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Development of green tender coconut splitter-cum-punching machine for tribal population of Bastar region of Chhattisgarh

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Abstract

In India coconut cultivation is more concentrated along the coastal areas which contribute about 88% coconut cultivated area with 90% production. However, states like Chhattisgarh have emerged as non-traditional areas for the cultivation of coconut with a total of 1561 ha area and annual production are 12.6 million nuts. It leant that cutting of coconut tender is cumbersome process which involves trimming of head for sipping of coconut water followed by splitting to eat coconut meat. During cutting process, cultivator/ vendor has to apply force and carry the coconuts' weight in hand which needs muscular effort. Similar, procedure is being preferred across the Bastar for coconut cutting with chopping knife having long blade (radius of curvature) and short handle. So, the challenges faced by the farmers of Bastar would remain same as traditional area. It is therefore, ergonomical evaluation of adapted traditional method in Bastar has been investigated. It is found that local sickle and knife is not suitable for tribals and it create callous in hand palm. Thus, a low-cost coconut splitting cum punching machine for green tender coconut is fabricated. The developed machine is able to punch the hole in tender coconut for sipping the water whereas it cuts the coconut into two halves to get coconut meat. The punching force observed to be about 178N whereas cutting of green tender demands 645N. The machine is fabricated using simple lever and spring mechanism. The developed machine found faster enough compared to existing traditional method and easily portable. Further, it was economical for tender coconut vendors. The use of machine reduced the drudgery of workers and hand injurious which intern save money of medical treatments as well as reduce the absentia of workers from the workplace.

Keywords: coconut, ergonomics, mechanization, Bastar, tribals

Introduction

Coconut is cultivated over 95 countries across the world India, Indonesia, Philippines and Sri Lanka together accounts for nearly 80% of total world coconut production. In India coconut cultivation is more concentrated along the coastal regions like are Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, Goa, West Bengal, Pondicherry, Maharashtra and Islands of Lakshadweep and Andaman and Nicobar etc. out of these states, Kerala, Karnataka, Tamil Nadu and Andhra Pradesh contribute about 88% coconut cultivated area and 90% production. Such states are traditional area for coconut cultivation. However, several states like Chhattisgarh, Assam, Gujarat, Madhya Pradesh Bihar and Tripura etc. have emerged as non-traditional areas for the cultivation of coconut. As for as Chhattisgarh state is concerned, about 12 districts like Bastar, Kanker, Dhamtari, Dantewada and Kondagoan with a total of 1561 ha are undergone in coconut cultivation. The annual production from such districts are 12.6 million nuts in the state of Chhattisgarh. The major coconut growing district are Kondagoan, Jagdalpur, Dhamtari and Kanker accounts about 82 % of the total area and 93 % of coconut production in state. Therefore it seems that the growth of coconut cultivation area is at far when traditional area of coconut production.

It is evident that Chhattisgarh state is being gradually increasing in its coconut cultivation area and production, so challenges faced by the farmers would be remains same as traditional area. It has been observed that traditional area are facing lot of difficulties in making appropriate tool and machinery for the coconut grower though mechanization level of India is gradually increasing day by day with the introduction of innovative tools and machinery. But all the innovations are limited to grain crop, vegetable and selected fruit. There are various hand tools and machinery available for the coconut production like post hole digger for planting the coconut plant, power weedier for weeding and earthling operation and coconut tree climber for harvesting the nuts.

Coconut is considered as holy fruit for various rituals in Hindu religion and as a token for greeting the guest of honour.

Hence, the coconut fruit is not only used for sip of water and coconut meat it is also used during every worship it is dried. Coconut vendors are used to sell about 100s of green coconut(tender) per day for the purpose of coconut water to offer the coconut tender to the customer its head has to cut properly. The cutting of head would make convenient passage to sip water to do the same vendor has carry coconut tender in hand and cut it. During this process vendor has to rotate coconut tender and apply force simultaneously which is tedious task and not gender friendly. It requires lot of muscular effort and holding force. In other case, vendor use to cut coconut head by keeping it at platform and apply force for cutting. Later process is more convenient comparatively. Such methods are traditionally adoptable by the coconut vendors. They prefer chopping knife comprises blade having long radius of curvature and short handle to apply grater force.

