African Journal of Food Science Vol. 4(11), pp. 718 - 722, November 2010
Available online http://www.academicjournals.org/ajfs
ISSN 1996-0794 ©2010 Academic Journals

Full Length Research paper

Design and development of manually operated fruit bar/candy sizer machine

Ranjeet Singh* and D. Banshi Shukla

Central Institute of Agricultural Engineering, Nabi-Bagh, Berasia road, Bhopal, India-462038, India.

Accepted 04 August, 2010

In view of the importance of proper sized candies having sharp edged sides for high quality standards and in various capacities, a manual operated fruit bar/candy sizer machine based on the principle of dye and punch system was designed and developed. The main components of the sizer machine are base table, cutter blade assembly and manual operating system consisting of flywheel, flywheel shaft and flange connected eccentrically. The base table of the sizer machine was made from 1300 × 800 × 5 mm thick MS sheet with 2 mm thick SS Sheet top. Two MS bright bar 670 mm long, 50 mm diameter was fitted over the base table to support the cutter blade assembly attached with connecting rod, MS flange and flywheel. Angular movement of flywheel imparts up and down movement of cutter blade assembly against the solid base table fitted with food grade plastic sheet resulting in sizing of the fruit bar/candy sheet. The plastic sheet acts as dye and cutter blade assembly as punch. The sizer had the provision to cut the fruit bar/candy into different sizes just by changing the cutter blade unit made-up of 5 mm thick sharp edged SS sheet having eight segments. The capacity of manually operated sizer machine was 50 kg/h with excellent sharp edged size fruit bar/candy of 10 × 5 cm with 8 pieces in single cut without any damage.

Key words: Sizer, fruit bar/candy, sizer design.

INTRODUCTION

India is unique in having a long fruit season and varieties to suit every plate. The cull, low grade and/or surplus fruits can be utilized for the preparation of value added products. India is the largest producer of fruits after China, with an annual production of 44.04 million tonnes of fruits from an area of 3.72 million hectares (Anon, 2004). Among a large variety of fruits grown in India: Mango, banana, citrus, guava, grape, pineapple, and apple are the major ones. Out of these, a good quality fruit bar/candy can be prepared. The fruits pulp has been dehydrated to form fruits leather/bar or candy with addition of sugar, acid and other ingredients. Researchers have worked on the quality improvement of mango bar (Rao and Roy, 1985; Mir and Nath, 1993), fortified mango bar (Mir and Nath, 2000) apple cloth (Singh, 1989), guava papaya blended fruit bar (Vennilla, 2001), Jack fruit bar (Manimegalai et al., 2001). In the present scenario, high quality ready to eat fruit bars can attract consumers appeal and fetch good price in the market. At domestic or cottage level, these fruit bars are sized with sharp edged knifes resulting in irregular cutting. Industrial scenario is some thing different, where sizing is done with hi-fi pneumatic cutters, which are very expensive. In view of the importance of proper sized candies having sharp edged sides for high quality standards and in various capacities, a manual operated fruit bar/candy sizer machine based on the principle of dye and punch system was developed. The main components of the sizer machine are base table, cutter blade assembly and manual operating system consisting of flywheel, flywheel shaft and flange connected eccentrically.

MATERIALS AND METHODS

Sizer machine consisted of base table, cutter blade assembly and manual operating system consisting of flywheel, flywheel shaft and

*Corresponding author. E-mail: razi100@rediffmail.com.

Table 1. Component detail of fruit bar sizer machine.

