

Energy Expenditure and Exertion For Opening a Tender Coconut

N Divya Pranathi, Neeraja Telaprolu and V Prasuna

Department of Family Resource Management, College of Home Science, Lam, Guntur, A. P.

ABSTRACT

The present study was undertaken to gain knowledge of the energy spent and the physical exertion experienced during opening a tender coconut in traditional process and by using punch cum splitting machine and tender coconut opener. Tender coconut vendors aged between age 28 and 45 years having a minimum experience of 5 years in tender coconut vending formed the sample. The mean energy spent in opening a tender coconut by coconut punch and splitting machine, tender coconut opener and traditional method were 8.03 kJ/min, 7.20 kJ/min and 6.78 kJ/min respectively. Traditional process of opening a tender coconut by using a hand sickle was found less energy consuming. Vendors were relatively comfortable with the conventional method. There was a high significant mean difference ($P < .0001$) in the physical exertion of the vendors when opening a tender coconut using punch cum splitting machine, tender coconut opener and traditional process. Out of the three methods vendors perceived comparatively less exertion when opening a coconut in traditional process. The tender coconut opener and punch cum splitting machine were equally causing body discomfort while operation. With reference to energy expenditure and physical exertion the conventional way of opening the coconut was found better than the other two. Though the traditional process scored superior to the tools used in the study, the vendors expressed that skill is required to punch the tender coconut and the chances of cutting the fingers is very high in this process. For that reason there is a need to redesign the tender coconut opening tools for the safety of vendors.

Keywords: *Coconut, Energy, Exertion and Expenditure.*

Tender coconut water is beneficial to human health, it is a thirst quenching liquid and also contains the minerals (Poduval *et al.*, 1998). Tender coconut water is recommended to patients in many instances as it contains major electrolytes (Priya and Ramaswamy, 2014), glucose, vitamins, hormones and minerals (Yong *et al.*, 2009). India is the third largest coconut producers in the world with production over 119 million tones. The south India states alone constitute to 90 percent of the total production in the country. The yield of coconut in the state of Andhra Pradesh was 10,321 kg/hectare (<https://www.worldatlas.com/articles/the-world-leaders-in-coconut-production.html>).

Though India being the biggest producer and huge advantages of consumption of coconut water, only fifteen percent of produced coconuts are being used for tender coconut water consumption (<https://economictimes.indiatimes.com/news/economy/agriculture/tender-coconut-consumption-booming-in-the-country/article-show/4229635.cms>). Every consumer cannot cut and punch tender coconut for consuming. The consumer has to rely on the seller who can only cut and punch a tender coconut. Probably dependency on a skilled vendor to cut and punch the tender coconut is the restrictive reasons for consuming coconut water.

The long established technique of cutting tender coconut demands effort of 300 N and 150 N for cutting and opening respectively (Anil *et al.*, 2016). The vendor has to use high force which may affect the nerves, blood vessels or tissues inside the hands. Tender coconut opening is labour intensive and exhausting operations that take a lot of energy. This is one of the major reasons that the tender coconut vending business cannot be taken up by women.

As on date there were no suitable hand operated tender coconut opening tools available in the market. When explored online markets a total of nine tender coconut opening machines/tools were available. Based on the mechanism and availability for ready purchase punch cum splitting machine and tender coconut opener were selected for the study.

The aim of the study is to find out the energy expenditure and physical exertion of the worker during opening a tender coconut with traditional sickle and by way of punch cum splitting machine and tender coconut opening tool.

MATERIAL AND METHODS

A sample of fifteen tender coconut vendors were selected for studying energy expenditure and physical exertion when opening tender coconut by the selected two manually operated tender coconut tools and conventional process.

An experiment was designed for studying energy expenditure and exertion. Since there is a linear relation between heart rate and energy expenditure, heart rate of the subject was taken to measure the energy expenditure. The vendor was asked to perform the activity without any disturbance. While performing the activity five readings of heart rate with one minute intervals were noted. After five minutes the respondent was asked to stop the activity and he was allowed to recover. At recovery phase another five heart rate readings with one minute intervals were

taken. Then the vendor was asked to report the intensity of exertion of the activity he perceived and measured as per Borg's rating of exertion scale. The same procedure was repeated with the selected coconut punching tools.

