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Testing and Evaluation of Peeling Tools

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ABSTRACT

Background: In different regions of the country, they use the only knife for cutting, peeling and chopping the vegetables. The knife caused some design related problems when it is used for peeling. The present study was undertaken to identify those problems and suggest appropriate tool for same purposes.

Methods: The performance of each tool (knife and peeler) was studied after a year of use by rural women for peeling purposes. Performance of peeling was analyzed on the basis of peeling efficient, peel thickness, peel weight proportion and capacity of each tool. A psychophysical study was done to compare the both tools based on women preferences.

Conclusion: The capacity and peeling efficiency of the peeler ($\bar{X}$ =980.39±80.5 grams/min and respectively) were found to be higher than knife ($\bar{X}$ =440.26±38.9 grams/min. and). The wastage of fruits/vegetables in peel was also found less (9.0% with thickness of peel was $\bar{X}$ =1.1±1.9mm) by using peeler. Peeler was found to be reducing the peeling time (35.29%) as well as making the peeling task easy (∑=3.54) for women. As well as use of peeler was significantly (p=0.05) reducing the problems of pain, stiffness, cuts in hands and was found highly accepted (∑=4.37) by women for peeling purposes.

Key words: Capacity, Knife, Peeler, Peeling efficiency, Peeling tools.

INTRODUCTION

Every day, millions of women spend time at home preparing food to eat or to serve their household (Stone, 2018). In 2014, the US Department of labor reported 56.3% of the population engaged in food preparation and cleanup, averaging 1.04 hours daily spent on this activity (Bureau of Labor Statistics, 2014). While the younger population might have no trouble completing kitchen tasks, those who are aging or have other physical disabilities might have problems using certain kitchen tools to prepare food the way they want to (Gustafsson, 2002). Cooking in the kitchen is a necessity for many people and making tools and tasks easier or less time consuming can have a significant effect on the person's ability to complete them (Ritzel and Donelson, 2001). In designing anything for a human being, it must be kept in mind, the dimensions, capabilities and limitations that should form the basis for designing of the tools. The designs of the equipment require the minimum utilization of physiological cost to the body and ensure the safety in use. (Kumari *et al.,* 2017). The vegetable cutter and peeler are the most common hand tools used in an Indian kitchen. They are used regularly, usually twice a day, by Indian housewives. The duration of use of the tool varies from 15 minutes to one hour each time depending on the amount of vegetables and fruits required to be peel and cut for the family. A hand tool operating system has three major components, *e.g.*, worker, tools and task (Kreifeldt and Hill, 1975). Therefore, it is not a luxury, but rather a necessity that hand tools be designed with a focus on comfort (Kuijt-Evers and Lottie, 2009). Baber [2005] stated that a well-designed tool would be the one that focuses on the achievement of the goal rather than on the design. Most of the Indian women are engaged in the kitchen for long periods of time. Peeling and cutting of vegetables, cooking, and grinding are the main activities of women in the kitchen. Peeling of vegetables and fruits is one of the most frequent operations even at house hold purposes or at hotels. Manual peeling is peeling the vegetables with hand tool is toughest and time consuming process. It also causes for the loss of vitamins and become contaminated with the atmospheric air (Gaodi *et al.,* 2017). This has led to the use of a tool which peels the vegetables with less human effort and less time. In different regions of the country, they use the only knife for cutting, peeling and chopping the vegetables. The main goal of research related to kitchen tools is to identify and reduce the existing incompatibilities in peeling vegetables/fruits and to improve work performance by using appropriate tool.

MATERIALS AND METHODS

Selection of site and subject

The present study was conducted for evaluating kitchen peeling tools (knife and peeler). In 2020, RAWE of final year students was conducted in Siswal village, Hisar, where women were studied regarding their day to day activities and their management and skill of doing tasks, during RAWE, it was found that women were using knife for peeling of vegetables and fruits and none of them were found to be using potato peeler for peeling purposes. Under the RAWE, 9 groups of women were made in which 10 women were in each group so the total 90 potato peelers were distributed among all women and a demonstration was given on how to use potato peeler and its advantages. After a year, in April, 2021, women were studied

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on status of use of peeler in peeling purposes in kitchen, 30 women who were found to be using potato peeler for peeling purposes in day to day activities from last one year were taken as respondents.

