

Development and Performance Evaluation of Ginger Washing, Peeling machine and efficient Drying of ginger

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Abstract:

Day by day, use of spices is increasing in over the world. Some spices are good and some are bad. Ginger is one of the valuable and important thing in all kitchens. Time for ginger processing is quite high by traditional way, that is why in this paper we want to replace the traditional ways of ginger processing to improve the capacity as well as reduction in processing time. Now a days small scale farmers are taking their ginger bags and going to the water source (like river etc.) for washing the ginger only. After washing for Drying most of them are going to Drying plant which is not affordable for them, in this paper we will design and develop two machine one will perform the washing and peeling operation and another will improve the drying efficiency.

So we can use “Developed washing and peeling machine for washing and peeling operation” Also new “Developed Solar cabinet drier for drying operation”. In this paper we will evaluate their performance and design. Washing is important for all types of vegetables as well as fruits before their use. In our machine washing will be performed by abrasive material connected to drum assembly. Capacity of drum is of 6-8kg (approx.). One metal frame support the drum and motor and drum will be used for peeling and washing operation. AISI C-channel frame is support structure. Revolution per minute for drum is 100 and belt drive is used for peeling. Velocity ratio of belt drive is 5.6 which is sustainable in belt drive. 1HP three phase motor is used for power. For drier cabinet of AISI material is there of square section which will supporting structure for drier and all the surfaces of drier will be black painted which will reduces the drying time by 2-3 hrs. as compared with ordinary open sun drying. Size of drier is of 700x700mm. Height of drier is 1000mm. There are two trays for placing the ginger pieces on it. Weight of each is 100gm. Maximum temperature rise in the cabinet is 55 to 60 degree Celsius which is good to avoid the extra heating or bursting of ginger pieces. Trays of the cabinet made up of perforated sheet of metal (AISI) and another one is made from glass to improve the heating of ginger. Heat carried away by the cabinet drier per KG is 131.71KJ. Normally open sun drying of ginger takes 20-24hrs for complete drying of ginger, After using the drier it reduces by 8-6 hrs that is time taken by the cabinet to dry the ginger completely is 8-10 hrs for one batch. It is reliable and profitable for small scale farmers to use both this setup instead of wasting of water and time, budget of our machine is 48,500rs only. Group of small scale farmers can buy this and they can do the task of washing peeling and drying at one place without going anywhere. So that transportation cost travelling cost also get reduced and it becomes profitable for farmers.

Keywords — Ginger, washing, Peeling, drying, Shaft, Bearings, Farmers.

I. INTRODUCTION

Ginger is the most important cash crop among all spices, and many ginger growers in the north eastern region rely on it for their living. Ginger is grown in practically every state in the region, but Meghalaya, Mizoram, Arunachal Pradesh, and Sikkim are the largest producers. However, due to a lack of local demand, growers suffer marketing challenges and are forced to sell surplus crops outside of the state through middlemen at lower prices. Although ginger is a seasonal item,

it is widely utilized in a variety of dishes. To make the crop profitable, it is necessary to transform a portion of it into low-volume, high value ginger. Different goods, such as dehydrated ginger, ginger oil, and ginger oleoresin, could be produced because it is widely available in the region. Ginger oil is largely utilised in the confectionary and soft drink businesses as a flavouring aid. Ginger can also be used to treat many diseases. The current project plan study constructs with the possible market opportunity of such units in mind. The major goal of such an effort is to make efficient use of the abundant