Energy expenditure

Heart rate monitors can be used for monitoring heart rates without interfering subject's work (Vitalis *et al.*, 1989). Hence energy expenditure was calculated by the formulae proposed by Verghese *et al.* (1994). Heart rate of the subject was measured using polar heart rate monitor.

$$\begin{aligned} \text{Energy expenditure of worker (Kj/min)} &= 0.159 \times \text{average heart rate (bpm)} - 8.72 \\ & \quad \text{average heart rate} \\ &= \frac{\text{Reading (1st + 2nd + 3rd + 4th + 5th)}}{\text{Number of times the reading were taken}} \end{aligned}$$

Exertion

Exertion is the feeling of how heavy and strenuous a physical task is (Borg, 1998). The central nervous system response to perceived job stress may increase sensitization to pain stimuli leading to development of musculoskeletal disorders (Devereux *et al.*, 2004). Hence the exertion of the tender coconut vendors was studied to understand the intensity of exertion while opening a coconut by traditional method and by using the tools selected for the study. Borg's rating of exertion scale (1998) was used for scoring the exertion.

Analysis of variance (ANOVA) was carried out using SAS PROC MIXED (SAS 9.4v) procedure, considering tender coconut punching tools as fixed and vendors/respondents as replications. Means were calculated for tender coconut tools from ANOVA and also performed pair wise comparisons for significant tender coconut punching tools effects.

RESULTS AND DISCUSSION

The age of the vendors selected for the study ranged from 28 years to 75 years. The mean age was 46.7 years. Mostly men were taking up tender coconut vending business. The one who was actually carrying out tender coconut vending was considered as respondent. On an average the vendors were selling 202 coconuts per day. More than sixty percent of the respondents were selling 124 to 280 coconuts per day. The income of coconut vendors ranged between Rs 2,000 to Rs 20,000 in a month. The mean income earned was found to be Rs 10,900 with a standard deviation of Rs 4,596. The mean profit earned by the respondents in a day through tender coconut business was Rs 440.

a) Energy expenditure

From table (1) it was identified that the mean energy expenditure while operating the punch cum splitting machine was 8.03kJ/min with a S.D of 0.49. Nearly seventy (68.89 %) per cent of the vendors spent energy in between 7.54 to 8.52 kilojoules per minute. The mean energy expenditure while operating the tender coconut opener was 7.20kJ/min. More than seventy (73.33 %) per cent of the vendors spent energy of 6.3-8.11 kilojoules per minute.

The mean energy spent when opening a tender coconut by conventional process was 6.78kJ/min. Eighty per cent of the vendors spent 5.9 to 7.68 kilojoules per minute.

Punch cum splitting machine required more energy. The process of opening a coconut with sickle took less energy. This may be due to the number of years of experience in using long established process.

b) Exertion

From table (2) it was observed that exertion is the perception of the respondent about the energy exerted while performing the task. The mean exertion

while operating punch cum splitting machine was 19.07 with a deviation of 0.80. The exertion of sixty percent of the respondents was between 18.27 and 19.87. The mean exertion perceived by the vendors while operating tender coconut opener was 16.53 with a deviation of 1.18. More than seventy (73.33 %) per cent of the respondents have their perception exertion between 15.35 and 17.72. The mean exertion perceived by the vendors while using traditional way of opening coconut was 14.6. More than sixty five (66.67 %) per cent of the respondents have exertion between 13.43 and 15.9.

Energy expenditure was measured for the two manually operated tender coconut machines selected for the study viz., punch cum splitting machine; tender coconut opener and traditional process of cutting and opening a tender coconut. The vendor spent relatively more energy while operating punch cum splitting machine followed by tender coconut opener and traditional method.

Mean difference in energy expenditure ($P = <.0001$) between punch cum splitting machine and tender coconut opener while opening a tender coconut was highly significant. Mean difference ($P = <.0001$) in energy spent between punch cum split machine and conventional process of cutting tender coconut using a hand sickle was found highly significant. Mean difference ($P = <.0001$) in energy spent between tender coconut opener and traditional process of opening a tender coconut highly significant.

From table (3), it was observed that the energy spent for opening a tender coconut by three methods showed significantly. Conventional process of opening a tender coconut by using a hand sickle was found less energy consuming. Vendors were relatively comfortable with traditional process of cutting and opening a tender coconut.