Performance evaluation

The performance evaluation of tools was carried out in terms of machine capacity, peeling efficiency, peel thickness, which are as follow.

Peel weight proportion

The peeling weight proportion as given by Balami *et al.,* (2012).

$$Pw = \frac{Mpc}{Ms} \times 100$$

Where

Mpc= Weight of peel collected (grams)

Ms= Weight of the sample (grams)

Machine/tool capacity was given by (Singh, 2017).

Tool/machine capacity (kg/hr) = Weight of potato, kg/ Total time taken, min.

Peeling efficiency

Peeling efficiency is the r^3 | Pageatio of the through put capacity to the theoretical capacity expressed as a percentage. The peeling efficiency of the machine was determined by an expression as given by (Agrawal, 1987) in Equation.

$$\eta p = \frac{}{M_{pO} T_{wp}} \times 100$$

Where

ηp= Peeling efficiency (%).

Mpo= Weight of peel collected through the peel outlet of the machine (kg).

Twp= Total weight of peel collected by manual peeling (kg).

Peel thickness

Peel thickness was measured by using caliper.

Grip strength

was recorded by using stethoscope and before and after the task.

Comfort assessment for peeling tools

The comfort rating is taken from the users on various areas of the hand. The hand was divided into 5 areas based on the surface of the knife handle it is used for. A sheet was used containing five areas of hand and comfort rating for each area by using tools. The pictorial representation for the area of hand was as below.

Psychophysical studies

Psychophysical study, which deals with the relationship between physical stimuli and their subjective correlates, or percepts, was carried out for assessing on peeling tools. Different characteristics of the peeling tools (*e.g*, length of tools, weight of tools, peeling time and easiness of use) were the physical stimuli and the subjective response for each stimulus was tested during the study. For this purpose paired comparison tests were employed. The paired comparison test was done using a subjective scale, which consisted of zero mark in the middle and negative increments (up to -5 marks) at left hand and positive increment (up to +5 marks) at right hand (Ebe and Griffin, 2001). During the experiment the subjects were asked to use both peeling tools; knife and peeler for 5 minutes and to express their subjective impression on a comparative basis. In the scale '0' value indicates the same comfort level between the 1st and 2nd tools. Increase of the scale towards the positive direction (+1 to +5) indicates greater comfort level of 1st tool in comparison to 2nd. On the other hand increase towards the negative direction (-1 to -5) indicates lesser comfort level of 1st tool than that of 2nd one. (Dhara, *et al*., 2015).

The subjective impression of each of the points in the scale was expressed as follows:

+5 1st very very much more comfortable than the 2nd
+4 1st very much more comfortable than the 2nd
+3 1st definitely more comfortable than the 2nd
+2 1st moderately more comfortable than the 2nd
+1 1st slightly more comfortable than the 2nd
0 1st as comfortable as the 2nd
-1 1st slightly less comfortable than the 2nd
-2 1st moderately less comfortable than the 2nd
-3 1st definitely less comfortable than the 2nd
-4 1st very much less comfortable than the 2nd
-5 1st very very much less comfortable than the 2nd

Table 1: Design particulars of peeling tools.

Particular	Knife	Peeler
Length of blade		
Less than 4 inches	5 (16.7)	16 (53.3)
5-6 inches	18 (60.0)	14 (46.7)
More than 6 inches	7 (23.3)	NA
Material of blade		
High carbon stainless steel	19 (63.3)	30 (100.0)
Iron	11 (36.77)	NA
Length of handle		
Less than 4 inches	9 (30.0)	17 (56.7)
4-6 inches	12 (40.0)	13 (43.3)
More than 6 inches	9 (30.0)	NA
Material of handle		
Wood	9 (30.0)	NA
Plastic	5 (16.7)	9 (30.0)
Carbon fiber	6 (20.0)	14 (46.7)
G10	3 (10.0)	NA
FRN (fiberglass-reinforced nylon)	7 (23.3)	7 (23.3)
Diameter of handle		
Less than 4 cm	6 (20.0)	11 (36.7)
4-5 cm	16 (53.3)	17 (56.7)
More than 5 cm	8 (26.7)	2 (6.6)
Total length		
Up to 20 cm	6 (20.0)	7 (23.3)
20-24 cm	14 (46.7)	23 (76.7)
Above 24 cm	10 (33.3)	NA
Total weight		
Upto 50 grams	8 (26.7)	17 (56.7)
50-75 grams	18 (60.0)	13(43.3)
Above 75 grams	4 (13.3)	NA

Figures in parentheses indicate percentage.

