Development of a Household Coconut Punch-cum-Splitter

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ABSTRACT

A power operated coconut punch-cum-splitter was developed for extracting coconut water and coconut meat. The equipment mainly consists of screw rod, channel section, tapered roller bearing, pulleys, movable tray, and supporting frame, cutting blade, punch and electric motor. The nut of the screw rod was rotated with an electric motor and the drive was transmitted with a belt and pulley system. The tender coconut was placed on the top of the screw rod in natural rest position and was raised to press against either the punch or the blade fixed above the screw rod. The average energy requirement for punching and splitting of the selected range were found to be 11.74 kJ and 12.13 kJ.

Keywords: Coconut, punch-cum-splitter, force, energy

1. INTRODUCTION

Coconut is the “tree of heaven”, provides many necessities of life including food and shelter. It is mainly cultivated for its nuts; it yields oil, oil cake and fibre. Water from tender coconut is a common refreshing drink and has been used as an excellent isotonic in several tropical countries. It is not only a thirst-quenching liquid, but also a mineral drink, which is beneficial to human health (Poduval et al., 1998). It contains traces of proteins, fats, and minerals like Na, K, Ca, Fe, Cu, P, S, Cl, vitamin C, vitamins of the B group like nicotinic acid, pantothenic acid, riboflavin and biotin. Coconut water contains organic compounds possessing healthy growth promoting properties. It carries nutrients and oxygen to cells, raise the human metabolism, boost human immune system, detoxify and fight viruses, control diabetes and also aids the human body in fighting against viruses that causes flue, herpes and AIDS (Poduval et al., 1998).

Mondal et al. (1970) found out that deoxyribonucleic acid (DNA), ribonucleic acid (RNA) and proteins present in coconut water are in the soluble form and not associated with any cell organelles. Santoso et al. (1996) described the presence of vitamins, sugar, organic acids, fatty acids, amino acids, fibres and minerals in coconut water. Cytokinins were identified and determined using micellar electrokinetic capillary chromatography after pre concentration by solid phase extraction. Even contaminant species must be considered in the complex composition of coconut water since pesticide residues were detected recently. Besides, minor constituents such as free ammonia gas also contribute to the over flavor and mouth feel (Poduval et al., 1998). Stefan et al., (2000) studied the influence of coconut water on plasma coagulation *in vitro*. Coagulation capability of diluted plasma was evaluated by thrombelastography. They found that the influence of coconut water on hemostasis as assessed by thrombelastography doesn't differ from the effect caused by an identical volume of physiological saline. Rodrigo et al. (2007) evaluated the use of potentiometric stripping analysis for Zn determination in the matrix of coconut water samples, since Zn plays a fundamental role in the regulation of human immunizing power.

Despite of all these uses, a common problem that many peoples are facing in a developing country like India is punching and splitting the tender coconut. Present trends and tools used are unsafe, messy and need skill and training. The risk of injury is also too high. There are some machines for paring coconut, but until now no household tool exists to punch a hole and split it open. This necessitates the development of a punch-cum-splitter for punching and splitting open the tender coconut. In 1926, Carter has developed a coconut splitter. The invention was mainly to split open, so that kernel can be easily removed from the shell after sun drying. Rey in 1956 developed an apparatus to split open the coconuts. But the apparatus is too bulky. Shamsudeen and Anitha (1997) developed a tender coconut punch and splitter. It consisted of a punch assembly and seat assembly. The punch was pivotally attached to a hand-lever, which was hinged along a horizontal pin mounted on a stand. The up and down swinging of the hand-lever made the punch reciprocate up and down in a sleeve. Though it could punch a hole in the tender coconut, movement of the punch through the sleeve was not easy. Later Jippu (1998) developed a tender coconut punch, activated by a slider crank mechanism. In this equipment, a tender coconut was placed on a ring stand and as the main hand-lever was lowered, the punch moved downward and punched the husk and shell. Difficulty was experienced in punching more matured tender coconuts due to increased hardness of the shell. Shamsudeen et al. (1999) developed a tender coconut cutter. But it was experienced that the mechanical work was not adequate to split open the overripe nuts easily. Beloin in 2008 developed a coconut splitting device that has a lowering means to lower a coconut onto blades and thereby splitting is done. The blade is stationary; the coconut is pushed down in order to split it open.

