

Original Research Article

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Development of *Mung wadi* (Green Gram Nuggets) Making Machine

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ABSTRACT

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The *mung wadi* (Green gram nuggets) making machine was developed which consisted of cylinder, piston driving mechanism, trigger and handle assembly and the extrusion plate. The *mung wadi* making machine was optimized at three parameters namely, diameter of extrusion hole, moisture content of batter and length of stroke. The machine parameters [extrusion hole diameter 8 mm, length of stroke 0.4 cm and moisture content of batter 45-50%(wb)] of *mung wadi* making machine has been found to be suitable on the basis of size of *wadi*, capacity of machine and optimum cooking time of *mung wadi*. The capacity was found to be maximum (635.93 g/min) for treatment combination of extrusion hole diameter 8 mm, moisture content of batter 45-50% (wb) and length of stroke 0.4 cm (D1M1L3). The optimum cooking time was found to be minimum (5.683 min) for combination of extrusion hole diameter 12 mm, moisture content of batter 45-50% (wb), and length of stroke 0.2 cm (D3M1L1).

Introduction

Green gram (*Vigna radiata* L.) belongs to family *Leguminosae* is one of the major food legumes grown and consumed which is also commonly known as *mung* bean. The nutritional composition of *mung* beans contains high levels of protein, a digestible carbohydrates and low concentrations of fat and fibres. The local product like *mung wadi* which is made using soaked green gram is very popular in Vidharbha region of Maharashtra and also consumed all over India and is used throughout the year. *Mung wadi* is

a popular traditional pulse based culinary item used in many Indian dishes. Mainly it is prepared manually in rural areas using green gram dal by skilled women by using fingers for dropping *mung wadi*. Mechanizing the process of preparation of traditional food and its value addition by incorporating the hygienic ingredients in Indian Heritage Foods may provide an opportunity to explore its product to world market. An extrusion technique might be a suitable proposition for the process of *mung wadi* making. Extrusion is used for quite long time for extrusion of products like vermicelli, pasta, in the food

industry, where the food materials are mixed, wetted, melted, cooled and /or cooked before being forced through a die in order to get definite shape product (Rahman *et al.*, 2002). Stickiness of the dough, non-uniformity in quality are some of the drawbacks of few commercial machines, which can be avoided by mechanical extrusion (Sridhar 1991). The product is having very good market demand in the country and also in abroad. In the view of this increasing demand for *mung wadi* in Indian market, mechanisation of the *wadi* making process is very important. There is no literature available on the mechanization of *mung wadi* making process. Thus efforts were made to develop the *mung wadi* making machine. The objective of this work was to develop a portable, manually operated *mung wadi* (green gram nuggets) making machine and to evaluate the performance of developed machine.

Materials and Methods

The developed *mung wadi* (green gram nuggets) making machine consisted of cylinder, piston, trigger and a handle, extrusion plates. The manually operated system consisted of handle and lever assembly for actuating the piston inside the cylinder. A piston extends through the two aligned openings formed in the center of handle. A piston was used to compress the batter in the cylinder which makes the batter to squeeze through the holes of the extruding plate. Three plates having extrusion hole of star peripheral diameters of 8 mm, 10 mm, and 12 mm were used during extrusion process. The front and the side view is given in Fig. 1.

Cylinder

Cylinder is a storage device used to dispense the batter through extrusion plate. Cylinder was made up of stainless steel. The capacity

of the cylinder in this design was considered to be 1.5 kg of *mung wadi*, totaling upto 2 kg of batter. The bulk density of batter was experimentally found to be 4.24 g/cm³. Therefore the dimensions of the cylinder were calculated as 10 cm diameter and 15 cm height.

Piston

A piston extends through the two aligned openings formed in the center of handle. A piston was used to compress the batter in the cylinder which makes the batter to squeeze through the holes of the extruding plate. The piston was welded to a piston plate.