S/No.	Components	Material	Quantity
1	Flange	Mild steel	1
2	Flywheel shafts	MS Bright bar	1
3	Ball Bearings	Std	2
4	Bush	Mild steel	2
5	Fly wheel	Mild steel	1
6	Cutter blade frame with bush	Mild steel	1
7	Bush and flat	Mild steel	2
8	Connecting rod assembly	Mild steel	1
9	Check nuts	Mild steel	2
10	Stud	Mild steel	1
11	Hitch	Mild steel	2
13	Connecting rod pin	Mild steel	1
14	Plastic sheet	PVC	1
15	Cutter blade assembly	Mild steel	1
16	Connecting rod stud	Mild steel	1
17	M-12 Hex. Nut Bolt, 65 mm long	Std	10
18	Base flat	Mild steel	3
19	Bright bar	Mild steel	2
20	Base table top	Mild steel	1
21	Handle	Mild steel	1
22	Flywheel support channel	Mild steel	1
23	Base table	Mild steel	1
24	Split pin, 3mm dia, 30 mm long	Std	1
25	M-12 Bolt, 25 mm long	Std	1
26	M-25 Bolt	Std	1
27	M-8 Bolt	Std	2
28	Sunk key	Mild steel	2

flange connected eccentrically. Component detail of sizer machine is given in Table 1.

Design aspects

The purpose of design is to transform the resources in the best way possible into needed device or systems. As designing means to take decisions therefore a designer has to choose the best out of the available alternatives of source keeping in view some constraints imposed. A decision based upon conjecture, poor judgments and inadequate knowledge is likely to result in poor design. Important aspects of design are given in Table 1.

Detailed design

The design includes the finalization of the details and preparation of working drawings, which can be handed over to the manufacturer. In this, complete specification of all the components are assigned. The detailed diagram of cutter/ sizer machine was shown in Figure 1.

Dimension of fruit bar sheet

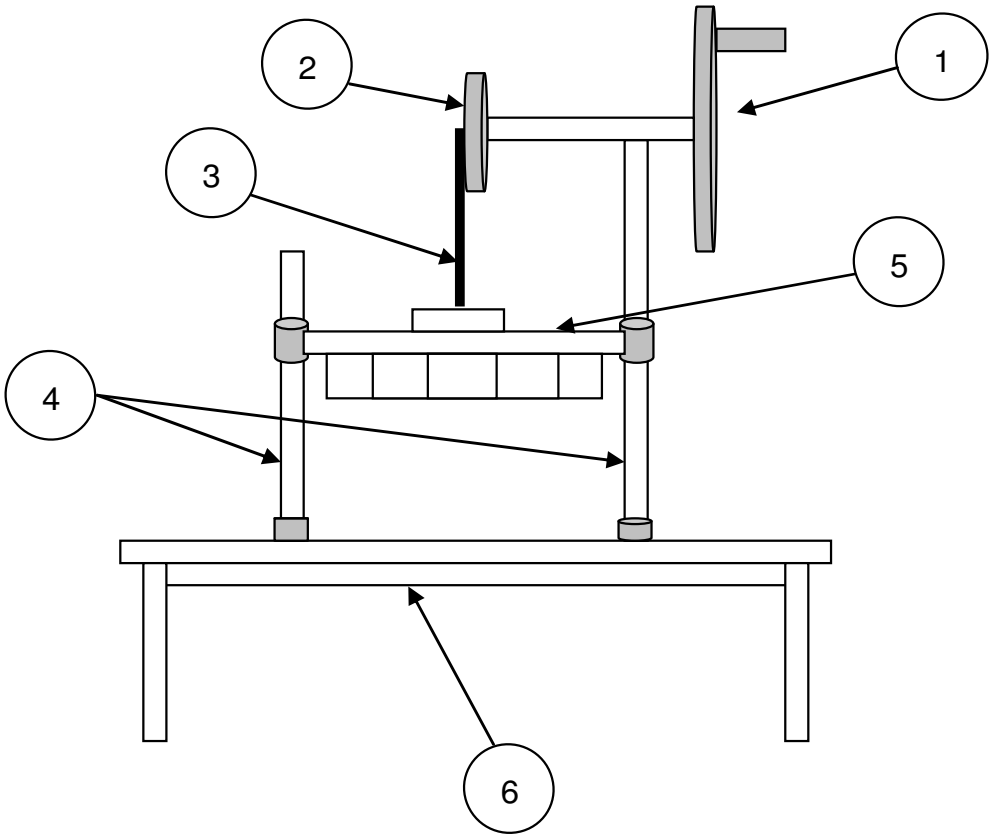
The dimensions of fruit bar sheet after drying in cabinet tray dryer are 700 × 400 mm. The final moisture content of the fruit bar sheet after drying was in the range of 13 to 14% (w. b.). Dried fruit sheets are further reduced into small pieces of definite sizes with the help of developed sizer machine manually.