resources available in the area and to provide a year-round supply of products to the market. The dried subsurface stem or rhizome of the Zingiberous herbaceous plant is known as ginger or adrak. Zingiberofficinale rhizomes are used to make ginger. When the tops of the ginger plants have died down, the rhizomes are dug out. Ginger, among the many vegetable crops, has a lot of potential for commercialization in the north eastern region. In Indian, Continental, and Chinese cuisine, fresh and dried ginger, ginger oil, and ginger powder are used in large quantities in a variety of vegetarian and non-vegetarian dishes. Ginger is also used in many families and pharmaceutical companies for its medicinal potential. These products' exports have also increased dramatically over time. Because of the growing use of these goods in many culinary and allied industries in the country and overseas, there is a solid opportunity for the development of a ginger-based industry to fulfil the region's future needs. There is a lot of potential for the growth of ginger-based industries in the country and overseas to satisfy the region's future needs. Ginger is a spice and a preserve made from the subterranean stem (rhizome) of a perennial herb. India is the world's leading ginger producer, accounting for 35 percent of global production. We will make two machines. One for washing, peeling and another one for drying of ginger of small pieces. We want to make one metal bar frame on which HDPE drum will be there for washing and peeling.[1] We will make cabinet drier for drying of ginger in combination with hot mechanical air drier. Inside that drier drying of ginger will be takes place. [7] Washing will be carried out inside the drum simultaneously peeling will be happen with the help of hard nylon brush type structure mounted on inside surface of drum. [1] We want to reduce costing as well as want to make machine of washing and peeling that will operate manually also with the help of electricity. Relevance: In previous days peoples are used to go on river sides or sea sides for washing and peeling of ginger, for that process plenty of water is wasted out. Also for peeling that carried out by human efforts. All that processes like washing, peeling we want to carried out in drum because of that wastage of water will be reduce and also human efforts. We will design our machine such that it can run with manual as well as with the help of electric motor. That is it can run with or without electricity, for manual operation we will provide one handle. This are the some of the advantages of our project.[4]

II. EXISTING TECHNIQUE

Ginger is a spice and a preserve derived from a perennial herb's underground stem (rhizome). India is the world's largest producer of ginger, accounting for 35% of global production. Traditional methods of washing and peeling has different drawbacks that we want reduce with the help of mechanical designing of a machine according to follows: Designing and development of Mechanical washing and peeling machine also efficient drying with the help of Solar cabinet dying(with blower) is the title of our project. To do the Performance

Evaluation of the process is our ultimate aim. Reduce the efforts and costing of the overall process. Existing techniques are of traditional washing and peeling and drying under the open sun which is not affordable and time consumable

III. DESIGN AND ANALYSIS

Design of Drive:

Our velocity ratio for Pulley & Belt need to be considered. Capacity of our machine is about 5 kg. Also for designing we will use catia software for 3D and Autocad for 2D. Preparation of Manufacturing Drawing.

Following are the some components and their specifications: Frame: Material: mild steel (C Section) dimensions: (length x height x width) in mm Drum:

Material: Galvanized Iron Sheet Capacity: 12 lit.

Dimensions: diameter: 400mm Height: 620mm Driving Pulley Driven Pulley AC induction motor of 1HP of rpm 1440. Revolving shaft: Length: 1200 mm. diameter: 60mm cabinet drier dimensions: frame: 600x600x700mm

Calculation: Power required to peel the skin of ginger :

1. Mass of ginger = 2kg
2. Mass of drum = 3kg
3. Specification of drum (22lit):-
4. Length of drum = 370 mm
5. Width (dia) of drum = 280 mm
6. Weight of drum = 1.84 kg
7. Standard Dimensions :-
8. Specification of drum :-
9. Length of drum = 370 mm
10. Width (dia) of drum = 280 mm
11. Weight of drum = 1.84 kg

1] Determination of torque acting on shaft:-

Weight of drum = 1.84kg

Weight of ginger = 2kg

Weight of the metal sheets for peeling = 0.5kg

Weight of water in the drum = 0.5kg (circulating)

Total Weight = 1.84 + 2 + 0.5 + 0.5 = 4.84 kg

Now weight in N = 47.4641N

Radius of drum = $313/2 = 156.8\text{mm} = 0.156\text{m}$

Torque = $F \times r = 474641 \times 156.5 = 7475.08 \text{ N}\cdot\text{m} = 7.4274 \text{ N}\cdot\text{m}$

2] Power Required to drive the shaft Assume $N=200 \text{ rpm}$
 $P = 2 \times 3.14 \times N \times T / 60000 \text{ kw} = 2(3.14) \times 200 \times 7.42479 / 60000$
 $P=0.555$

Two or more pulleys are connected by a belt in a belt and conveyor system. Axle-to-axle communication of mechanical power, torque, and speed is now possible. When pulleys have different diameters, a mechanical advantage is gained.