Piston driving system

Piston driving system is the heart of the mechanism of developed machine. It consists of two grip plates and two compression springs. The two grip plates have central aligned openings which loosely receive the piston rod there through. Actuation of piston occurs due to compression of two springs. The two springs of same diameter having different tension were used. By drawing the trigger towards the handle, the grip plates moves relative to the piston causing the openings to grip the piston and move it into the cylinder. When the trigger is released it returns to its original position along with the grip plates by the spring. The piston is normally held against rearward movement during the return of grip plates to their starting position and in fact at all times by a one way clutch or lock formed by a metal strip located at the rear of the handle (Sherbondy, 1953). The Fig. 2 shows the piston driving mechanism.

Trigger and Handle assembly

The combined trigger and the handle assembly comprise a channel shaped, sheet

metal member having two side walls and an interconnecting rear wall and a knob. Complete assembly was made up of stainless steel. The trigger when pressed against the handle, actuates the piston to moves downward. The trigger decides the length of stroke required for extrusion of *wadi*. Handle is an important component of the assembly and during operation it provides support to the machine. The knob present at the center of the handle engages the strip and moves it against the force of springs when the trigger is drawn towards the handle by operator. When the knob is pressed, the strip slightly reciprocates with the piston and piston can be moved up and down freely. The piston can be withdrawn from the cylinder manually by pressing the knob and strip forwardly against the force of springs. With the complete handle and trigger assembly the machine can be lifted during operation.

Extrusion plates

It was the most important part of machine made up of stainless steel. The diameter of extrusion plates was kept 10 cm. Star shaped hole was drilled in the extrusion plate. Three plates having extrusion hole of star peripheral diameters of 8 mm, 10 mm, and 12 mm were fabricated. Extrusion plate is fitted to cylinder with the help of collar. Total numbers of extrusion holes in one extrusion plate were nine. Fig. 3 shows the extrusion plate having three different extrusion hole diameters and a collar.

Performance evaluation of developed *mung wadi* (green gram nuggets) making machine

The green gram dal was soaked for 4-5 h and then grinded to make batter. The batter of two different moisture content levels [45-50% (wb), 50-55% (wb)] was filled in the cylinder. The experimentation on *mung wadi* making

machine was conducted at three diameters of extrusion hole(8 mm,10 mm,12 mm) and three lengths of stroke (0.2 cm, 0.3cm, 0.4 cm). The effect of various parameters like diameter of extrusion hole, moisture content of batter, length of stroke on capacity of *mung wadi* making machine and optimum cooking time of prepared *mung wadi* were determined.

Capacity of *mung wadi* making machine

The capacity of *mung wadi* forming was calculated by the following formula described by Kalaivani *et al.*, (2012);

Capacity of *mung wadi* making machine
(g/min) = $\frac{w}{t}$

Where,

w = weight of *mung wadi* prepared

t = time required to prepare the *mung wadi*

Optimum cooking time

The optimum cooking time is defined as the time required in cooking when the cooked sample does not contain any white core (uncooked part) in it (Battacharya and Sowbhagya, 1971). This time was estimated as follows. Eight to ten *mung wadi* were cooked in a boiling cooking medium (2% NaCl solution in distilled water). A *wadi* was withdrawn at a time a regular interval (1 min) and then it was pressed in between two transparent colourless glass slides. The pressed nugget, which shows no visible core in it, was identified and its time of cooking was noted.

Results and Discussion

The developed *mung wadi* making machine was evaluated with eighteen different treatment combinations of extrusion hole diameters of 8 mm, 10 mm, 12 mm (D1, D2,

D3), the moisture content of batter at two levels i.e. 45-50%(wb), 50-55%(wb)[M1,M2] and length of stroke of 0.2 cm, 0.3cm, 0.4 cm(L1, L2, L3) and the performance of machine with reference to capacity and optimum cooking time are presented in Table 1.

