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Development of Drudgery Reducing Tools for the Workers in Food Processing Enterprises

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Food processing is a drudgery prone activity and exposes the workers to several musculoskeletal discomforts. The present study was conducted to identify the most drudgery prone activities in micro, small and medium scale food processing enterprises and thereafter develop the tools to reduce the drudgery. For testing the feasibility of tools, 15 respondents were selected and they were allowed to work with and without the tool, and their responses were recorded. Results revealed that all the developed tools were acceptable by the respondents on musculoskeletal factors, grip fatigue, physical stress factors, work output factors, tool factors and acceptability factors.

Keywords: Discomforts; drudgery; food processing; manual material handling; workers.

1. INTRODUCTION

Processing of agricultural products makes the major industries in India [1]. Workers in food processing enterprises face several health problems among which the major one is musculoskeletal disorders [2]. A major cause of developing musculoskeletal disorders in food

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processing enterprises is the manual material handling tasks performed by the workers. The processing of fruits and vegetables is the most complex as it is done in various steps and manual involvement is high at every step. Especially in small and micro enterprises due to the lack of machinery, almost all the activities are performed by workers. It is a skilled work so women involvement is more and the maximum number of workers are female.

The aim of ergonomics is to reduce the work-related musculoskeletal discomforts by adopting the work to fit according to the person, instead of forcing the person to fit the work [3]. In all cases, the preferred method for preventing and controlling work-related musculoskeletal discomforts is to design jobs, workstations, tools, and other equipment to match the physiological, anatomical and psychological characteristics and capabilities of the worker [4]. Therefore the present study aims to identify the most drudgery prone activities in food processing enterprises and develop tools for reducing their drudgery.

2. METHODOLOGY

The drudgery prone activities were identified in the food processing enterprises and tools were developed/ modified to replace the strenuous manual task either by mechanising it or fitting the tool to the worker. For feasibility testing of the developed tools, 15 physically fit respondents were selected purposively who were actively involved in the selected activities. They were allowed to work with and without the tool and their responses were recorded. Responses of the respondents were recorded using interview schedule which comprised of different statements categorised under six main headings i.e. musculoskeletal factors, grip fatigue, physical stress factors, work output factors, tool factors and acceptability factors. The responses were recorded on 5 point scale. The qualitative score was quantified by assessing scores i.e. strongly agree – 5, agree – 4, undecided – 3, disagree – 2 and strongly disagree – 1. This scoring was done for positive statements. For negative comments, the scoring was as follows. Strongly agree – 1, agree – 2, undecided – 3, disagree – 4 and strongly disagree – 5. The mean scores were calculated for each category of statements and attained scores were calculated by summation of the mean scores of different statements under each heading. The percentage of the gained score was calculated by using the following formula:

$$\text{Gained score} = \frac{\text{Attained score}}{\text{Maximum attained score}} \times 100$$

The overall scores were then classified as below:

< 40	Not acceptable
40-60	Needs modification
60-80	Acceptable
80-100	Highly acceptable

3. RESULTS AND DISCUSSION

The tools developed under the present study are presented below:

3.1 Pulp Extractor

The pulp extractor (Fig. 1) can be used to scoop out the pulp of fruits like wood apple, watermelon and muskmelon. In micro and small-scale enterprises, respondents were extracting the pulp of wood apple for making *juice.* There were no tools available to extract the pulp. Respondents used the spatula or spoon to extract the pulp which did not have any handle (Fig. 2). Many times, their spoons broke during removing the pulp which leads to cuts in their palms. Therefore, there was a need to modify the tool used by them. The pulp extractor has a moderately sharp edge which assists in scooping the pulp without putting extra pressure on palm and fingers. The sharp edge is at the exterior side of the scooper so that the workers can easily clean the scooper without any injury. It has a wooden handle wrapped with a slip-proof material which provides proper grip while scooping (Fig. 3). The feasibility testing of pulp extractor was done on 15 respondents whose results are shown in Table 1. The modified tool was highly acceptable by the respondents on all six factors i.e. musculoskeletal stress, grip fatigue, physical stress, work output, tool factor and acceptability.

3.2 Veg-multi-slicer

The Veg-multi-slicer can be used to cut vegetables in several pieces in one effort (Fig. 4). Seven to eight strand of vegetables like baby corn, carrot, radish can be placed and cut in a fixed size in one go (Fig. 5). It is a useful tool for

Fig. 1. Side and front view of pulp extractor

Table 1. Feasibility testing of pulp extractor

n=15

Factors assessed	Maximum attainable score	Attained score (mean)	% Score gained	Remarks
Musculoskeletal stress factor	50	47	94	Highly acceptable
Grip Fatigue	25	24.2	96.8	Highly acceptable
Physical stress factor	15	13.9	92.66	Highly acceptable
Work output	15	14.1	94	Highly acceptable
Tool factor	40	38.1	95.25	Highly acceptable
Acceptability	15	14.8	98.6	Highly acceptable

Fig. 2. Extracting pulp traditionally

Fig. 3. Worker using pulp extractor

the workers engaged in micro, small and medium scale enterprises as they were cutting a number of vegetables either by holding several pieces in hand (Fig. 6) or on traditional chopping board (Fig. 7) which required more effort. In the newly developed Veg-slicer, the force got evenly distributed on all the pieces with less effort. The feasibility testing of Veg-multi-slicer was done on 15 respondents and its results are displayed in Table 2. Results reveal that it was found to be highly acceptable on musculoskeletal stress factor, grip fatigue, physical stress, work output and acceptability whereas was acceptable on the cool factor.

