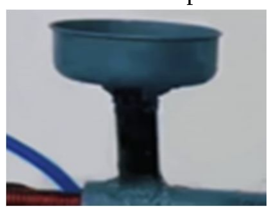
III. PROBLEM STATEMENT

A Compact and Cost-Effective Coconut Oil Expeller: Design and Fabrication." Copra is a plentiful source of oil that can meet the rising demand for daily use. By setting up local market expellers that produce fresh oil from copra, we can attract more customers and increase our profit. Industrial groundnut oil expellers are available in various sizes, shapes, and materials, but they are too costly and complex for small-scale and low-income oil millers. To help them, we need to design and construct small-scale groundnut oil expellers with locally sourced materials. Non-renewable energy sources are becoming more expensive and harmful to the environment. We need to explore alternatives that are renewable and clean. Solar energy is one such alternative that can power our expellers and reduce our carbon footprint

IV. DESCRIPTION OF PARTS

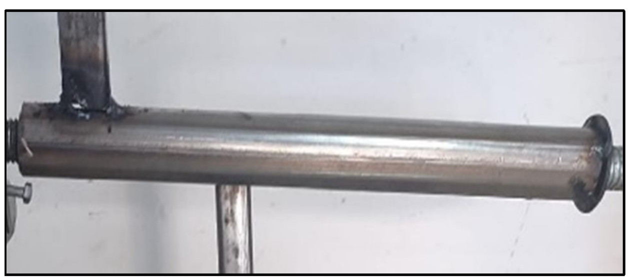
A. Hopper

A hopper is a funnel shape device used to move material from one receptacle to another.



B. Cylindrical Case

Dimensions:
Length of barrel =315mm
Diameter of barrel =36mm
Minor diameter of barrel = 32mm
Material - Cylindrical pipe (Stainless steel)



C. Expeller Shaft

This will be made into the following section; the section of the nut that crushes or grinds and presses. Dimensions of the Screw shaft:
Length of the shaft = 400mm
Diameter of shaft = 25mm
Minor diameter of the shaft = 20mm and pitch of the screw shaft =5mm
We will choose the material for the expeller screw based on the analysis result that we obtained that Mild Steel with Zinc Plating.

D. Frame Design

The machine is supported by frame which is fastened together using nut and bolt to enable easy dismounting. The prime mover is a 12Volt electric motor of 30 rpm with belt and pulley arrangement. Dimension of the frame
Top =350 x 250mm
Height =300mm
Material =Half inch angle iron (Mild Steel)

E. Solar Panel

The solar panel is assembly of few photovoltaic solar cells mounted in a rectangular frame. Sunlight is captured by with Solar Panels being a source of radiant energy, converting it into electric form of DC Current.

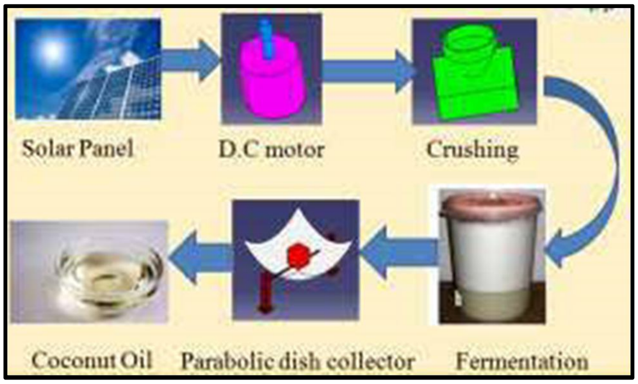
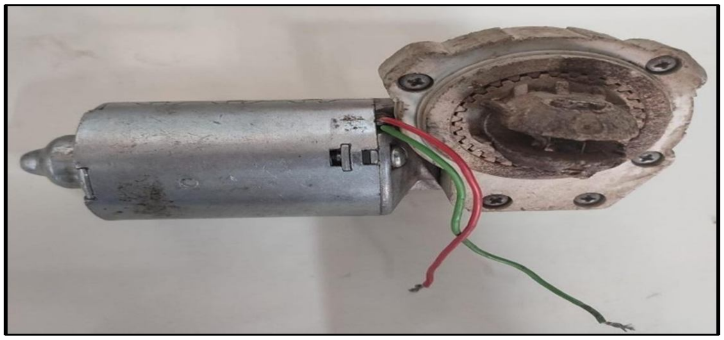


Fig 1: Layout of Solar Power Oil Extraction Machine

F. Motor

A motor of 12V and 2.36amp with power of 28watts is used to power the machine.