• Required Drum RPM = 200 rpm

• Actual Motor Shaft Rpm = 1120 rpm Speed Ratio = $N1/N2 = \text{Speed Ratio } 1120/200 = 5.6$ If we Select Driving Pulley 2'' then We have to select 11'' Driven pulley. Driving Pulley:

- Location : Mounted on Motor Shaft
- Material : Cast Iron Grade 3
- Diameter : 50 mm Driven Pulley:
- Location : Mounted on drum shaft end
- Material : Cast Iron Grade 3 Diameter : 280 mm

Design of Shaft : Shafts are a common and important machine component. It is a rotating component with a circular cross-section that transmits power. The shaft can be hollow or solid, depending on the use. The shaft is supported on bearings and rotates a set of gears or pulleys to convey power. Forces acting on the shaft include bending moment, torsion, and axial force. The basic purpose of shaft design is to locate the strains caused by the aforementioned loads at critical points along the shaft. Axle and spindle are two other forms of coupled shafts. The axle is a non-spinning component that supports rotating wheels without transmitting torque. The term "short shaft" is used to describe a shaft that is not too long. As belt drive can sustain for small vibrations of shocks so we can use flexible V-belt drive. $KW = 0.746 \text{ kw}$

$$N = 200 \text{ rpm}$$

Step i) Selection of material:- Shafts are subjected to torsional shear stress Therefore we can use plain carbon steel of grade 40C8 ($S_{ut}=380 \text{ N/mm}^2$) Factor of safety assumed to be 2 Keys are subjected to shear & compressive stresses and the pins are subjected to shear bedding stresses on basis of strength criteria plain carbon steel of grade 30C8 ($S_{ut}=400 \text{ N/mm}^2$)

Step ii) Dimension of Shafts: Diameter of shafts Starting Torque= 150 % rated torque $M_t = 60 \times 10^6 \times 0.746 \times 1.5 / (2 \times 3.14) \times 200$ $M_t = 534.283 \times 10^3 \text{ N-mm}$ $T = 16 \times M_t / 3.14 \times d^3 \times 95 = 16 \times (534.283 \times 10^3) / (3.14 \times d^3)$ $d = 30.59 \text{ mm}$ $d = 32 \text{ mm}$ Method 2] Based on hollow shaft design: $KW = 0.746 \text{ N} = 200 \text{ rpm}$ $t = 80 \text{ N/mm}^2$ Assume $D_i = 0.6 \times D_o$

1] Torque Transmitted by shaft: $M_t = (60 \times 10^6 \times KW) / (2 \times 3.14 \times N) = 118714.1948 \text{ N-mm}$. 2] Inner and Outer Diameter of shafts: $C = D_i / D_o = 0.6$ From the design of hollow shaft on strength basis we have standard equation is as follows: $t = (16 \times M_t) / ((3.14 \times D_o^3) \times (1 - C^4))$ $80 = (16 \times 118714.1948) / ((3.14 \times D_o^3) \times (1 - C^4))$ $D_o = 31.59 \text{ mm}$ $D_i = 0.6 \times 32 \text{ mm} = 17.89 \text{ mm}$ Therefore we can take the diameters of shafts as 32mm and 16mm as standard sizes are available in the market.

Design of Bearings:

Design of bearing:- Total Weight of drum = 4.84 kg = 47.4641 N Radial load on each bearing = 47.4641/2 Fr = 23.7320 N $N = 200 \text{ rpm}$ $L_{10} = 30000 \text{ hr}$ $d = 32 \text{ mm}$ Step 1] Dynamic load capacity The bearing is subjected to pure radial load, $F = F_r = 23.7320 \text{ N}$ $L_{10} = 60 \times N \times L_{10} / 10^6 = 60 \times 200 \times 30000 / 10^6$ $L_{10} = 108 \text{ million Revolutions}$ $C = Pr \times (L_{10})^{1/3} = 23.7520 \times (36)^{1/3}$ $C = 113.01 \text{ N}$ From standard table We can use the bearing 61806 Bore diameter = 30 mm Outside diameter = 42 mm Width = 7 mm Material:- Cast iron bearing Chrome steel bearing Weight = 600 gm Selection of Motor: As the power required to drive the shaft is 0.555 Kw so we can use the three phase AC motor of 1 Hp power rating as the starting

torque is 150% of rated torque it is easy and safe to use the 1 Hp motor Design of Drier: Size = 3x3 Feet

