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Design and Development of Turmeric Polishing Machine

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Abstract: Polishing of harvested turmeric is a bigger problem for the turmeric producers in an India. The customer is in need of high quality polished turmeric for making turmeric powder. In this regard there is a need of polishing machine for washing turmeric to remove unwanted impurities and scales of harvested turmeric. The paper presents the new design of turmeric polishing machine which is based on designed for manufacturing, assembly and maintenance. The phenomenon of abrasion used in polishing, which is caused by the friction between expanded wired metal mesh and turmeric. The scale and unwanted impurities are fallen down on the base easily, which seems to be quite difficult in hand polishing. The designed machine is very simple in operation, efficient in polishing of harvested turmeric at a good speed of production. This machine seems very simple at same time very efficient in polishing about 50 kg of harvested turmeric at a speed about of 75 rpm for about 20 min.

Keywords*:* Turmeric polishing machine,

I. Introduction

India is a agriculture oriented country, agriculture is the prime business of India and so we aim to help the farmers by designing a mechanical device empowered width the capacity of polishing one of the important spice of India "The Turmeric". Turmeric is very important spice in India, which produces nearly entire whole world's crop and consumes 80% of it. India is by far the largest producer and exporter of turmeric in the world. Turmeric occupies about 6% of the total area under spices and condiments in India. As World scenario, Turmeric is also cultivated in China, Myanmar, Nigeria and Bangladesh. However, authentic figures about area and production are not available. Major area is in India which constitutes 82% followed by China (8%), Myanmar (4%), Nigeria (3%) and Bangladesh (3%).

Turmeric plays a very important role in increasing the taste of spicy Indian foods; also it is having a great role in medicinal product making. As the harvested turmeric product is surrounded by the mud and the other unexpected waste it was the prime need to polish the harvested turmeric and very there comes the idea of developing a machine which would meet such requirements. And that's because we thought of developing such a machine.

Table 1 Physical properties of turmeric

Physical property	Primary finger, raw		Primary finger, dried	
	Range	Average value	Range	Average value
Length, cm	8.94-9.55	9.25	5.15-7.50	6.3
Diameter, cm	1.47-1.69	1.58	1.0-1.4	1.2
Bulk density, kg/m3	678-710	694	470-496	483
True density, kg/m3	1,295-1,317	1,306	1,136-1,164	1,150
Porosity, %	46-47	46.5	57-58	57.5
Angle of repose, º	30-32	31	35-37	35-37

II. Need of Development of Machine

The need to develop such type of machine is raise due to the following reasons-:

Turmeric needs to be polished and cleaned before 48 hours after harvesting to avoid loss in its nutrient values since it is not every time possible to have this much man power to enable hand polishing ,machine polishing was required.

Machine polishing enables greater and furnished quality of turmeric which may or may not be possible in hand polishing.

There are some where drums are used but this development in the machine can provide simple and easier to operate whose working would be easily understood by the local farmers. This development tries to make machine smaller and compact so that space constrain should be satisfied also employ a gear pair to run the machine under power cut conditions which is being run by motor in normal conditions so that power cut would not hamper the production capacity.

III. Basic Concept of the Machine

Figure 2. Turmeric polishing machine

Turmeric rhizomes can be mechanically washed as well as polished in a portable, electric power operated, rotary drum type turmeric washing and polishing machine. The machine when operated at optimum rotational speed for optimum time can wash 50 kg of turmeric rhizomes. At optimum performance parameters, i.e.75 rpm for 15-20 min. there is no bruising of turmeric rhizomes. The same machine can be used for polishing turmeric with some modification.

To increase the friction, three detachable perforated screens (0.91mm) of G.I. steels are attached along the inner periphery of the drum with abrasive surface on the inner side. The capacity of turmeric polishing machine is 50kg. The optimum performance parameters for polishing are 75 rpm for 15-20 min. at which the desirable olive yellow color is obtained and the surface becomes smooth. The microbiological quality of turmeric rhizomes is also improved by polishing because the surface microbial load is reduced to half.

IV. Mechanical Design of the Machine

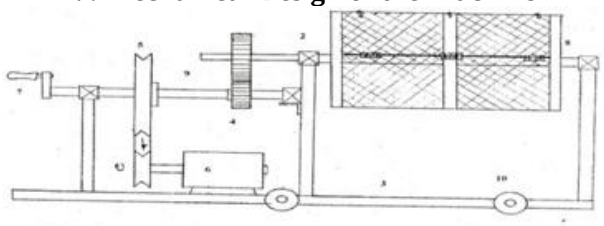

Figure 2 Conceptual design of turmeric polishing machine

Nomenclature:-
1 Drum (Expanded Metal Mesh) with door,2 Bearing,3 Base, 4 Gear Drive, 5 Pulley Arrangement, 6 Motor, Handle , 8,9 Counter shaft , 10 Roller for movement.