Bill of Material

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Table 1: Bill of Material

Serial No	Name of Part	Description of Material	Quantity
1.	Hopper	Mild Steel Plate	1
2.	Cylindrical Barrel	Stainless Steel	1
3.	Expeller Screw	Zinc Plated Mild Steel	1
4.	Motor	12Volt, 2.36amp	1
5.	Solar Panel	2.35Wp	1
6.	Frame (Body)	Mild Steel	1
7.	Raw material	Groundnut, Coconut, Oil seeds	-

CAD is a computer system (or workstation) that helps create, modify, analyze, or optimize a design. CAD software helps the designer work faster and better, communicate more clearly with documents, and create a database for making things. CAD output can be electronic files for printing, machining, or other making operations. CAD software for mechanical design can use vector graphics or raster graphics to show the objects of traditional drafting. But it is more than just shapes. Like in manual drafting of technical and engineering drawings, CAD output must give information, such as materials, processes, dimensions, and tolerances, following application-specific rules.

Cad Model

Fig.2

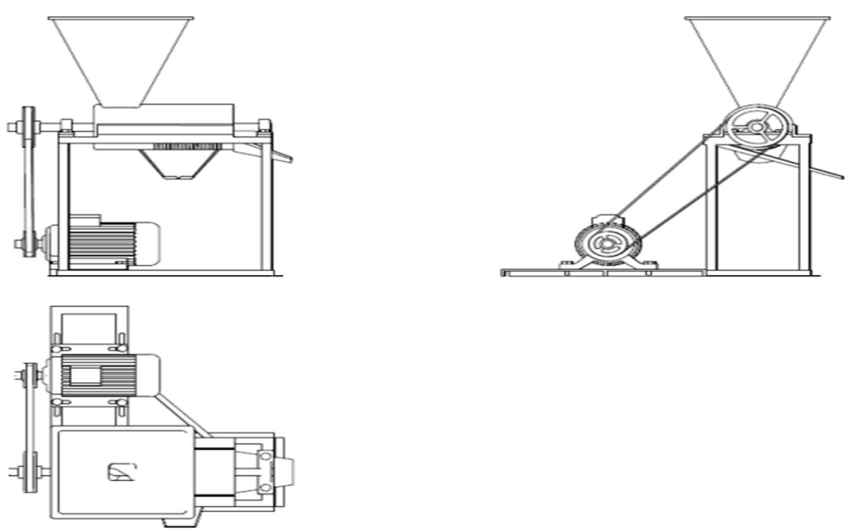

Fig 2a

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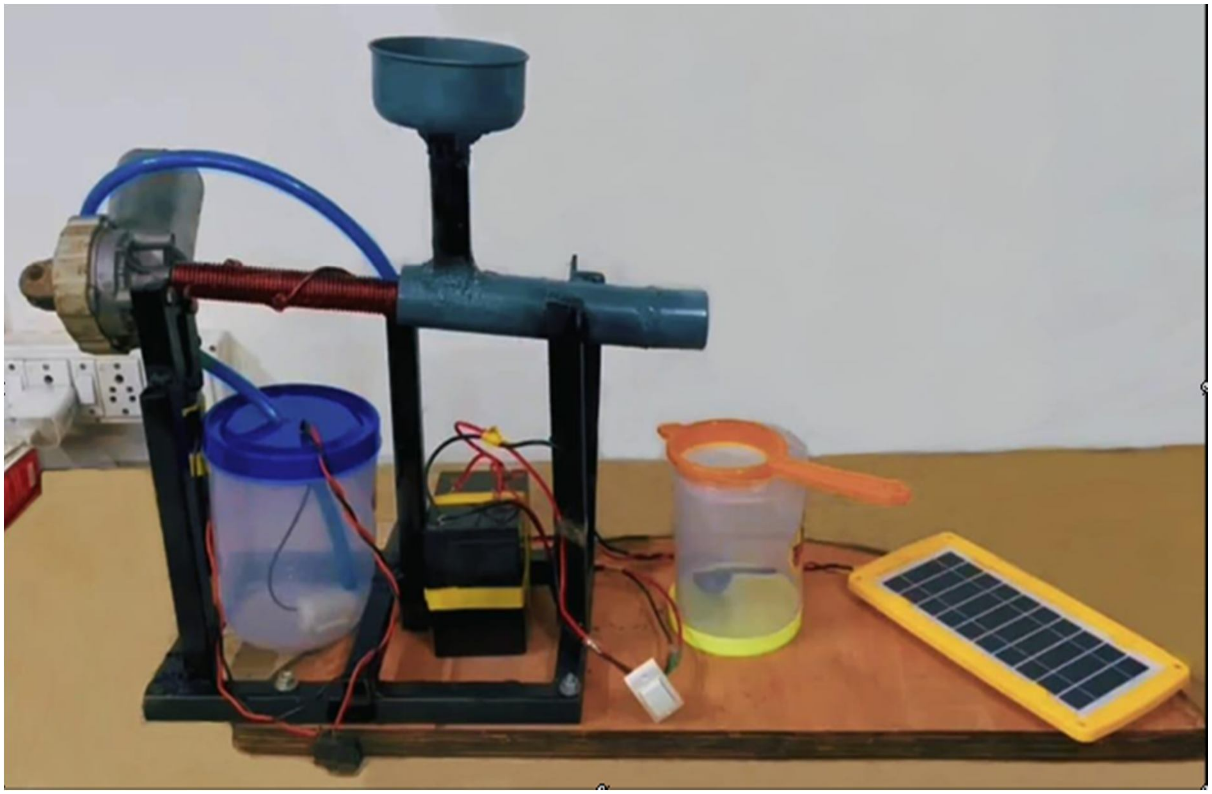
Main Model



V. ANALYSIS

FEM is a numerical method for solving engineering and mathematical physics problems. FEM is a numerical method for solving engineering and mathematical physics problems.

These problems usually need the solution to boundary value problems for partial differential equations. The finite element method makes the problem into a system of algebraic equations. The method gives approximate values of the unknowns at a discrete number of points in the domain. To solve the problem, it breaks a big problem into smaller, simpler parts that are called finite elements. The simple equations that describe these finite elements are then put together into a bigger system of equations that describes the whole problem. FEM then uses variation from the calculus of variations to find an approximate solution by making an error function smaller.