In Bastar (CG), it is learnt from the survey that the process of chopping the tender coconut is very tedious and chances of hand injuries are expected more. One has to expertise and experienced in cutting and operation of tool otherwise chances of injuries would be more. Hence, utmost care and skill is required to chop the coconut in traditional way.

In view of this one may merely pertained that the cutting tool and machine could be brought directly from the traditional coconut grown areas like Kerala Andhra Pradesh Karnataka and provided to farmers of Chhattisgarh for their disposal. But one has to consider the design parameters and constraints of tools and machines. Traditional devices currently in use, such as the blade and spear are dangerous and minimally productive. Based on this realization, a machine is fabricated that simplifies an important process as well as increases the productivity of the coconut industry.

The selected hand tool and machine could be suitable for the local population since it has gone under several research modification based on local anthropometric and parameters. Moreover it is matter of concern that physical body dimension of selected population may not be similar for to two states. Therefore it is obvious that the design of tools and machine would differ state by state particularly in view of weight of machine material of construction handle height handle diameter radius of curvature the tools and machinery etc.

In view of mention fact the major objective is to fabricate a low-cost coconut splitting cum punching machine for tender coconut. This machine could be able to punch the hole in tender coconut for sipping the water while it cut the coconut into two halves to get coconut meat. The use of this machine would reduce the drudgery of farm workers and reduce the annual amount of hand injuries. Which is turn can save money of medical treatments as well as reduce the absentia of workers from the work place.

Coconut water is a natural, healthy, nutritious drink forms naturally in the fruit and contains 94% water and very little fat. Coconut water has a sweet, nutty taste. It contains easily digested carbohydrates in the form of sugar and electrolytes (zulaikhah, 2019). Tender coconut water has a therapeutic effect containing various nutrients such as minerals, vitamins, antioxidants, amino acids, enzymes and growth hormone (Prema and Rajmohan, 2012). Recent studies have shown that tender coconut water is rich in L-arginine, a free form amino acid, and vitamin C, which can prevent heart disease and lipid (Lukose, 2013) tender coconut water also contains various important compounds for the body, such as magnesium, potassium, calcium, selenium, methionine, zinc, iodine, manganese, boron, molybdenum and phyto-hormone such as auxin, cytokines, gibberellins (Prathapan and Rajamohan,

2011; Fife, 2008). A study conducted by Priya and Ramaswamy (2014) showed that tender coconut water has a beneficial effect, significantly lowering MDA levels and increasing levels of antioxidant enzymes. Tender coconut water improve mitochondria and provide protection against isoproterenol (free radical) induced damage (Kumar *et al.*, 2013).tender coconut water could lower total cholesterol (TC), low-density lipoprotein (LDL) and triglycerides (TG) levels and decrease height-density (HDL) (Tkachenko and Kurhalyuk, 2011).

Though India being the biggest producer and huge advantages of consumption of tender coconut water still only fifteen per cent of produced tender coconuts are used for tender coconut water

consumption (<https://economictimes.indiatimes.com/news/economy/agricultural/tender-coconut-consumption-booming-in-the-country/article-show/4229635.cms>).for every 100 soft drink outlets there are only three of four tender coconut outlets (john, 2011). Tender coconut can be coconut for consuming. The consumer has to depend on a vendor to cut and punch the tender coconut can be one of the limiting factors for consuming coconut water. Due to the technique essential to cut and punch the tender coconut, the business is centred on street vendors who possess skill in opening a tender coconut. Low consumption of tender coconut water may be related to difficulty in the processing of tender coconut while consuming,

Tender coconut vending is one the common street vending business. It is at its peak especial in summer season. The method of punching coconut is tough a strenuous. The common traditional tool used for making a hole for tender coconut is a hand sickle. This method is unsafe, messy and has high risk of injuries. This conventional method cannot be done by everyone as it requires special skill. The time required for cutting the top portion of the tender coconut demands use of force and more time. One should have expertise in cutting the coconut. Roshini *et al.* (2009) stated that the major problem the tender coconut vendors faced in developing countries like India was punching and splitting of tender coconut.

