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*A Case Study*

# Erogonomic evaluation of grater

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**ABSTRACT :** The use of modern gadgets and appliances in recent years has apparently simplified the methods of performing household activities. It has on other hand brought in several ergonomic issues towards the health and safe working performance of the users. As there are very few ergonomical studies on kitchen tools, the present study was conducted to evaluate identified models of graters through case analysis. Four models of graters were identified based on the household and market survey and the ergonomic evaluation was carried out on a multiparametric approach. The quantitative and qualitative evaluation of the identified models of the graters revealed that more energy and time was spent while using grater 1 compared to other graters. Grater 2 was found to be user compatible in view of user's comfort, safety and efficiency.

**KEY WORDS :** Awaren

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Food preparation, a part of cooking activity involves the use of kitchen tools *i.e.* knives, peelers, tongs, graters, beaters and many more. Different models of these tools are available in the market which may be ergonomically compatible or incompatible and the women may not give much thought in making wise choices with regard to the design of the tool in terms of comfort and usability. Graters are one of the important and frequently used kitchen tools. These should be chosen not only with the view of how well they will grate food but also how easily they can be cleaned. The designer should take conscious advantage of unique human capabilities while designing tools. Reduced injuries, fatigue and mental stress are sufficient reasons in themselves for applying ergonomics, independent of any associated cost savings. Hence, the present study was taken up to evaluate the design features of different identified models of graters available in the market.

The study was conducted in the twin cities of Hyderabad and Secunderabad of Andhra pradesh. Four models of the graters were identified from the household and market survey. A subsample of ten respondents was taken as a sample for case analysis after standardizing the procedure. The experiments were conducted in their respective homes in twin cities of Hyderabad and Secunderabad. The ergonomic evaluation was carried out on a multiparametric approach considering the two major aspects of subject and object through quantitative and qualitative evaluation. Four types of commodities which are commonly grated and comprises of hard and soft food categories were selected for the study *i.e.*, dry coconut, fresh coconut, carrot and cucumber. Two hundred and fifty grams of each commodity, which is sufficient for a meal of medium sized family was taken. Each experiment was carried out in three replications.

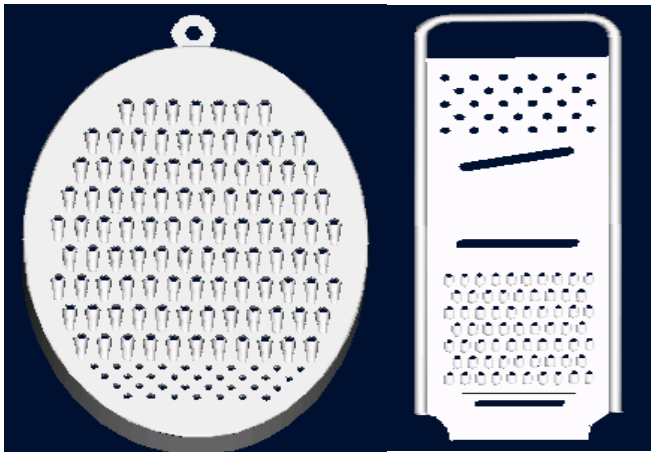
The profile of the identified models of the graters (Fig. 1) in terms of their dimensions was studied which is depicted in Table 1 under object aspect. The quantitative evaluation was conducted under subject aspect. The anthropometric and physiological aspects of the users were studied under quantitative evaluation.

**Anthropometry :**

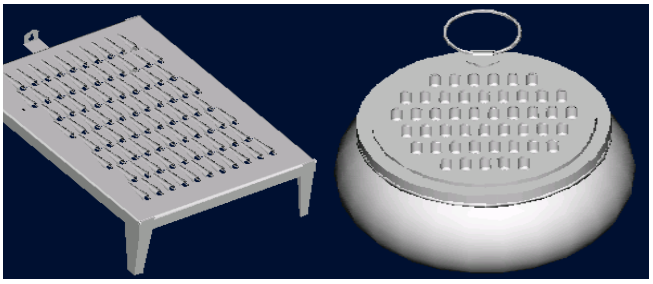
The user's anthropometry is one of the vital issue to be considered while evaluating grater. The biomechanical aspects considered were Grip strength and wrist angle.

In the present study the grip strength of both right and left hands were taken. The results indicated that there was highly significant reduction in grip strength from neutral posture with 90$^{o}$ elbow flexion in case of grater 1 compared to

other three graters. The reduction may be due to the reason that flexed wrist postures increases the pressure in the carpal tunnel, which is in confirmation with the findings of Mathiowetz *et al.* (1995) which revealed that 90° elbow flexion yielded greater reduction in grip strength values than the fully extended elbow posture.



Grater 1 Grater 2



Grater 3 Grater 4

**Fig. 1 : 3D depiction of the graters used for the ergonomic**

The grip strength in neutral posture was taken before performing the work using grip dynamometer for both the left and right hands. The difference in grip strengths before and after work of both right and left hands for four commodities is depicted in the Table 1.