Base table

Keeping in view the dimension of the dried fruit sheet, the dimensions of sizer machine are decided. Base stand of sizer was made from 70 × 70 × 8 mm mild steel square section. Length and width of the base table was 1000 × 800 mm square shaped. The height of the table was kept 1000 mm for proper working height of the sizer. The table frame was covered with 2 mm thick mild steel sheet with 1 mm stainless steel sheet fitted atop to act as a base for the sizer. The dimensions were also chosen, keeping in view the comfort in working (Table 1)

Main support shaft with bush and flat

Two main support shafts (Bright bar) 670 mm long and 50 mm diameter were fitted inside the bush on the base table with the help of mild steel flat (Figure 1).



Component no.	Component name
1	Flywheel assembly
2	Flange connected with flywheel shaft
3	Adjustable connecting rod assembly
4	Main support shaft with bush and flat
5	Cutter blade assembly
6	Base table

Figure 1. Schematic diagram of manually operated fruit bar/candy sizer machine.

Cutter blade assembly

This consisted of cutter blade, cutter blade frame, adjustable Connecting rod and bearings.

Cutter blade

The dimension (that is width of the blade) of the cutter blade was decided keeping in view the width of the dried fruit sheet. The width of the dried fruit sheet was 40 cm. Thus, the width of the cutter blade was kept 40 cm for full width cutting with minimum pilferage. The required size of fruit bar is 100 × 50 mm sized bar as per our requirement. Hence, keeping in view the requirement, the dimension of the cutter section was calculated as:

Length of the cutter blade = 100 mm.

Separate full fruit bar sheet in 7 columns. In one column there is 8 fruit bar pieces of 100 × 50 mm. Height of the cutter blade was 100 mm for stronger support and sharp cutting action (Figure 1).

Cutter blade material

In cutter blade with strict aseptic requirements, it is important to select material so that it can withstand repeated cutting action cycles. Stainless steel blade is useful material because it gives smooth surfaces, is non-toxic, corrosive proof, non erosive and it is usually ease to sharpen the edges of the blade. The thickness of the stainless blade was kept 5 mm for stronger cutting action (Table 1)

Adjustable connecting rod

Connecting rod was made with mild steel, circular in section. The length of the cutting blade. The length of the connecting rod was kept 325 mm centre to centre. Both ends of the connecting rod were fitted with ball bearing having 20 mm internal diameter for

Table 2. Typical uses of material used.

Type of steel	Carbon (%)	Uses
Mild steel	0.18 - 0.20	Sheets
	0.20 - 0.30	Shafts and connecting rod
	0.35 - 0.45	Flywheel, flanges and keys
Stainless steels	0.3 - 0.4% carbon 4.5 - 18% chromium.	Cutter blade and base plate top

smooth running. Left hand thread and right hand threads were provided for appropriate pressure, accurate cutting and fine adjustment. The adjustable connecting rod and cutting blade is connected horizontally with mild steel pin 20 mm in diameter (Figure 1). The bearing fitted inside the seat of the connecting rod ends and were supported by mild steel washers 5 mm thick, circular shaped to prevent lateral thrust of the pressure exerted during cutting (Table 2).

Anti-frictional bearings

Ball bearings are used in sizer machine as anti-frictional bearings.

Manual operating system

This consist of the following components: Flywheel, flywheel shaft and flange connected eccentrically.