Materials and Methods

The following design considerations have been considered in mind while designing the machine:

1. Simple in fabrication with locally available materials and easy to use
2. Able to split and punch the coconut easily with less
3. Farmer friendly, light in weight and cheap.
4. Able to shift from one place to another and easily install
5. Minimal force requirement for penetration into the tender coconut.

Development of coconut splitting and punching machine

Development of machine

1. **Material of machine:** The mild steel availability is more and the strength is also more. It has less cost than stainless steel. Easy repair and maintenance cost.is is mostly used in agricultural sector.
2. **Weight of machine:** Our objective is to develop coconut splitting machine for easy portability. So that one can easily take from one place to another place and installed for selling purpose. It has been observed that human can lift the weight of about 40% of its weight.so it is decided that mechanical weight should not exceed the 25-30kg

considering 70kg of body mass of tribal population of Bastar.

3. **Height of machine:** The mechanism is decided to work in standing posture. By applying muscle force by hand. It is therefore decided that the height of machine may be maximum height may not go beyond the waist height of the selected population.
4. **Width of machine:** Width of machine allows comfortable cutting of tender coconut and keep them a side for next cutting. It is therefore decided that the platform should have width to keep one coconut each side from the centre and must not extend beyond then should width of selected population this allow comfortable height of tender for given population.
5. **Length of machine:** The machine bed holds the knife along its length. Thus the length of machine bed may not go beyond the forward reach of the selected population. The knife is well supported by the extreme mechanical bed while another end would be in grip of user for applying force. Thus it is similar to cantilever mechanism in which knife end is fixed at far end another near to user there is also one arrangement at far location hold the knife in non-working condition.
6. **Handle length:** Handle length has been decided based on the length of coconut and also there is consideration of applying less force to cut coconut by having longer length. so the length of handle match with the length of 40% of blade and rest of handle lever.
7. **Grip diameter:** Grip diameter decided on the basics of applying higher force.
8. **Length of cutting unit:** The length of the cutting unit must place in the middle of the handle were the coconut is placed so that it is easy for cutting the tender coconut.
9. **Holding jaw for cutting:** It has been observed that the different shape and elliptical shape for feasibility
10. **Fixing arrangement:** All the components of the machine are placed with proper arrangement so that it can be easy for punching and splitting of tender coconut
11. **Overall dimensions of machine: the overall dimensions is taken**
12. **Turning mechanism**
13. **Punching tool diameter:** The punching tool diameter helps in easy penetration in to the tender coconut while punching in to the tender coconut for sipping of water.
14. **Length of punching tool:** The punching tool must be stainless steel so that it can be protected from rusting while punching in to the tender coconut. The length of punching tool is around 20cm. so that it can penetrate in to tender coconut for punching.
15. **Holding ring for punching:** The holding ring should be place correctly downwards to the punching tool for keeping the tender coconut in the ring for punching the tender coconut. It is made up of iron.
16. **Reaction frame:** Frame is a structure of machine on which the other components are placed. It is made up of iron.

Results and Discussion

Design considerations of selected machinery

Designed based on the average Tender coconut dimensions by measuring the length from top of Tender coconut to the water level its measures to be average of 5cm. So by giving 2cm extra length to the Punching bit a total length of 7cm (70mm) is made. In the punching bit 20mm provision is provided to remove the dust particle during punching of a Tender coconut. The punching material selected is Stainless Steel as it has corrosive resistant properties and has good strength.