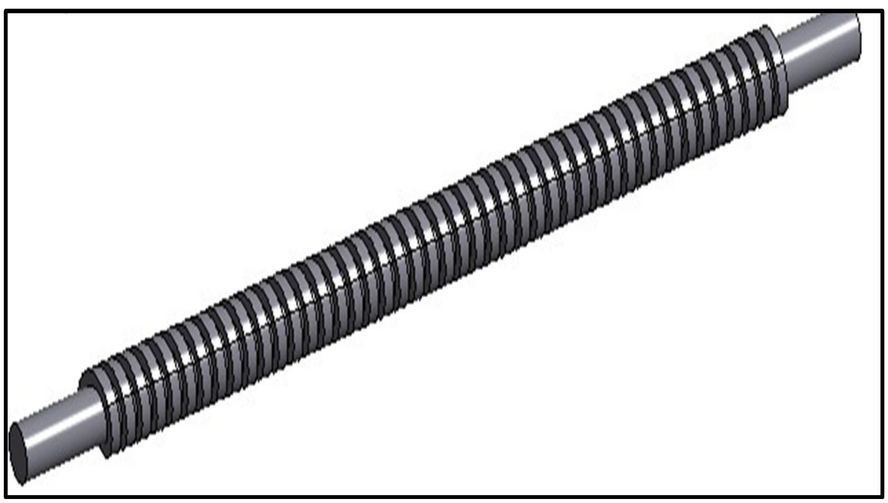


Fig 3. Geometry of expeller screw

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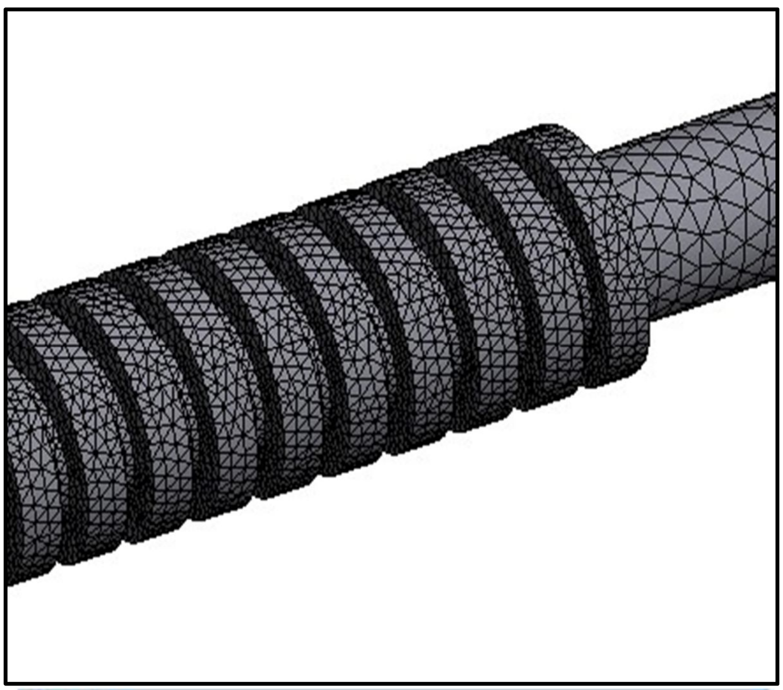
Properties of material

Properties of Outline Row 4: Structural Steel

	A	B	C	D	E
1	Property	Value	Unit		
2	Material Field Variables	Table			
3	Density	7850	kg m^-3		
4	Isotropic Secant Coefficient of Thermal Expansion				
6	Isotropic Elasticity				
7	Derive from	Young's Modul...			
8	Young's Modulus	2E+11	Pa		
9	Poisson's Ratio	0.3			
10	Bulk Modulus	1.6667E+11	Pa		
11	Shear Modulus	7.6923E+10	Pa		
12	Strain-Life Parameters				
20	S-N Curve	Tabular			
24	Tensile Yield Strength	2.5E+08	Pa		
25	Compressive Yield Strength	2.5E+08	Pa		
26	Tensile Ultimate Strength	4.6E+08	Pa		
27	Compressive Ultimate Strength	0	Pa		



Statistics	
Nodes	933013
Elements	214794

Fig 4. Meshing of expeller screw

Static Structural Analysis is carried out with the given loading conditions in ANSYS. At point A we applied the torque which we have calculated above and point B is fixed shown in fig. 5.

Fig 5. Boundary conditions

The results for Total deformation, equivalent stress and maximum shear stress are plotted as shown in fig. 6, 7 and 8.

