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Development and testing of lab model mango slicer and cube cutter for pickle industries

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Abstract : Pickling is one of the oldest methods of food preservation. The major unit operations involved in pickle making are slicing and cutting, brining, salting and processing and pasteurization operations. In India, manual labour is used for slicing and cutting operations. The mangoes are available only for a short period. Hence hiring labour for short period is difficult due to labour scarcity and incurs higher cost. Also manual cutting is unhygienic. Hence, lab model mango slicer and cube cutter were developed for mechanizing the cutting operations in a Pickle industry. The capacity and efficiency of the mango slicer and cube cutter are 500 Kg/hr, 100 Kg/hr and 80 per cent, 86 per cent respectively. The cost of operation of cutting of mango into cubes has reduced from Rs. 352/tonne to Rs.192/tonne compared to manual cutting. The mechanical cutting is faster to handle larger quantities of mango in shorter period. It is also hygienic. Hence, these machines are very useful for pickle industries having processing capacity of 1 tonne/day.

Key words : Mango slicing, Cube cutting, Efficiency, Cost of operation, Labour requirement, Hygienic condition.

Introduction

India is one of the largest exporter of horticultural produce both in the raw form and processed form exporting 2,99,000 tonnes of food earning Rs. 761 crores of US $ 200 million during 1997-98 (Anon, 2001). Among the processed products, pickle is one of the major item. Pickling is one of the oldest method of food preservation known to mankind. A pickle is defined as an edible product that has been preserved and flavored in a solution of brine and edible acid. Pickles are good appetizers and adds to the palatability of a meal which help in the digestion of food. In addition to the foreign exchange, lot of pickle is sold in the domestic market. The major unit operations involved in the making of pickle are slicing and cutting, brining, salting and processing, and pasteurization opera-tions (Linda *et al.* 1976). In foreign countries machines are available for cutting potatoes in to cubes.(William, 1975). But these machines are not useful for cutting mangoes which contain seed at the center. Due to the developments in the package technology, lot of manufacturers are producing mango pickle in small scale industries. One of the major problems in pickle industries is that the availability of mangoes is only seasonal. The mangoes are to be cut into pieces during the short mango season. Hence large number of labours are required for a short period of time. The mangoes are cut into pieces only using manual labour which involves higher cost and labour scarcity. Moreover manual cutting of mangoes is unhygienic. Hence the necessity of mechanical slicing and cube cutting was felt and the present study was taken up to develop and test a mango slicer and cube cutter.

Materials and Methods

The cutting of mangoes into cubes was achieved in two stages. First the mango was cut into vertical slices by raw mango slicer and the slices were cut into cubes using raw mango cube cutter.

Raw mango slicer:

The raw mango slicer consists of main frame, blades and shaft assembly, inlet and outlet chute and power transmission system. The main frame was made out of 40 mm X 40mm X 4mm MS angle and was having the dimensions of 500 mm width, 1000 mm length and 1000 mm height. There were six blades fixed in a frame of dimension 500 mm length, 400 mm width and 700 mm height inside the main frame. Two pairs of shaft were mounted perpendicular to each other using 25 mm ball bearings. Circular blades of 200 mm dia and 1 mm thick were mounted on the shaft using hubs. The hub is having 120 mm dia where the blade was attached and 50 mm dia where shaft was connected. The top pair of shaft were fitted with one blade per shaft and the bottom pair of shafts were fitted with 2 blades per shaft. The bottom blades are separated using 20 mm spacer. The inlet chute is made out of four L angles of 25mm X 25mm X 2mm and were connected in such a way to form a chute so that the raw mangoes can be fed in to the cutting section in vertical direction. The two pair of shafts were powered by two number of 1 hp single phase electric motors. The power was transmitted to the two shafts using chain and sprockets. The ratio of the sprockets were designed in such a way that the revolution of the shaft was 400 rpm. Two idler sprockets were used to rotate the blades in opposite direction to each other. There was an overlap of 1mm between the blades to ensure proper cutting of the mangoes. The outlet was made of MS sheet and was fitted at a angle of 45° to the horizontal so that the cut mangoes are collected on one side of the machine.