From table (4) it is evident that the vendors have perceived high exertion when operating punch

Table 1. Distribution of tender coconut opening tools during energy expenditure

S.No	Tender coconut opening tool	Drudgery index			
		Minimum energy expenditure	Maximum energy expenditure	Mean energy expenditure	S.D
		(kj/min)	(kj/min)	(kj/min)	
1	Coconut punch and splitter	6.8	9.41	8.03	0.49
2	Tender coconut opener	5.24	9.15	7.02	0.9
3	Traditional method	4.92	8.99	6.78	0.88

Table 2. Distribution of tender coconut opening tools during exertion

S.No	Tender coconut opening tool	Drudgery index			
		Minimum exertion	Maximum exertion	Mean exertion	S.D
1	Punch cum splitting machine	17	20	19.07	0.8
2	Tender coconut opener	14	19	16.53	1.18
3	Traditional method	13	17	14.6	1.23

Table 3. ANOVA tables for energy expenditure for opening tender coconut

source	df	Estimate	Standard Error	Z Value	Pr> Z	SEM	CD
Repetitions	14	0.04574	0.05154	0.89	0.1874		
Machines	2	0.3377	0.1386	2.44	0.0074	0.287	0.697
Error	28	0.2611	0.03428	7.62	<.0001		

Table 4. ANOVA tables for physical exertion while opening tender coconut

CovParm	df	Estimate	Standard Error	Z Value	Pr> Z	SEM	CD
Replication	14	0.045	0.051	0.89	0.187		
machines	2	0.3683	0.2536	2.45	0.0732	0.156	0.319
Error	28	0.8222	0.2197	3.74	<.0001		

cum splitting machine followed by tender coconut opener and long established hand process.

Out of the three methods vendors perceived comparatively less exertion when opening a tender coconut in traditional method. The punch cum splitting machine and tender coconut opener were equally causing body discomfort while operation. The physical

exertion when opening tender coconut opener and traditional method does not have significant differences.

With reference to energy expenditure and physical exertion the conventional way of opening the coconut was found better than the other two equipments. Though the traditional method scored

superior to the tools used in the study, the vendors expressed that skill is required to punch the tender coconut. The vendors also reported that the chance of cutting the fingers is very high in this process. According to the vendors the tender coconut opener was safe in operation. Therefore, there is a need to redesign the tender coconut opening tools for the safety of vendors.

CONCLUSION

According to the vendors the tender coconut opener was safe in operation. But which needs more energy expenditure and also physical exertion. Therefore, there is a need to redesign the tender coconut opening tools for the safety of vendors.

LITERATURE CITED

- Anil S, Promod U, Rahul K and Manohar H 2016** Design and fabrication of green coconut cutting machine. *International journal on research and modern trends in engineering and management*. 1(1).
- Borg G 1998** Borg's perceived exertion and pain scale. *Human kinetics*. 29-38.
- Devereux J, Rydstedt L, Kelly V, Westun P and Buckle P 2004** The role of work stress and psychological factors in the development of musculoskeletal disorders. *HSE Health and Safety Research Report*. 273.
- John S 2011** Drink tender coconut water easily. *Indian Coconut Journal*. Coconut Development Board. Kochi. 34-35.
- Maps of India**. *Coconut growing states in India*. <https://www.mapsofindia.com/india-agriculture/oil-seeds/coconut-growing-states.html>.
- Poduval M, Hasan MA and Chattopadhyay 1998** Evaluation of coconut cultivators for tender nut water for West Bengal. *Indian Coconut Journal*. 29(1):3-6.
- Priya S R and Ramaswamy L 2014** Tender coconut water-natures elixir to mankind. *International Journal of Recent Scientific Research*. 5(8): 1485-1490.
- The Economic Times**. *Tender coconut consumption booming in the country*. <https://economictimes.indiatimes.com/news/economy/agriculture/tender-coconut-consumption-booming-in-the-country/articleshow/4229635.cms>.
- Varghese M A, Saha P N and Atreya N 1994** A rapid appraisal of occupational workload from a modified scale of perceived exertion. *Ergonomics*. 37 (3): 485-491.
- Vitalis A Gaskin J and Jeffrey G 1986** The physiological cost of work - an ergonomics approach. *LIRA REPORT*. 11(9):1-14.
- World Atlas** *The world leaders in coconut production*. <https://www.worldatlas.com/articles/the-world-leaders-in-coconut-production.html>.
- Yong J W H, Ge L, Ng Y F and Tan S N 2009** The chemical composition and biological properties of coconut (*Cocos nucifera* L.) water. *Molecules*. 14(12):5144-5164.