**Table 1 : Reduction in grip strength (KGS) (Right hand) (n=10)**

| Grater | Dry coconut | Fresh coconut | Carrot | Kheera | Total |
|---|---|---|---|---|---|
| 1. | 5.73 | 5.63 | 3.84 | 4.17 | 19.37* |
| 2. | 2.35 | 2.09 | 1.89 | 1.02 | 7.35* |
| 3. | 3.52 | 2.06 | 1.74 | 2.15 | 9.47* |
| 4. | 3.96 | 4.75 | 3.09 | 2.68 | 14.48* |
| Total | 15.56* | 14.53* | 10.56* | 10.02* | 50.67 |

| F | (Cal) | C.D. |
|---|---|---|
| Graters | 6.79 | 0.98 |
| Commodities | 25.35 | 0.98 |

* Indicate significance of value at P=0.05, respectively

From the above table, it is evident that the reduction of grip strength of right hand while using grater 1 was more followed by grater 4 and grater 3. The reduction in grip strength while using grater 2 was found to be less.

The reduction of grip strength while grating all the foods with four graters was found to be significant. In case of commodities, for grater 1 the difference between grip strength before and after work is more for dry coconut, followed by fresh coconut, kheera and carrot. The reduction in grip strength for remaining three graters is in the order of dry coconut, fresh coconut, carrot and kheera.

**Table 2 : Reduction in grip strength (kgs) (left hand) (n=10)**

| Grater | Dry coconut | Fresh coconut | Carrot | Kheera | Total |
|---|---|---|---|---|---|
| 1. | 3.93 | 3.27 | 1.77 | 1.77 | 10.64* |
| 2. | 1.67 | 0.44 | 0.46 | 0.67 | 3.24* |
| 3. | 1.57 | 1.22 | 1.32 | 1.15 | 5.26* |
| 4. | 2.80 | 2.50 | 1.48 | 0.89 | 7.67* |
| Total | 36.7* | 32.4* | 18.4* | 15.3* | 102.8 |

| F | (Cal) | C.D. |
|---|---|---|
| Graters | 9.59 | 0.95 |
| Commodities | 6.10 | 0.95 |

It can be noted from the above table, that the grip strength reduction of left hand is more while using Grater1 and Grater4. Grater2 was found to be having less reduction in grip strength.

In case of commodities, for Grater 1 the difference between grip strength before and after work is more for Dry coconut, followed by Fresh coconut, Kheera and Carrot. The reduction in grip strength for remaining three graters is in the order of Dry coconut, Fresh coconut, carrot and kheera.

The reduction of grip strength of left hand also showed similar results as the right hand but the reduction of grip strength is low compared to right hand since left hand is used only to hold the grater but right hand is used to grate and due to the repetitive movements more stress falls on right hand compared to left hand. The fact was supported by Oberoi and Kaur (2001) who reported that percent decrease in grip strength was less for left hand compared to right hand.

**Table 3 : Wrist angle (degrees) of both the hands while using various graters**

| Graters | Wrist angle (n=10) | |
|---|---|---|
| | Right hand | Left hand |
| 1. | 53 | 47 |
| 2. | 86 | 88 |
| 3. | 93 | 88 |
| 4. | 84 | 86 |

The observations indicated that while using grater 1, the right hand is at 46° elbow flexion and 53° ulnar deviation and left hand is at 46° elbow flexion and 47° ulnar deviation which increases the carpal tunnel pressure and leads to severe carpal tunnel injuriesc Fig. 2. These results are supported by the results of Robbins (1996) who stated that palmar flexion of the wrist causes rotation of the anterior part of the lunate and its palmar projection, which compresses the median nerve and reduces the volume of carpal tunnel leading to Carpal Tunnel Syndrome.


**Fig. 2 : Wrist angle of right and left hand while using four graters**

**Operation evaluation :**

Four models of graters for grating four foods (dry coconut, fresh coconut, carrot and kheera) were evaluated. Each experiment was carried out in three replications. The time of starting and ending were noted down for each experiment and the difference was taken. The differences of three replications were averaged to come out with the actual time taken to complete each trial with each grater.

**Table 4 : Time taken for completion of each operation using various graters in minutes (n=10)**

| Commodity / Grater | Dry coconut | Fresh coconut | Carrot | Kheera | Total |
|---|---|---|---|---|---|
| 1 | 30.15 | 24.85 | 13.13 | 10.80 | 78.93* |
| 2 | 25.11 | 18.83 | 11.60 | 9.45 | 64.99* |
| 3 | 29.12 | 23.45 | 12.37 | 10.20 | 75.14* |
| 4 | 29.99 | 27.64 | 13.12 | 10.40 | 81.15* |
| Total | 114.37* | 94.77* | 50.22* | 40.85* | 300.21 |
| F | (Cal) | | C.D. | | |
| Graters | 5.32 | | 2.86 | | |
| Commodities | 129.2 | | 2.86 | | |

* Indicate significance of value at P= 0.05, respectively

The time taken to grate while using grater1 was significantly higher when compared to the other three graters. There is no significant difference between the time taken by grater 1 and grater 4 Fig. 3. The grating time taken by grater 2 was less compared to others. This shows that the posture to be adopted while using the grater influences the force required which in turn effects the time of operation. The present findings corroborate with the study of konz (1990) who reported that the tool should be shaped to allow normal operation with the hand in neutral position and as close to the body as possible. Avoiding awkward postures will have positive effect on the performance and output. More amount of time was taken to grate dry coconut followed by fresh coconut, carrot and kheera. The reason being dry coconut harder than other three foods.