The women respondents were asked to answer each question by commenting on the level of comfort. Then the answers were sorted using the numeric system stated above.

RESULTS AND DISCUSSION

Design particulars of peeling tools

Results in table represent the design particulars of knife and potato peeler. As per length of blade more than fifty per cent women were found to be using knife having 5-6 inches of blade and peeler having blade length less than 4 inches, followed by 53.3 per cent women were using peeler having blade length between 5-6 inches. Regarding material of blade, Cent per cent peeler were having high carbon stainless steel blade instead knife were found to be having both type of blade *i.e*. high carbon stainless steel blade (63.3%) and iron (36.7%). length of knife was found between 4-6 inches (40.0%) followed by less than 4 inches (30.0%) and more than 6 inches (30.0%). Peeler's handle length was found to be less than 4 inches (56.7%) and between 4-6 inches (43.3%). Data in table represent that diameters of handle of knife and peeler were between 4-5 cm (53.3% and 56.7%), more than 5 cm (26.7% and 6.6%) and less than 4 cm (20.0% and 36.7%), respectively. As per study done by Kumari *et al.,* (2017) that 46.0% per cent respondents were found to be using knives of recommended size (6"-7") further 'Diameter of handle' was found more than 6cm in most of the families and 40 per cent of the respondents were having 'Handle length' of kitchen tools below or above the recommended value (< 5 cm). Most of the handle material of peeler was made up of carbon fiber (46.7%), plastic (30.0%) and FRN (23.3%) others side handle materials of knife were wood (30.0%), FRN (23.3%), carbon fiber (20.0%), plastic (16.7%) and G10 (10.0%). Data pertaining to 'Material of blade' indicated that cent per cent of the standardized brand of Vegetable knife, Potato peeler and Lemon squeezer were made of high carbon stainless steel as per recommended by Dhesi (1973) whereas in case local brand almost all the vegetable knives, potato peeler and lemon squeezer were found to be made of stainless steel, wood and iron respectively. The total length of peeler and knife was 20-24 cm in most of the houses (76.7% and 46.7%, respectively) followed by up to 20 cm (20.0% and 23.35) and above 24 cm (33.3%, knife). Regarding weight of peeling tools; more than fifty per cent household were having knife of weight 50-75 grams (60.0%) and peeler of up to 50 grams (56.7%) weight followed by 13.3 per cent household were having knife of weight more than 75 grams.

Performance assessment of peeling tools

Results in table reflect the work performance of peeling tools (knife and peeler). Table shows that performance of each tool was analyzed on peeling of 1kg of potato. As per data knife took more time in potato peeling ($\bar{X}$ =2.27±0.90 min.) compare to peeler ($\bar{X}$ =1.02±0.15) and the capacity of knife ($\bar{X}$ = 440.26±38.9 grams/min.) was found less than peeler ($\bar{X}$= 980.39±80.5 grams/min). Table further revealed that peel weight proportion was found less by using peeler (9.0%) comparative to knife (15.0%). Peel thickness was also found minimum ($\bar{X}$ =1.1±1.9mm) by using potato peeler in compare to knife ($\bar{X}$=1.7±2.3mm). the peeling efficiency of peeler was 60.0 per cent. The average peeling weight proportions of the prototype were 10%, 15% and 20%. Mean manual peeling capacity of using knife obtained from the trials were 0.1175kg/min (Temam, 2017). Singh (2017) found that the under best performance of pedal operated potato peeler machine the maximum machine capacity 144 kg/h and peeling efficiency was 85.8%.