This project is used to cutting and punching the coconuts. The basic principle of the project is to apply the pressure to cut and punch the coconuts. Initially coconut is placed in the circular box. After that lever is attached to closed coil. The pressure is applied on the lever to punch the coconut. After removing pressure lever comes to original position by tension of spring. After removing the water coconut is placed in that rectangular tray. Apply the pressure on the lever to cut the coconut by the use of knife. It is very simple operation. It does not have more skill to cut the coconut

Dimension of punching tool. Average depth of shell of coconut from outer surface was found between 70 to 100 mm and the diameter of straw generally and radically available was 6 to 8mm therefore a punch of 160mm and length 12mm diameter was selected. one end of tool was threaded up to 25mm length to fix it securely in the holder and other end was pointed up to 30mm length. As the tool had to work in contact with tender coconut water, stainless steel material was used to prevent corrosion.

Cutting mechanism

Designed based on the average Tender coconut dimensions by measuring the total length of Tender coconut its measures to be average of 20cm. So by giving 10cm extra length to the Cutting blade a total length of 30cm (300mm) is made. The Cutting blade material selected is Stainless Steel as it has corrosive resistant properties and has good strength. The time required for making punching and slicing a tender coconut measures to be 8second and 16 second.

Applied forces

The full bore piston diameter is 63mm and piston rod diameter is 20mm. the working pressure range of the pneumatic cylinder I 1 to 10 bars.

The basic principle of the project is to apply the pressure to cut and punch the coconuts. Initially coconut is placed in the circular box. After that lever is attached to closed coil. The pressure is applied on the lever to punch the coconut

The coconut cutting machine is has following dimensions. Its height is about 38 cm and the width is 30 cm with a platform and the threads of jack is BSW 38(it is the standard screw jack available in market, the threads of cutting tool blade holding nut is BSW 12 mm and the hole making tool is of 10mm

Statistical parameters of measured anthropometric dimension**Table 1:** Statistical parameters of measured anthropometric dimension of Male

Parameters	Mean	Min	max	SD	CV (%)	SE	5th	95th
1 Iliocrystale height	97.86	92	103	2.89	2.97	0.37	93	102
2 Elbow height	107.7	98	117	5.27	4.89	0.37	99.9	117
3 Waist Circumference	62.46	52	94	5.46	8.75	0.70	54	66
4 Biacromial breadth	43.16	37	53	3.16	7.34	0.40	40.95	45
5 Elbow width	41.1	37	49	3.31	7.86	0.42	37	48.05
6 Acromion height	141.4	130	150	4.10	2.09	0.53	134.9	148.05
7 Grip diameter	7.4	5	9	1.25	16.91	0.16	6	9
8 Hand length	18.33	18	19	0.45	2.48	0.05	18	19
9 Hand width	10.93	10	12	0.84	7.69	0.10	10	12
10 Weight	66.21	47	80	6.95	11.0	0.89	53.9	75.05
11 Age	26.33	22	29	2.06	7.83	0.26	22.95	29

Table 2: Statistical parameters of measured anthropometric dimension of Female

Parameters	Mean	Max	min	SD	CV (%)	SE	5th	95th
1 Iliocrystale height	83.4	89	80	2.21	2.65	0.35	80	87
2 Elbow height	95.62	99	92	1.73	1.81	0.27	92	99
3 Waist Circumference	86.35	91	82	3.16	3.66	0.50	82	91
4 Biacromial breadth	37.82	39	37	0.930	2.46	0.14	37	39
5 Elbow width	40.77	42	38	1.25	3.06	0.19	38	42
6 Acromion height	124.27	128	122	2.16	1.73	0.34	122	128
7 Grip diameter	5.3	6	5	0.46	8.75	0.073	5	6
8 Hand length	16.72	17	16	0.45	2.70	0.071	16	17
9 Hand width	8.5	9	8	0.50	5.95	0.08	8	9
10 Weight	46.05	49	41	2.19	4.76	0.34	41	49
11 Age	37.52	45	26	6.13	16.33	0.96	26	45