All the above methods can be either used to split open the coconut and also to drain the coconut water or to punch hole in the coconut. Some of the motor driven operated equipments are bulky and does not have a punching and splitting mechanism together. Therefore the present study aims to develop a household scale, screw assisted tool to punch and split the tender coconut in an ergonomic and easy approach, so that everyone can do it at home and also in small parlors.

2. MATERIALS AND METHODS

2.1 Design of Coconut Punch-cum-Splitter

The design of this equipment is based on the principle of a screw-jack. The main components of the machine are screw rod, pulley-cum-main nut, movable cross-rail, end columns, cutter blade, punch, base, electric motor and power transmission system as shown in figure 1. The screw rod has an overall length of 499 mm with a screw length of 331 mm. It is having a pitch of 3 mm. The screw rod carries the cross rail at its upper end. Screw rod together with the cross rail was raised and lowered with respect to the base by rotating the pulley-cum-main nut. A V-grooved pulley of 300 mm diameter with a hub of 60 mm outer diameter was selected. Its hub was internally threaded at its centre to act as the main nut for the screw rod. The hub, projecting to one side was machined to a step of 40 mm diameter and 20 mm length. This matched with the inner race of a taper roller bearing. This permitted the rotation of the pulley-cum-main nut in the bearing. Its rotation allowed the movement of the screw rod up and down depending upon the direction of rotation of the pulley. Movable cross rail consisted of two pieces of mild steel (MS) angles, two MS sleeves and another small sleeve at centre. The end columns are placed at 454 mm distance from each other. The lower end of the columns rests on the channel section base. Cutter blade was made of stainless steel and fitted to a cross pipe. The blade was of curved shape, and is 300 mm in length and 50 mm wide. Cutting edge was serrated with the adjacent crowns at a distance of 40 mm apart. The blade was bolted between two pairs of flat pieces of 150×45×5 mm size, which were welded to the cross pipe. Punch was made of stainless steel having a length of 115 mm, outer diameter of 16 mm and inner diameter of 10.5 mm. The punch was bolted between two clamps to which two flat pieces were welded on opposite sides. This was then welded to the cross pipe, exactly opposite to the cutter blade. MS channel section having a length of 865 mm was provided with a hole of 31.75 mm diameter at a distance of 231 mm from one end to allow the screw rod to move below the base. The other end of the channel section acted as a base for the motor. A 0.75 hp single phase motor (revolution of 1440 min^{-1}) was mounted vertically to drive the main pulley via a V-belt. Two pulleys and V-belt were used for power transmission system. A pulley of 63 mm diameter was fitted to the motor shaft and was connected to the 300 mm pulley-cum-main nut by the V-belt. The belt and pulley system transmitted the power from the motor to the screw rod, giving a speed reduction of 4.8:1.