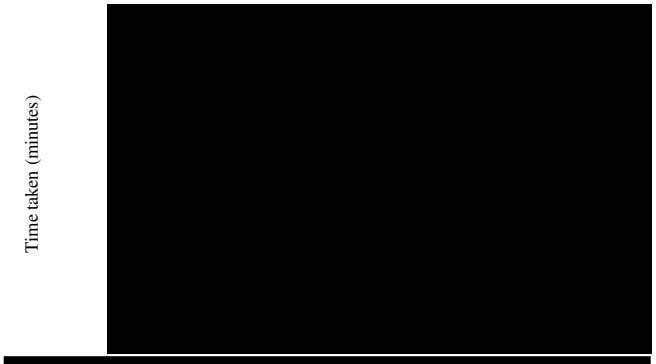



**Fig. 3 : Time taken for completion of grating using four graters**

**Physiological evaluation :**

The amount of physiological stress imposed on users while using graters was assessed by measuring heart rate and energy expenditure.

**Heart rate:**

**Table 5: Difference in heart rate (beats/mt)while grating with various graters (n=10)**

| Commodity / Grater | Dry coconut | Fresh coconut | Carrot | Kheera | Total |
|---|---|---|---|---|---|
| 1 | 13.5 | 12.7 | 5.3 | 6.0 | 37.5* |
| 2 | 6.2 | 4.7 | 3.0 | 2.5 | 16.4* |
| 3 | 9.4 | 7.3 | 5.4 | 3.7 | 25.8* |
| 4 | 8.4 | 6.9 | 4.7 | 3.1 | 23.1* |
| Total | 36.7* | 32.4* | 18.4* | 15.3* | 102.8 |
| F | (Cal) | C.D. | | | |
| Graters | 9.59 | 0.95 | | | |
| Commodities | 6.10 | 0.95 | | | |

* Indicate significance of value at P=0.05, respectively

**Energy expenditure :**

Energy expenditure while using different graters was taken as the other parameter to assess the physiological stress. It was calculated using the formula-

EE = 0.159 x AHR x 8.72.

EE : energy expenditure

AHR : average heart rate

0.159 and 8.72 are constants

**Table 6 : Energy expenditure (kilo joules) (n=10)**

| Commodity Grater | Dry coconut | Fresh coconut | Carrot | Kheera | Total |
|---|---|---|---|---|---|
| 1 | 18.71 | 17.61 | 7.37 | 8.34 | 52.03* |
| 2 | 8.62 | 6.53 | 4.17 | 3.47 | 22.79* |
| 3 | 13.07 | 10.15 | 7.51 | 5.14 | 35.87* |
| 4 | 11.68 | 9.60 | 6.53 | 4.31 | 32.12* |
| Total | 50.98* | 44.99* | 25.58* | 21.26* | 142.81 |

| F | (Cal) | C.D. |
|---|---|---|
| Graters | 9.94 | 3.57 |
| Commodities | 14.00 | 3.57 |

* Indicate significance of value at P=0.05, respectively

In the present study the increase in heart rate while using grater 1 is significantly higher with dry coconut and fresh coconut. The difference of heart rate was less pronounced using grater 2, Fig 4. While using grater1 the deviation from the neutral posture is more resulting in increase of physical stress. Grating of carrot and kheera with any of the graters has minimal influence on the heart rate. The results are in accordance with the study by Kroemer and Grandjean (1997) who mentioned that the heart rate increases linearly with the work performed, provided it is dynamic, not static and is performed with a steady rhythm and is influenced by the posture adopted, force applied and the type of product.


**Fig. 4 : Energy expenditure in grating four foods using four graters**

The amount of energy spent while grating with grater 1 is comparatively more followed by grater 3, 4, and 2. This may be due to the awkward posture maintained while using grater 1 and demand for higher force. These results are in accordance with the findings of Moore and Garg (1994) reported that extreme or awkward postures increase the required force necessary to complete a task and it in turn will increase the energy spent on that particular task.

**Conclusion :**

The findings of the present study revealed that more energy is spent while using grater1 compared to other three graters. Grater 2 was found to have better design features among all the graters with less energy expenditure, less force application and less time taken to complete the operation. So, while designing the graters the major parameter to be considered is the shape of the grater, area of the grater and type of the hole to reduce the application of force energy expenditure time taken wrist deviation to reduce the risk of carpal tunnel injuries. The grater can be designed to cater to multipurpose needs but th basic purpose of the grater should be given first priority keeping in mind user's comfort, safety and efficiency.

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