Grip strength of women after using peeling tools

Potato peeling activity was performed by women for 5 minutes by using knife (available at home) and peeler for assessment of physiological cost of work stress of the respondents while performing the activity. Findings in table 3 unveiled that mean grip strength of right hand of women was $\bar{X}$ =28.04±5.1 kg, which was found to be significantly (t=3.35 and p=0.004) decreased (15.47%) after using knife, besides, peeler was not found to be affecting the grip strength (t=0.879 and p=0.0049). Similar findings were found regarding left hand as the strength was significantly (t=3.025 and p=0.0082) decreased (19.41%) after work by knife but by using peeler no significant (t=1.33 and p=0.109) grip strength was decreased. Results in table give a clear picture of results of grip strength shows that by using knife, grip strength of both hand was found to be decreased ($\bar{X}$= 24.5±4.4kg to =21.46±3.2kg; 12.41%) but by using peeler no significant (t=1.28 and p=0.117) affect was found on grip strength of both hands. Study on testing and evaluation on kitchen tools done by Kumari, *et al.,* (2017) depicts that percentage decrease in grip strength in right, left and both hands was found more in local brand kitchen tools as compared to standardized brand. It may be due to mismatch ergonomic design according to the users.

Fig 1: Areas in which hand was divided for study.

Sheet: Comfort rating of peeling tools.

Area	Knife	Potato peeler
Area 1		
Area 2		
Area 3		
Area 4		
Area 5		

For studying the comfort level of hand by using knife and peeler; hand was divided in 5 areas as shown in Fig 1. Regarding hand area 1,2 and 3 potato peeler was significantly (t=-4.73, -3.28 and -6.34) found to be having more comfort level (∑=3.6, 3.4 and 3.0, respectively) than knife (∑=1.7, ∑=2.2 and ∑=1.6). Hand area 4 and 5 have similar comfort level by using knife and peeler for peeling purposes. in line similar findings were mentioned by Kumari, *et al.* (2017) that majority (48.5%) of the respondents complained "Very mild" pain after peeling potato with knife followed by 45.4 percent perceived "Mild" pain and minimum (6.1%) perceived "Moderate" pain in Finger. "Severe" pain was identified by majority of the respondents in wrist and finger.

Result shown in Fig 2 unveiled the performance score of women regarding size of peeling tool. For both tools; women were found to be satisfied by the dimension, but high level of satisfaction was observed for potato peeler size ($\bar{X}$=3.5) compare to knife ($\bar{X}$=2.1). Fig 3 unveiled that preference score of women regarding weight of peeling tools. No major difference was noticed regarding preference of tools on the basis of weight; besides peeler had slightly high score ($\bar{X}$=1.2) than knife ($\bar{X}$=0.8). Fig 4 shows the preference score of the women regarding easiness of tool use. Score was taken from -5 to 5 on the performance of the peeling tools. Regarding knife, the score was -4.02, which shows the highly discomfort level by the use of knife as a peeling tool, besides peeler got $\bar{X}$=3.56 score represent highly comfort in use. Fig 5 represents the level of preference score for time taken by peeling tool for peeling one kg of potato. as per fig. Low score ($\bar{X}$ =-3.18) was given by women to knife after using knife for peeling purposes of potato, besides peeler got good comfort score ($\bar{X}$ =3.38), represent the high level of comfort

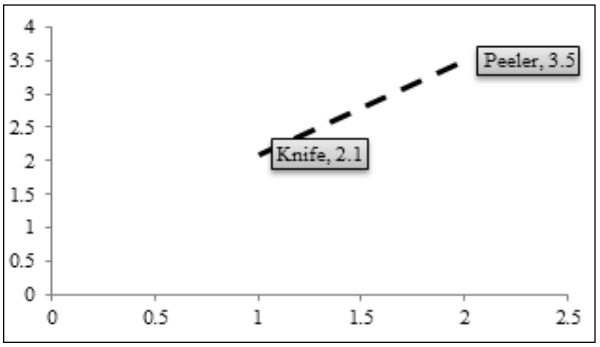

Fig 2: Level of the preference score of the subjects for size of peeling tools (Knife= $\bar{X}$ =24.3±3.1cm and potato peeler= $\bar{X}$=19.7±2.1cm).