4.1 Design of Shaft:-

The diameter of shaft was determined on the based formula proposed by Sharma and Aggrawal (1998)

$$\text{Maximum shear stress} = \frac{16\times 103/\pi\times d3}{\sqrt{M2+Td2}} \quad (1)$$

τ_{max} allowable shear stress is 88.8 N/mm^2 as per ASME code, Maximum torque founded for the rated power 0.745 kw at a speed of 75rmp, there is gear mounted on the shaft 8 as in fig 2 which has 336 PCD and 30 N its weight. By considering gear weight and 50 Kg of turmeric i.e. 490 N. As shown in fig 5 Maximum bending moment obtained at point C.From equation (1) diameter of shaft was determined 20mm.

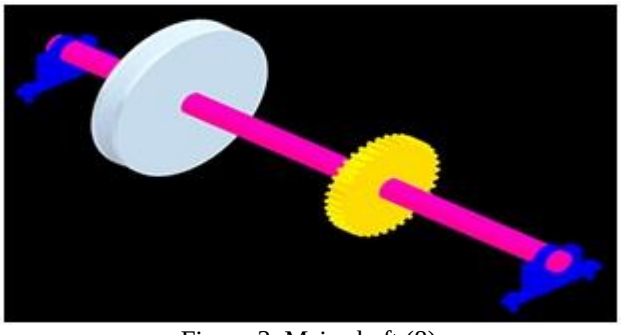

Figure 3. Main shaft (8)

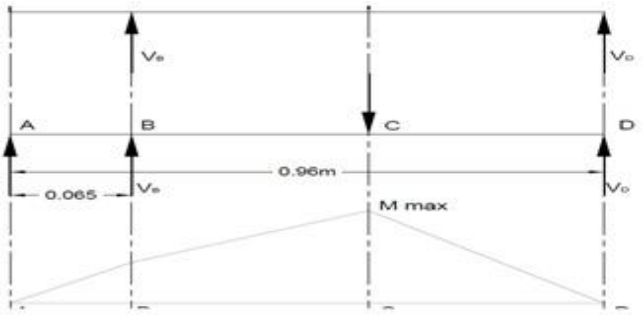

Figure 4. Bending Moment Diagram

Counter shaft diameter was determined 16mm by using equation (1), in fig. 1 the shaft is rotated by two bearing with speed of 300rpm, there is pinion 4 in fig.1 which is meshes with gear which has 84mm PCD with 21 teeth, By considering pulley weight 119N and the tensions on pulley 9, T_1 Tension on tight side 179.4N, T_2 Tension on slack side 47.43N

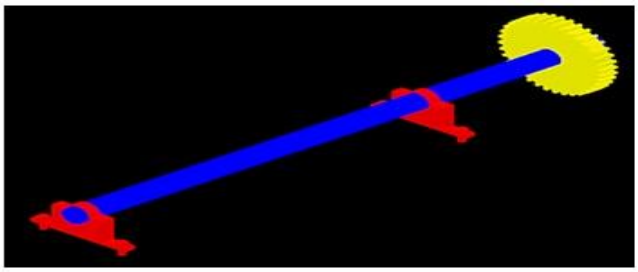

Figure 5. Counter Shaft (9)

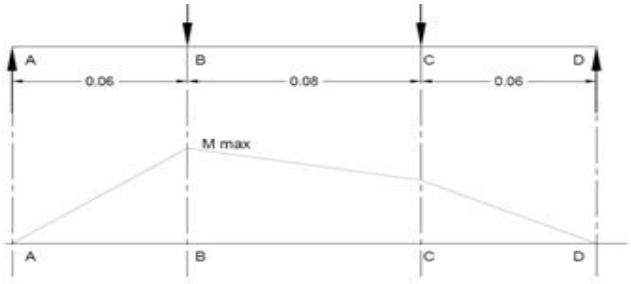

Figure6. Bending Moment Diagram

4.2 Design of V-Belt Drive:-

Motor power is transmitted with the help of v-belt drive for which rated power was 0.745 kw, with 1440 rmp, and driven shaft was running at 300 rpm for electric motor calcuted design power was 0.92 Kw, form design power selected belt designation is C, for which belt width 13mm,belt thickness 8mm,diameter of small pulley 75mm, The peripheral velocity (Vp) of the driving pulley and the diameter of driven pulley D_2, were obtained from Equations (3) and (4) given respectively by Joshi (1981) and Sahay (2006).