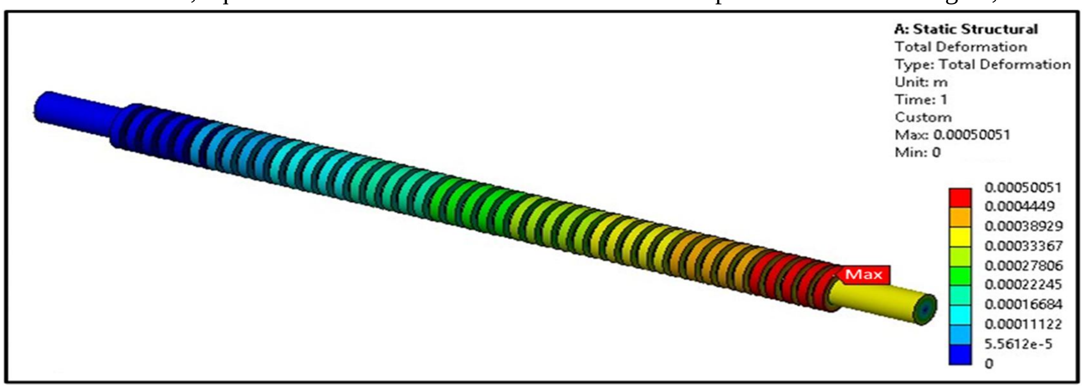


Fig 6: Total deformation

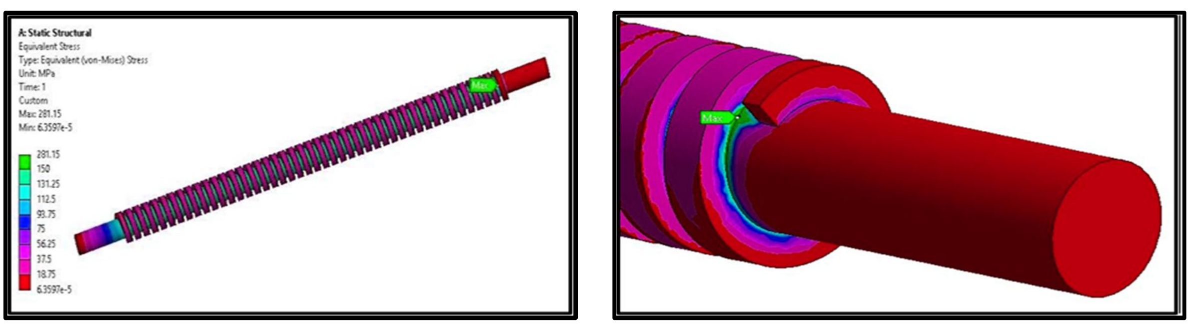


Fig 7: Equivalent stress

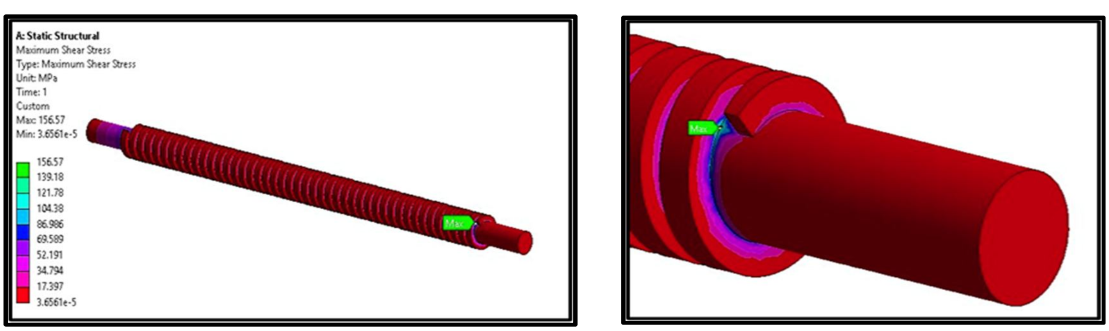


Fig 8: Maximum shear stress

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VI. RENEWABLE POWER SOURCE

The depletion of fossil fuels has led to the rising need to switch to alternative sources of energy that are renewable and sustainable. Implementation of Solar Panel in the machine enables the machine to operate using renewable energy, which is environment friendly as well as makes the machine more sustainable in case of unavailability of conventional sources of energy, thus, enhancing its overall utility.