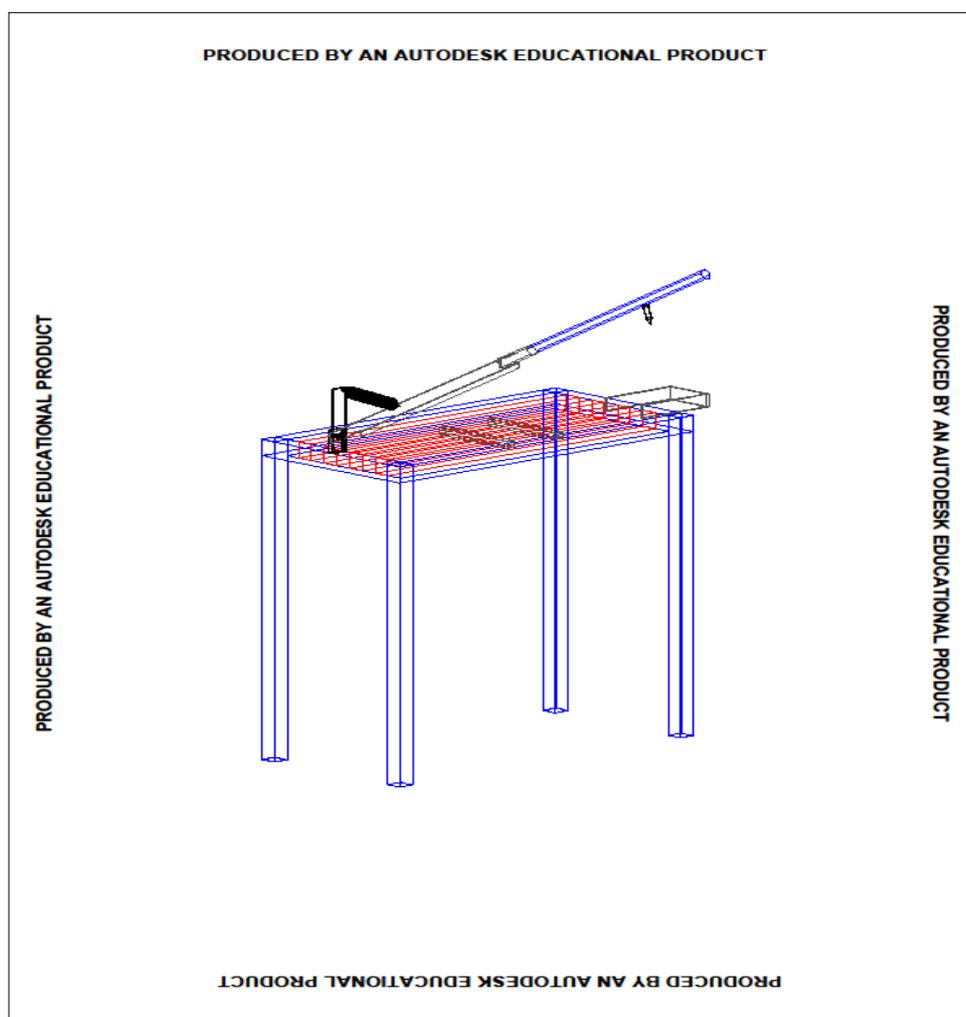
**Fig 1:** CAD drawing of the design of coconut punching cum splitting machine



Fig 2: Coconut splitter cum punching machine

Conclusions

- The manual coconut cutter is an advanced method, which is to cut the coconut in an easy way of operation. This will reduce the human effort and avoid chances for accidents of the manual method of operation. It reduces the operational cost of the work. Comparing to the automatic method, this project is a very effective and advantageous method. This project is to save more valuable time. In order to solve these problems to cut the coconut & punch the coconut.
- It is faster than the existing traditional method.
- Human effort is almost eliminated and also productivity is increased.
- The device can be easily assembled and dismantled.
- Spare parts (Bolts & Nuts) can be replaced with the use of simple tools.
- High efficiency compared to traditional method of punching and splitting.
- Easy to operate with minimum skill level.
- Product cost is reasonably economical for tender coconut vendors.
- Handle is such that it can suit the operator to operate both sitting and standing positions

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