$$Vp = \frac{\pi\times D\times N}{(60\times 1000)} \text{ m/s} \quad (3)$$

$$\pi\times D_1\times N_1 = \pi\times D_2\times N_2 \quad (4)$$

No. of belt required 1, length of belt is calculated form equations (7) and (8) given respectively by Joshi (1981) and Sahay (2006): in which ɵ angle of lap on larger

pulley is 2.8 rad., power/belt 863.18W ,working load F_w ,centrifugal tension F_c, calculated from

Power/belt= $F_w - F_c$ (5)

$F_w=W^2$, $F_c= K_c((\frac{Vp}{5})^2)$ (6)

No. of belt= $\frac{Pd}{(power\ /belt)}$ (7)

Length of belt = $\frac{\pi(D1+D2)+2\times C+(D1-D2)^2)}{4\times C}$

4.2 Design of Bearing:-

The bearing were designed using the loads resulting from the belt tension as well as from gear drives, rotating drum, and the appropriate size and strength of bearing to withstand such a load selected from calculation by assuming 40 hours per week for three years, equivalent load on the bearing calculated from

$F_e = (X\times Fr+Y\times Fa) \times ks \times kp\times ko\times kr$ (9)

K_s =Service factor, K_o = Oscillation factor, Kr = Preloading Rotational factor, and X = 0.65 Y = 2.8 selected for Self aligning ball bearings,

$C = (L_{10})^{1/3} \times Fe$ (10)

Avg. life = $L_{10} \times K_{ref}$, (11)

$L = (\frac{c}{Fe})^n \times K_{ref}$ (12)

A ball bearing that will withstand the load was selected for C = dynamic load capacity, n = 3 for ball bearing., K_{ref} = 5 for 50% reliability, from the code is 0201 with outside diameter 24mm and 13mm. width.

V. Cost Estimation

Table 1 Cost estimation for different machine component

Sr. No.	Component	Material	Qty.	Wt. Kg	Per unit Price in Rs	Amount
1	Shaft	M.S.	2	12	45	538
2	Angle	M.S.	16	38	45	1710
3	Flat plate	M.S.	9	6	33	198
4	Nut & Bolt	M.S.	-	1.5	60	90
5	Bush	M.S.	5	0.5	70	350
6	Circular disk	M.S.	2	3	50	150
7	Wire mesh1	G.I.	1	-	-	250
8	Wire mesh2	G.I.	1	-	-	95
9	Gear	C.I.	1	3	-	531
10	Pulleys	C.I.	2	5	-	150
11	V belt	Rubber	1	-	-	122
12	Motor 1hp	-	1	18	-	1200
13	Bearing	-	4	-	225	900
14	Pinion	C.I.	1	0.5	-	126
15	Pedestal	C.I.	4	2	125	300

5.1 Miscellaneous Cost:-

Labour cost = 500Rs

Fabrication charges = 1000 Rs

Oil paint charges = 100 Rs.

Total Cost:-

Material cost +Miscellaneous cost

Total cost= 6710+1600 = 8310 Rs

6 Result and Discussion

It took 20 minutes to polished a batch of 50 kg turmeric in the polisher to achieve 8% polishing. The field test data of the turmeric polisher are given in Table 5.

Table 5 Field performance data

Parameters	Turmeric polishing machine
Material processed	Dried turmeric
Amount processed	100 kg
Operating time	60 min
Capacity	100 kg/h
Power consumption	0.3 kWh/q
Labour requirement	1 man.h
Breakdown of equipment	Breakage of Vbelt,sliping
Test result	8% polishing achieved
Overall performance	Satisfactory
Remark	Useful for on-farm polishing job

Fig. 11. And fig.12, shows result on the turmeric before polishing and after polishing the

Fig.11. before Polishing

Fig.12. after Polishing

Machine is being fabricated according to our design and seems to satisfy the required condition as mentioned below

1. It can clean 50 Kg of turmeric with good result in terms of quality as well as quantity

2. It can be easily operated at 75 rpm at optimum load and 65 rpm for maximum load.
3. It can clean turmeric minimum time 20 min. at 70 rpm.

VI. Conclusion

The turmeric polishing machine is simple in operation and easily accessible to farmer because of its simple design. All parts are easily available in the market, and machine is easily assembled and dissembled in case of breakdown as well as for replacement of any part. The machine is easy to operate and maintenance, and requires only one operator to operate. This machine is very efficient in polishing and 50kg of harvested turmeric has been polished at a time. The 50kg of turmeric could be easily washed at an optimum speed of about 75rpm for about 20 min using this machine. The developed machine uses simple mechanism which found to be a simple and cost effective solution to the turmeric producers. Performance of the equipment was found quite satisfactory and therefore, can be used for carrying out tedious post harvested polishing operation.

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