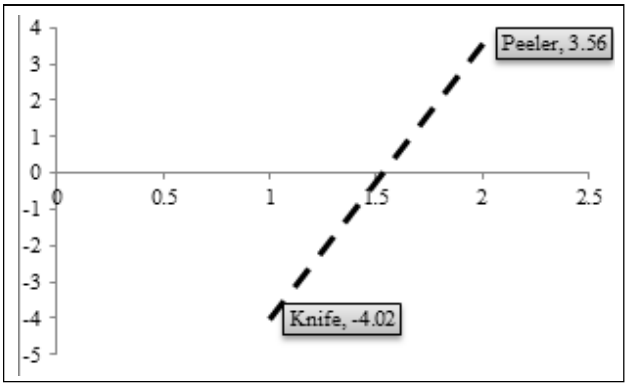

Fig 3: Level of the preference score of the subjects for easy in use of peeling toots (Knife= ∑ =2.46 and potato peeler ∑=3.54).

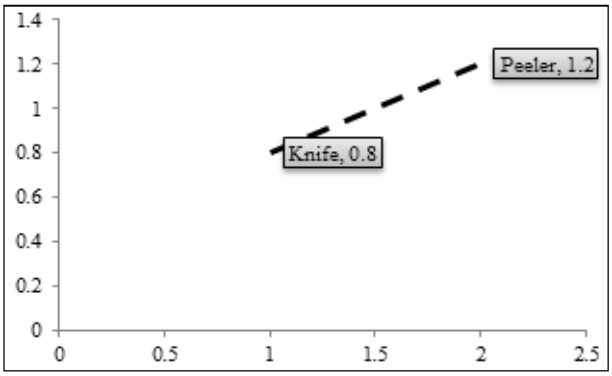

Fig 4: Level of the preference score of the subjects for weight of peeling tools (Knife, $\bar{X}$ =68.9±15.2cm) and potato peeler, $\bar{X}$=57.6±5.4cm).

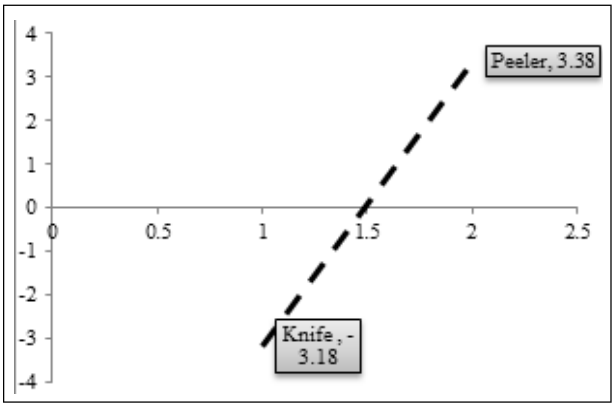

Fig 5: Level of the preference score of the subjects for peeling time taken by peeling tools (Knife $\bar{X}$ =2.27±0.90min/kg and potato peeler, $\bar{X}$=1.02±0.15min/kg).

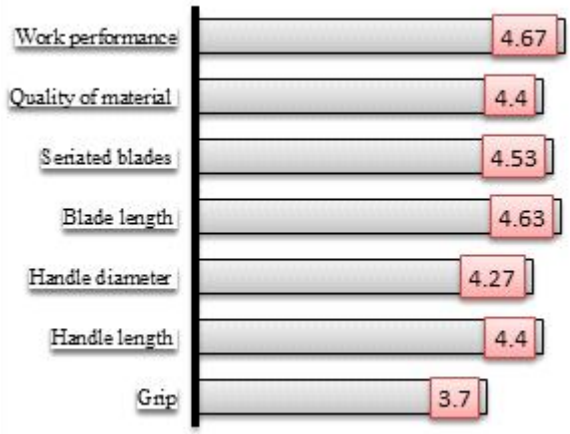

Fig 6: Acceptance level for potato peeler (weighted mean).

Table 2: Performance assessment of peeling tools.