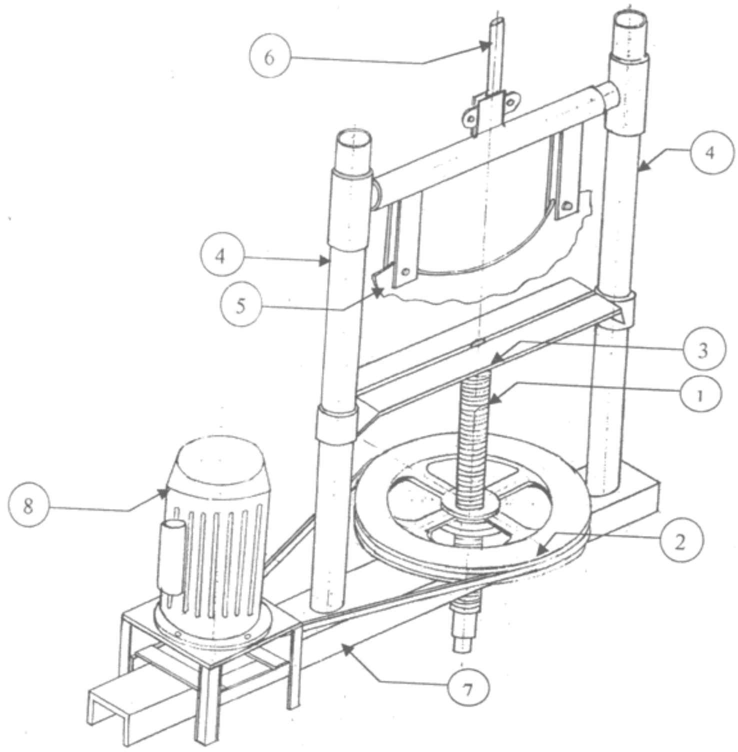

Figure 1. Isometric view of power screw assisted punch-cum-splitter (1-screw rod, 2-pulley-cum-main nut, 3-movable cross rail, 4-end columns, 5-cutter blade, 6-punch, 7-base, 8-electic motor)

2.2 Operation

Power was transferred using a V-belt and pulley mechanism. The main pulley was provided with inner threads in the hub, which meshed with the screw rod. The top of the screw rod was pinned to the cross rail which was restrained in the horizontal position by the two circular rings welded to its ends and passing through the end columns. As the motor shaft was rotated, the power was transmitted to the main pulley, which also started rotating. As the screw rod was restrained in its position, there was no rotation of screw rod. As a result, the rotation of the main pulley led to the vertical upward or downward movement of the screw rod according to the direction of the motor. For punching, tender coconut was placed over the movable cross rail in its natural rest position. The punch was so adjusted and fixed that it faced the cross rail carrying the tender coconut. The height of punch was so adjusted that it made the hole only in the top half of the tender coconut. The cross pipe carrying the blade and punch assembly could be rotated so that either the blade faced the cross rail or the punch. For splitting, the cross pipe was rotated and the blade was fixed in the downward direction facing the cross rail.

2.3 Evaluation

Experiments were conducted in 50 coconuts to determine the force required for punching and splitting. A direct reading type platform balance of 1962 N capacity was used for force calculation. Energy consumption was measured in between switch and motor for the up and down movement of the cross rail with and without coconut, and also for the punching and splitting operation.

3. RESULTS AND DISCUSSION

3.1 Force Required for Punching and Splitting

Experiments were conducted on different size and weight of coconuts and the force required for punching and splitting were calculated. In punching, the force varied from 392 to 1472 N, with a mean value of 712 N. Similarly, force required for splitting was also determined and it varied from 883 to 1962 N with mean value of 1277 N. It was indicated that the splitting required more force than punching. This was observed due to the larger length of cut required for splitting the shell. Details of the force required for punching and splitting on 17 different weights of coconut are shown in tables 1 and 2. The standard deviation for punching and splitting was found as 333 and 530 N.

Table 1. Force required for punching

No.	Weight of tender coconut (kg)	Force required for punching hole (N)
1	2.5	579
2	1.75	491
3	2	476
4	1.5	442

5	1.75	392
6	1.5	442
7	0.95	446
8	1.0	481
9	1.5	461
10	1.2	981
11	3.5	765
12	2.0	559
13	2.0	873
14	2.0	952
15	1.5	922
16	2.5	1471
17	2.0	1373