Fig. 4. Diagonal view of Veg-multi-slicer

Fig. 5. Cutting multiple baby corns with veg-multi-slicer

Table 2. Feasibility testing of Veg-multi-slicer

n=15

Factors assessed	Maximum attainable score	Attained score (mean)	% Score gained	Remarks
Musculoskeletal stress factor	60	56.5	94.1	Highly acceptable
Grip fatigue	20	19.3	96.5	Highly acceptable
Physical stress factor	15	14.5	96.6	Highly acceptable
Work output	15	14.6	97.3	Highly acceptable
Tool factor	55	37.9	68.9	Acceptable
Acceptability	15	14.6	97.3	Highly acceptable

Fig. 6. Cutting multiple baby corns at a time by holding in hand

Fig. 7. Cutting multiple baby corns at a time on chopping board

3.3 Shell Cracker

Shell cracker helps in breaking the hard outer cover of fruits like wood apple (Fig. 8). Cracking the shell of fruits like wood apple or coconut was a tedious job in the microscale food processing enterprises. Workers used to break each fruit by hitting it on the ground multiple times. They used to hit each fruit for nearly eight to ten times on the ground to break its shell (Fig. 9). Therefore, for processing of hundred of fruits they hit for around eight hundred to one thousand times with high intensity which put stress on their shoulders, hands, palms and upper back. To reduce this drudgery, a tool was developed which would break the shells by making simple hand movements (Fig. 10). A jack was fitted in the base which was operated with the help of a handle which breaks the shell in three to four hand movements with less force. The fruits break into pieces with very less force (Fig. 12) which previously required a high intensity of force on fingers (Fig. 11). The results of feasibility testing done on 15 respondents are portrayed in Table 3. The tool was found to be highly acceptable by the respondents on all six factors.

Fig. 8. Diagonal view of shell cracker

Table 3. Feasibility testing of shell-cracker

n=15

Factors assessed	Maximum attainable score	Attained score (mean)	% Score gained	Remarks
Musculoskeletal stress factor	60	58	96.6	Highly acceptable
Grip fatigue	20	19.5	97.5	Highly acceptable
Physical stress factor	15	14.5	96.6	Highly acceptable
Work output	15	12.5	83.3	Highly acceptable
Tool factor	60	56.7	94.5	Highly acceptable
Acceptability	15	13.9	92.6	Highly acceptable

Fig. 9. Breaking the shell of wood apples by hitting on ground

Fig. 10. Worker using shell cracker

Fig. 11. Separating shells after cracking traditionally

Fig. 12. Separating shells after cracking the shells with shell cracker

3.4 Shifting Trolley

Shifting trolley helps in moving the materials from one place to another (Fig. 13). In micro and small-scale food processing enterprises workers generally preferred to work in either shed or open area due to which they had to shift all the materials (Fig. 14) from room to the place of work which required several trips and awkward postures while lifting and carrying the materials. For this purpose, a trolley had been developed which can accommodate all the materials required by them and can easily be moved by maintaining an appropriate body posture. The trolley was equipped with hanging hooks and hanging bars which to hang cutting/pealing tools and mats/sacks respectively. The feasibility testing of Shifting trolley was done on 15 respondents whose results are presented in Table 4. The Shifting trolley was highly acceptable on musculoskeletal stress factor, grip fatigue, physical stress factor, work output and tool factor whereas, was acceptable on acceptability factor.

Fig. 13. Diagonal view of shifting trolley

Table 4. Feasibility testing of shifting trolley

Factors assessed	Maximum attainable score	Attained score	% Score gained	Remarks
Musculoskeletal stress factor	60	52.6	87.6	Highly acceptable
Grip fatigue	20	18.2	91.0	Highly acceptable
Physical stress factor	15	14.7	98.0	Highly acceptable
Work output	15	14.8	98.6	Highly acceptable
Tool factor	50	41.1	82.2	Highly acceptable
Acceptability	15	9.1	60.6	Acceptable

(a) *Patila*

(b) Plastic crates

(c) Sac for keeping wastes

(d) Knife

Fig. 14. Materials used by the workers in processing work

4. CONCLUSION

Workers in food processing enterprises faced several problems due to the unavailability of tools. Maximum discomforts were faced in pulp extraction, cutting vegetables, shell cracking and shifting of materials. Four tools were developed to reduce the discomforts of respondents engaged in food processing enterprises. The results of feasibility testing show that all the tools were acceptable by the respondents.

CONSENT

As per international standard or university standard, respondent's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard was written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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