Sr. No	Process parameters		Performance parameters			
	Weight of potato (kg)	Time taken (min.)	Tool capacity (grams/min)	Peeling efficiency (%)	Peel weight proportion (%)	Peel thickness
Knife	One kg	2.27±0.90	440.26±38.9	NA	15	1.7±2.3mm
Peeler	(1000gm)	1.02±0.15	980.39±80.5	60.0%	9	1.1±1.9mm

Table 3: Grip strength of women after using peeling tools. n=30

	At rest (kg) Mean + S.D	After work (kg) Mean + S.D	Decreased (%)	"t-value"	"p-value"
		Right hand			
Knife	28.04±5.1	23.70±4.9	15.47	3.35693	0.004989
Peeler		26.86±2.7	4.21	0.87954	0.202376
		Left hand			
Knife	25.14±4.4	20.26±4.5	19.41	3.02517	0.008215
Peeler		23.26±3.1	7.47	1.33532	0.109259
		Both hand			
Knife	24.5±4.4	21.46±3.2	12.41	1.98474	0.041221
Peeler		23.66±2.8	3.67	1.28149	0.117957

The result is significant at p < .05.

Table 4: Comfort rating of peeling tools.

Area	Knife	Potato peeler	
Area 1	1.7	3.6	The *t*-value is -4.73. The *p*-value is *.000083*. The result is significant at *p* < .05.
Area 2	2.2	3.4	The *t*-value is -3.28. The *p*-value is *.002052*. The result is significant at *p* < .05.
Area 3	1.6	3.0	The *t*-value is -6.34. The *p*-value is *.00001*. The result is significant at *p* < .05.
Area 4	3.0	3.5	The *t*-value is -1.42. The *p*-value is .085986. The result is *not* significant at *p* < .05.
Area 5	3.8	4.2	The *t*-value is -1.13. The *p*-value is .135858. The result is *not* significant at *p* < .05.

by using knife for peeling task. In line findings of research done by Dhara (2013) conclude that every hand tool designer must consider three components of designing a tool *i.e*., worker, tools and task. Designing of tool for task specific (like peeler of peeling purposes and knife for cutting purposes) influences the efficiency of the work. The tool should be designed in such a way that it is adapted to the limitations of the human physique. Ergonomically well-designed hand tools, which provide comfort to the user, decrease the risk of occupational health problems and increase the job performance.

Fig 6 shows the response of women regarding acceptance of potato peeler. Maximum score was found for work performance of peeler (∑=4.67), followed by blade length (∑=4.63) and seriated blades of peeler (∑=4.53). Quality of material of peeler and handle length got scores (∑=4.40) and grip of peeler had score of ∑=3.70, which revealed that peeler was accepted by women for peeling purposes of vegetables.

SUMMARY

Potato peeler was found locally available and it was simple for use. It can decrease the drudgery of women in home. It was also recommended to use it for peeling of other vegetables (carrot, cucumber, gourd, ridge gourd *etc.*) and fruits (apple, guava, mango *etc.*) similar to potato. It would result into good efficiency with less peel loss. The capacity and peeling efficiency of the peeler ($\bar{x}$=980.39±80.5 grams/ min and respectively) were more than knife ($\bar{x}$=440.26±38.9 grams/min. and) the wastage of fruits and vegetable was less (9.0% with thickness of peel was $\bar{x}$=1.1±1.9mm) by using peeler comparative to knife (15.0% of waste in peel with peel thickness was $\bar{x}$=1.7±2.3mm) for same purposes. Time involved in peeling of 1kg of potato was $\bar{x}$=2.27±0.90 min which was more than double to peeler time of peeling ($\bar{x}$ =1.02±0.15). The women response was satisfactory after using peeler for which was reducing their time (35.29%) in peeling as well as easy in use (potato peeler ∑=3.54). regarding grip strength, knife was found to be reducing the grip strength (12.41%) of women besides peeler was only reducing the strength upto 3.67%. As well as use of peeler was significantly (p=0.05) reducing the problems of pain, stiffness, cuts in hands and was found highly accepted (∑=4.37) by women for peeling purposes.

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