Capacity of mung wadi making machine

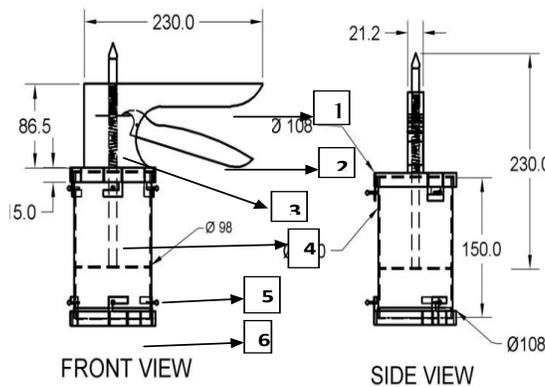
It is clear from the data that combined application of all the three treatment (D x M x L) was found to have significant effect on capacity of machine. However among all the three treatments the maximum capacity was recorded 635.93 g/min for D1M1L3 and

minimum capacity value was recorded as 214.19 g/min for D1M2L1. This may be due to the increase in size of *wadi* at higher diameter of hole of extrusion plate and greater length of stroke. Since the number of holes on the extrusion plate were same for all the treatment combinations, the capacity of machine was maximum for combination D1M1L3 mainly due to the effect of highest length of stroke 0.4 cm whereas minimum for combination D1M2L1 with smallest diameter of 8 mm and lowest length of stroke of 0.2 cm. Also as the size of *wadi* increases the *wadi* becomes porous and this reduces the weight of *wadi* which results in decreased capacity.

Table.1 Effect of treatment combinations on capacity of machine and optimum cooking time of *mung wadi*

Treatment	Capacity of <i>mung wadi</i> making machine (g/min)						Optimum cooking time (min)					
	M1			M2			M1			M2		
	L1	L2	L3	L1	L2	L3	L1	L2	L3	L1	L2	L3
D1	263.33	382.64	635.93	214.19	310.18	490.28	5.967	7.333	8.147	8.010	8.180	8.037
D2	281.71	347.52	392.84	258.99	353.86	486.65	7.75	7.957	8.730	6.500	9.033	7.557
D3	264.8	369.0	564.64	293.32	364.8	474.89	5.683	7.313	7.993	5.920	7.107	8.283

Fig.1 Front and side view of *mung wadi* making machine



1	Trigger
2	Handle
3	Piston driving mechanism
4	Piston
5	Cylinder
6	Extrusion plate with collar

Fig.2 Piston driving mechanism

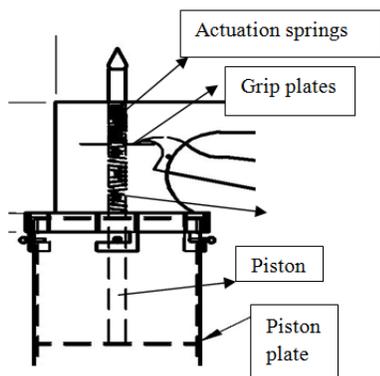
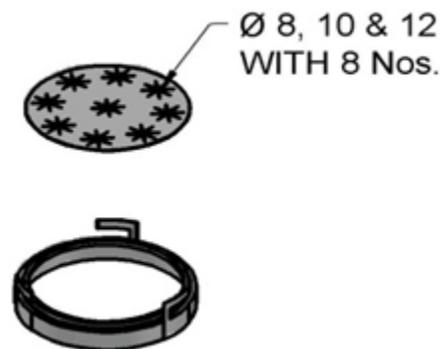


Fig.3 Extrusion plate with collar



Optimum cooking time of *mung wadi*

From Table 1 it is clear that combination of all the three treatments (D x M x L) was found to have significant effect on optimum cooking time of *wadi*. However, among all three treatment combinations the maximum values for optimum cooking time was found to be 9.033 min for D2M2L2 and minimum value was found to be 5.683 min for D3M1L1. This may be due to the varying size of *wadi* and the porous structure of *wadi* after drying. This porous structure allows the penetration of water into *wadi* during cooking. Since water absorption was faster in porous and bigger size *wadi*, the optimum cooking time required was noted to be minimum.

In conclusion the *mung wadi* (green gram nuggets) making machine consisting of cylinder, piston, piston driving mechanism, trigger and handle assembly and extrusion plate was developed. The machine was evaluated for its performance for different treatment combinations. The machine parameters *i.e.* extrusion hole diameter 8 cm, length of stroke 0.4 cm and moisture content of batter 45-50%(wb) of *mung wadi* making machine were optimized on the basis of capacity of machine and optimum cooking time of *mung wadi*. Maximum capacity was

found to be 635.93 g/min for minimum cooking time of 5.683 min.

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