Number of trays = 2 Mass of both trays = 50 g Weight of glass = 2 kg Weight of ginger = 3 kg Number of supporting pillars = 4 Total weight of dryer = 5.5 kg = 5.5 x 9.81 = 53.95 N Total load on pillars = 53.95 N Load on each pillar = 53.95/4 = 16.48 N Now, Total heat supply to machine $Q = m \times C_p \times (t_1 - t_2)$ Where, $T_1 = 55^\circ\text{C} = 55 + 273 \text{ K}$ (inside temp) $T_2 = 27^\circ\text{C} = 27 + 273 \text{ K}$ (initial temp of ginger) $Q = 3 \times 1.5085 \times (328 - 300) = 3 \times 1.508 \times 28$ $Q = 131.71 \text{ KJ}$

Galvanized Iron Sheets: GI sheet stands for galvanised iron sheet in its entire form. It's a type of steel sheet that's been zinc-coated to prevent corrosion and extend its useful life. Galvanized plain sheets and galvanised profile sheets are available on the market. Steel sheets that have been zinc-coated are known as galvanised iron (GI) sheets. These sheets come in a variety of hot dip galvanised finishes. Size of GI sheets: 700x900mm two sheets are used as packing material for the drier it will covers the drier from three sides.

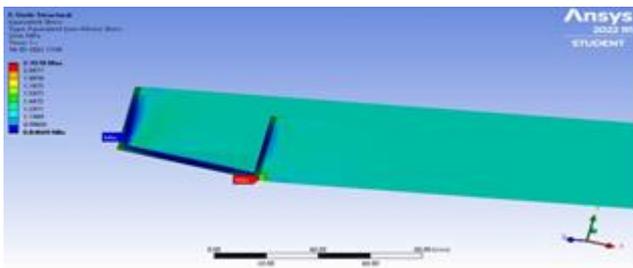
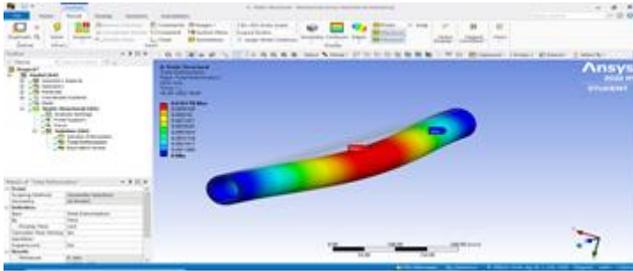
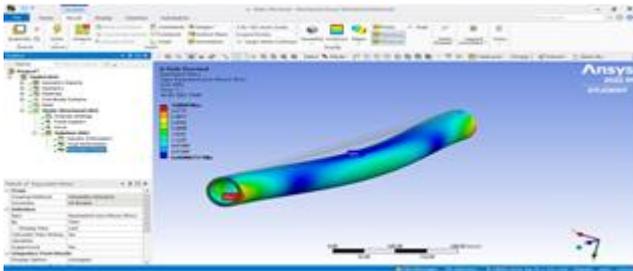
Poly carbonate sheets: Instead of glass, polycarbonate is utilised for doors and windows. These sheets are also utilised for showers and swimming pool enclosures to complement current house decors. Balconies, patios, and decks are some of the other areas where these sheets are employed in residential projects.

The biggest drawback of polycarbonate is that it is not scratch resistant. For example, if a branch falls on a polycarbonate patio canopy, the canopy may be scratched. Polishing the polycarbonate will solve this issue. One of the most significant differences between acrylic and polycarbonate is the cost. Acrylic sheets can be up to 35% more expensive than polycarbonate sheets.