Raw mango cube cutter

The raw mango cube cutter consists of main frame, cutting blade assembly, feeding drum, inlet, outlet chute and power transmission assembly. The frame was made of 40 mm X 40 mm X 4 mm angles and was having dimension of 900 mm length, 460 mm width and 750 mm height. Seven numbers of circular cutting blades of 150 mm dia were used to make the cutting blade assembly. The blades were fixed on a 15 mm dia shaft and 20 mm thick spacers were fitted in between the blades. The blades were held in position using lock nuts. The entire assembly was mounted on the frame using bearings. The feeding drum was fabricated using 180 mm diameter, 200 mm length and 6 mm thick MS pipe. Two end plates of 180 mm dia and 8 mm thick were welded on the sides to form a hollow cylinder. The feeding drum was fitted with 25 mm shaft and mounted on the frame using ball bearings. Seven rows of grooves of 2 mm X 2 mm were made along the circumference of the drum at center to center distance of 20 mm. To hold the mango slices in horizontal direction while cutting 7 rows of pegs of size 25mm length and 5 mm dia. rods were welded on to the feeding drum. This ensures the perfect cutting of the slices by the blades. A scrapper with 7 nos. of pegs was fixed on the other side of the drum to remove the pieces sticking in between the blades. A cover was provided on the top of the blade and drum assembly to prevent any injury to the operator. An opening size of 160 mm length and 100 mm width was provided to feed the mango slices in longitudinal direction. An inlet of size 400 mm length, 160 mm width and 50 mm height to store and feed the mango slices in to the feeding drum was fitted on the frame. An inclined outlet was provided at the bottom to collect the mango cubes. The power was transmitted from one hp electric motor to the blade assembly using V groove pulleys and belts. The blade assembly was rotating at speed of 450 rpm and the feeding drum was rotating at 10 rpm.

Performance evaluation

One of the very popular forms of mango pickles is "Avakaya" in which the mango pieces shape to be kept intact till it is consumed. For ensuring this the mango is cut in to pieces in such a way that the hard embryo cover is present in every mango piece. Due to the

presence of the hard embryo cover, the shape is maintained till its consumption. Based on this factor the performance of the machines were evaluated using the following methodology.

Chinna rasam variety of mango was used for testing. The raw mangoes were fed in to the mango slicer and the cut mango slices along with the kernel were collected at the outlet. The time taken for cutting 50 kilograms of mango into slices was recorded. Almost all the kernels were separated due to the impact of the cut slices on the outlet. The kernels were separated and discarded. The mango slices with hard portion of the embryo cover and without hard potions of the embryo cover were seperated.

The capacity of the mango slicer 'C_s' was calculated using the equation

$$C_s = (W \times 60 \times 60)/ T \quad \text{------- (1)}$$

Where C_s - Capacity of the machine, kg per hour.

W - Weight of the mangoes fed in to the slicer, kg.

T - Time taken, sec.

The efficiency of the slicer was calculated using the equation (2)

$$Ps = \{W_H)/(W_H - W_K)\} \times 100 \quad \text{----- (2)}$$

Where

Ps - Efficiency of the Mango slicer, percent

W_H - Weight of the slices with the hard embryo cover, kg.

W_K - Weight of kernals, kg.

A known quantity of the mango slices with the hard embryo cover was fed in to the raw mango cube cutter. The mango cubes were collected at the outlet. The mango cubes with the hard embryo cover and without hard embryo cover were separated and weighed. The capacity of the cube cutter 'Cc' was calculated using the equation (3)

$$C_c = (Ws \times 60 \times 60)/r \quad \text{------ (3)}$$

Where

C_c - Capacity of the cube cutter, Kg per hour.

Ws - Weight of the mango Slices fed in to the cube cutter, kg.

T - Time taken, sec.

The efficiency of the cube cutter was calculated using the equation (4)

$$Pc = \{W_{CH}/W_S\} \times 100 \quad \text{---- (4)}$$

Where

Pc - Efficiency of the cube cutter, percentage.

W_{CH} - Weight of the cubes with the hard embryo cover, kg.

Ws - Weight of the mango slices fed in to the cube cutter, kg.

The cost of operation of the machines for cutting 1 tonne of mango was calculated as per IS:9164-1979 (Anon, 1979) for manual cutting and machine cutting.

Results and Discussion

The performance results of the operation of the machines are given in Table 1. The capacity of the raw mango slicer and cube cutter was found to be 500 Kg per hour and 100 Kg per hour respectively. The capacity of the cube cutter can be increased by increasing the number of blades in the cutting blade assembly.

The efficiency of the raw mango slicer was 80 per cent. The capacity of the machine can be increased considerably by grading the fruits before feeding in to the machine. If the size of the fruits are less than 40mm width and more than 55 mm width the efficiency of the machine falls considerably.

Table 1. Performance results of the Raw Mango slicer and Cube cutter

Sl.No.	Parameter	Raw Mango Slicer	Raw Mango cube cutter	Manual Cutting
1.	Capacity (Tonnes / hr)	0.5	0.1	0.01
2.	Efficiency (%)	80	86	97
3.	Cost of operation Rs. / Tonne)	192		352

The performance of the cube cutter was found to be 86 percent. Usually the corner pieces of the machine were without the hard embryo cover. But the pieces are effectively used for preparation of other kinds of pickles like mango thokku or mixed fruit pickles etc. Hence it reduces the wastage.

The cost of operation of cutting the mango by manual cutting was Rs. 352 / tonne, while by machine was Rs. 192/tonne.

These machines are useful for Industries having a capacity of production of around 1 tonne per day. The labour requirement is reduced up to 80 per cent when compared to manual cutting.

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