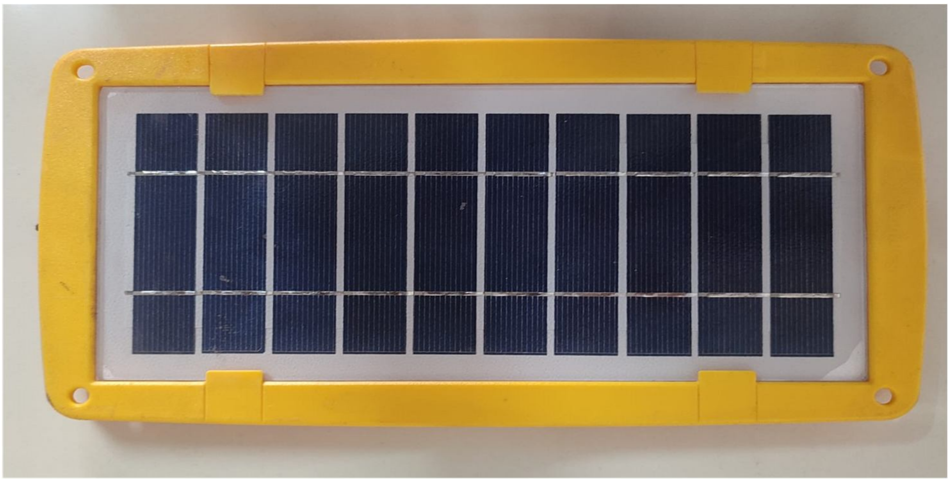

Fig 9: Solar Panel

VII. COST ESTIMATION

A. Machining Cost

Here we have to work on the different machines for having different operations. So, themachine is being hired for that much period of time.

Considering the depreciation and the electric light bill along with the rent of the workshop or the initial investment, the machining cost is calculated as the cost in Rs. /hour.

Following operations were involved:

Table 2: Machining Costs

Sr. No.	Machine	Time In hours	Rate In Rs.	Operation	Rupees
1	Lathe	5	100	Turning and boring	1500/-
2	Milling m/c	3	150	Teeth, slot, and gears	1450/-
3	Welding M/C	3	80	Fixing the linkages	1240/-
4	Drilling M/C and tapping Dieset	3	80	Making holes and, threads	1240/-
5	Boring attachment	1.5	100	Finishing inner dia.	2150/-
6	Grinding M/C	2	80	Finishing the comp.	1160/-
7	Cutting M/C	2.5	80	Parting off Objects	2200/-
	Total				10940/-

Hence the total machining cost (A) = Rs. 10940/-

Material Cost:

The cost of the raw material (C) = Rs. 500/-

Total Cost:

The total manufacturing cost = A + B + C + D (Miscellaneous)
= 10940 + 6560 + 500 + 750
= Rs. 18750/-

This cost can be reduced by 25%, if this machine is manufactured on Mass quantity asbelow:
Cost = 18750 – 3750 = Rs. 15000/-

The labour cost can be deducted from the total cost, as we have manufactured thismachine by our own.

VIII. RESULTS

The following outcomes were noted from the trials done. The raw material used were ground nuts, soy beans and grated coconut. Oil that got extracted was without any pureand without any additives.

Table 3: Results

Sr. No.	Material	Input Quantity (grams)	Output Quantity (ml)	Time Required (minutes)
1	Ground nut	100	20ml	6
2	Mustard	100	14ml	11
3	Coconut (grated)	100	8ml	15
4	Sesame	100	10ml	8

IX. CONCLUSION

The machine is simple and secure to use, consumes less energy and does not harm the environment. We have achieved our goal. However, the machine needs some improvement despite its high oil extraction rate. FEA of Oil Extraction Machine Screw, we conclude that Steel Grade Selection Will Be Based on Analysis. Vibration Analysis of Oil Extraction Machine is done and we get resonance frequency. Solar energy powers the set-up which preserves the non-renewable energy sources. Therefore, this system is cost effective and sustainable

X. ACKNOWLEDGEMENT

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