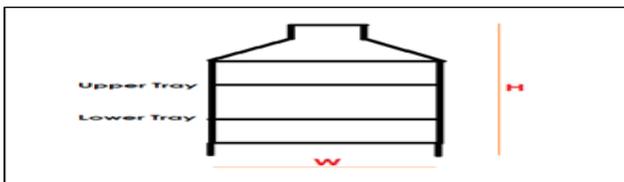
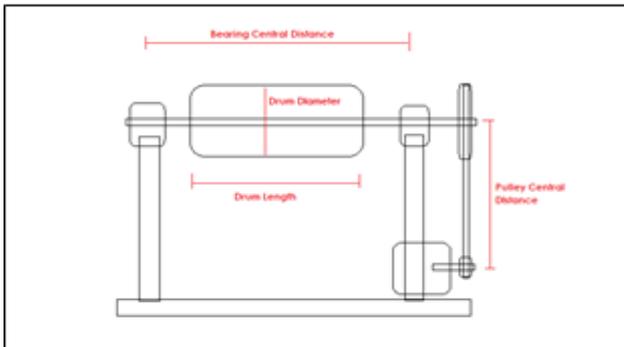
Polycarbonate is a high-performance insulating glazing material that gives the transparency and optical clarity of glass at a fraction of the weight and expense. It's ideal for conservatory roofs and sunrooms. Polycarbonate is extraordinarily strong, with 200 times the impact resistance of glass. When compared to fibreglass, polycarbonate panels offer a more cleaner and fresher appearance. When fibreglass is exposed to the outdoors and time, it becomes dingy relatively quickly. Regardless of the type or amount of modifications done to polycarbonate, it retains its clean appearance and strength.

Size of the Polycarbonate sheet: One Sheet of polycarbonate will cover the front door of the cabinet drier. It is having 900x700mm size which will cover the front side of drier. Polycarbonate is a transparent, impact-resistant, rigid, and durable polymer that can resist extreme temperatures. Polycarbonate sheet, rod, and tube are extremely durable and easy to work with. It thermoforms well, paints quickly, and adheres well to solvent cements and adhesives.

Analysis using Ansys:



CAD DESIGN OF MODEL:



IV. RESULT AND DISCUSSION

The result obtained from the both the machines are good and profitable as compared with the traditional methods of ginger processing: Following are the result obtained from the setups:

Observations obtained from washer and peeler when we vary the time:

Load on machine (ginger weight): 5kg

Sr. No.	Time of operation on washer and peeler	Electricity consumption	Quality of washed and peeled ginger
01	15min	12.45units	Fair not so good
02	25min	20.75units	Good
03	35min	29.05units	Better as compared with other
04	45min	37.35units	Best peeled ginger

Observations obtained from washer and peeler when vary the load in the drum:

Time of operation is being constant: 40min

Sr. No.	Load in the drum	Quality of washed and peeled ginger
01	3kg	Good for the drying
02	4kg	better

03	5kg	Best peeled and washed
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Drying with the help of the cabinet drier improves the Drying capacity and efficiency of the process also it reduces the time and cost of drying with the help of drier we can easily place under the open sunlight, then maximum heat from the sunrays will get absorbed by the black painted plate which acts a flat plate collector. With the help of flat plate painted with black paint it is easy and reliable to dry the ginger pieces and rhizomes along with we can dry our vegetables also foods and anything. This is the another one benefit of the cabinet drier.

V. CONCLUSIONS

A drum ginger peeler was developed. Design specifications of the peeler developed are presented. Experiments on mechanical peeling of ginger were conducted by varying drum load for various peeling durations.

From all over the evaluation it is sure that use of peeler and washer is better than any other method of processing. Use of the setup easily and no any extra skill is needed to run the operation on the machine. Following are the conclusion made after the successful evaluation of the process on the machines:

First and foremost thing the use of electricity for the operation is very less in amount which is profitable to the customer or user.

Increase in the time duration of washing and peeling operation in the drum it will increases the consumption of electricity but quality of peeled ginger will increases. When machine peel the ginger for 45min in the drum then that time duration is the best.

By keeping the operation time constant and varying the load on the machine it will increases the torque of motor and rpm gets reduces in small amount, with the increase in the load by keeping the load 6 kg and operation duration 45min then that will be the best combination for good quality ginger.

The drier not only for ginger drying but also for multiple use and it will always improves the efficiency of drying and reduced the drying time.

Increase the time duration of drying from 5hrs to 11hrs the moisture content in the ginger will get removed when we keep the drier in open sun for 12 hrs all the moisture content in the ginger will gets removed.

Normal open sun drying takes 24-30hrs for drying but in cabinet heat will get absorbed by the black plate because of that for complete drying of ginger only 10hrs are needed.

From all above we can conclude the best combination for operation is 6Kg of ginger with 10 hrs of cabinet drying.

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