Flywheel

The main function of flywheel is to store energy and deliver at the time of peak requirement. Its design was based on following formulas:

$$K.E = \tfrac{1}{2} . I. \omega^2 \quad (1)$$

Where:
I – Moment of Inertia
ω- Mean speed of flywheel, rad/s.

After differentiating (1), we get

$$\delta E = I. \omega. \delta\omega \quad (2)$$

Equation 2 is an important equation for design of flywheel, or

$$\delta E = I. \omega^2. \delta\omega/\omega \quad (3)$$

Where, δω/ω is co-efficient of fluctuation of speed.

From equation 2, weight of the rim of the flywheel was calculated. For disc type flywheel

$$\text{Moment of Inertia} = \tfrac{1}{2} . I. r^2$$

Where, r is radius of flywheel.

The diameter of the flywheel is worked out to be 380 mm, having 50 mm hubs external diameter. The thickness of the flywheel was calculated as 35 mm (Figure 1).

The length of handle is 220 mm for smooth and proper operation of the machine (Figure 1). The flywheel is supplying 120 N force during cutting which is an essential requirement for cutting fruit bar.

Design of Flywheel shaft of sizer machine

On the basis of strength: Shaft may be subjected to torsional loading, bending of axial loads or to a combination of these loads. When a pure torque, T acts on a circular shaft of diameter d, then

$$T = \pi/ 16\, d^3 f_s \quad (4)$$

Or

$$d = 1.72 . \sqrt[3]{T/ f_s}$$

Where:

d - Diameter of solid shaft and
Fs - 600 kg/cm^2; Maximum permissible shear stress.

The length of the flywheel shaft was 600 mm having diameter of 40 mm. The shaft is provided with sank keyholes of size 5 x 5 mm (Figure 1)

To support flywheel, flywheel support channel 520 mm long, both ends fitted with 200 × 50 × 20 mm mild steel base flats was provided (Figure 1)

Flange

To impart up and down motion to the blade assembly mild steel 310 × 20 mm, circular flange was fitted with connecting rod with the help of connecting rod stud (Figure 1). The flange is provided with eccentric hole of 10 mm diameter. The circular flange is mounted at one end of the horizontal flywheel shaft.

RESULTS

The fruit bar cutter/sizer machine was fabricated as per design and testing was done with papaya fruit bar. 50 papaya fruit bar sheets were cut in 100 × 50 mm pieces with the help of sizer machine manually. The weight of each sheets were around 1kg. The detailed test report for cutting and testing of fruit bar was given in Table 3. The capacity of manually operated sizer machine was 50 kg/h with excellent sharp edged size fruit bar/candy of 100 x 50 mm with 8 pieces in single cut without damage.

Table 3. Detailed test report for cutting fruit bar.

S/No.	Average weight of sheets (kg)	No of sheets cut	Average time for cutting (min)	Average shavings (G)
1	1.10	10	8	24.56
2	1.18	10	8	16.24
3	1.22	10	10	25.12
4	1.13	10	11	24.42
5	1.20	10	13	25.36
Total	5.83	50	60	23.14

REFERENCES

Anon (2004). National Horticulture Board. Annual report 2003-2004.
Rao R, Ray N (1985). Studies on dehydration of mango pulp. Indian Food Packer, 29(1): 64-79.
Singh SP (1989). Standardization of a simple process for apple cloth, Pantnagar. Rp. No. 5327: 17-23.
Mir M A, Nath N (1993). Storage changes in fortification of mango bar using soy protein concentrates and coconut powder. J. Food Sci. Technol., 30: 279-287.
Mir MA, Nirankar N (2000). Protein fortification of Mango Bar using Soy Protein concentrate and coconut powder. J. Food. Sci. Technol., 37(5): 525-528.
Manimegalai G, Krishnaveni A, Kumar RS (2001). Processing and preservation of jackfruit bar. J. Food Sci. Technol., 38(5): 529-531.
Vennilla P, Kingslay RP (2001). Studies on the preparation and storage behaviour of sapota-papaya fruit bar. Beverages and Food World, pp. 39-40.