Table 2. Force required for splitting

No.	Weight of drained tender coconut (kg)	Force required for punching hole (N)
1	2.0	1962
2	1.0	1177
3	0.5	883
4	1.0	1177
5	0.5	1275
6	1.0	1226
7	1.0	1079
8	1.5	1423
9	1.0	1442
10	2.0	1442
11	1.0	1079
12	1.0	1030
13	1.0	883
14	1.0	883
15	1.0	1177
16	1.0	1079
17	2.0	1472

3.2 Energy Required for Punching and Splitting

Energy consumption was observed to vary from 10.8 to 11.16 kJ for a cycle of travel of the screw rod with no additional load. The actual energy requirement for the travel of punch through the tender coconut was only 11.74 kJ and it was found to be 12.13 kJ for splitting. The energy requirement for the idle travel was very near to punching operation. This showed that the downward travel of the screw rod should be limited to a distance just adequate to accommodate the tender coconut between the tip of punch and top of cross rail to reduce energy consumption.

Like punching, splitting also necessitates the restraining of the screw rod movement to a distance just enough to accommodate the tender coconut between the cutting edge of the cutter blade and the top of the cross rail. Moreover, this equipment ensures the safe and easy way of punching and splitting operation. For safety, seating for coconut during punching and splitting has to be improved and also some holding mechanisms have to be included to accommodate coconuts of different sizes.

By comparing the electric motor assisted punch cum splitter for tender coconut with that of manual processing, the cost and time taken for the operation was more for the machine. But this new machine totally eliminated the manual effort required in punching and splitting the coconut. This new machine can also punch and split open nuts vary from 0.95 kg to 3.5 kg weight.

4. CONCLUSIONS

An electric motor assisted apparatus was developed to punch and split open the tender coconuts. The force required for punching and splitting was found with a mean value of 712 N and 1277 N, respectively. The average energy required for punching and splitting was found to be 11.74 kJ and 12.13 kJ for the selected range of coconuts.

In this equipment, the manual effort, as required in the case of hand operated punch-cum-splitter, was totally eliminated. This can also punch and split hard nuts, which was difficult to manage using hand operated punch and splitter. The whole equipment is very compact and simple. Some holding mechanism has to be provided for safety. With additional safety measures, this can trigger the tender coconut drink industry and popularize the concept of tender coconut parlours all over the tropical countries.

5. REFERENCES

Anitha, J. and K. P. Shamsudeen 1997. Development and testing of a tender coconut unch and splitter. Unpublished B.Tech Project Report. Kerala Agricultural University, Kerala, India.

Beloin, P. 2008. A coconut splitting device. United States Patent Office WO/2008/067653.

Carter, R. J. 1926. Coconut splitter. United States Patent Office 1577953.

Jippu, J. 1998. KAU tender coconut punch. *Indian Coconut Journal*, 29(3), 9-10

Mondal, H., R. K. Mandal and B. B. Biswas 1970. Nucleic acids in coconut water. *Plant and Cell Physiology*, 11(1), 177-181

Poduval, M., H. Abu and P. K. Chattopadhyay 1998. Evaluation of coconut cultivars for tender nut waters for West Bengal. *Indian Coconut Journal*, 29(1), 3-4

Pummer, S., P. Heil, W. Maleck and G. Petroianu 2001. Influence of coconut water on hemostasis. *The American Journal of Emergency Medicine*, 19(4), 287-289

Rey, H. D. 1956. Apparatus for splitting coconuts. United States Patent Office 2739630.

Rodrigo, A. A. M., K. Matias, C. S. Rita, V. O. Pedro and A. Lucio 2007. Ultrasound-assisted treatment of coconut water samples for potentiometric stripping determination of Zinc. *Journal of Brazilian Chemical Society*, 18(2), 93-98

Santoso, U., K. Kubo, T. Ota, T. Tadokoro and A. Mackawa 1996. Nutrient composition of kopyor coconuts. *Food Chemistry,* 57(2), 299-304

Shamsudeen, K. P., J. Anitha and J. Jippu 1999. KAU tender coconut cutter. *Indian Coconut Journal*, 30(6), 9