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Study of traditional processing methods of millet crop and its ergonomic assessment

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Abstract
Kodo and little millet are an important crop of Central India (Madhya Pradesh) mainly grown in arid and semi-arid regions. A survey was conducted on identification and documentation of the traditional method of threshing method of millet and for the traditional methods, ergonomical study was conducted to see its effect on human health. Physical efforts required for the operation of threshing with exposure to varying temperature, relative humidity, nature of the job causes a lot of stress on the operator resulting in physiological and psychological fatigue after the daylong operation. Psychophysical measurement to determine overall discomfort and body part discomfort. The mean heart rate of all subjects was 102.46 beats/min and mean oxygen consumption was 0.70 l/min respectively. The mean value of overall discomfort was 8.2 with a 9.2 rating of the arm, 9.1 for shoulder, 8 for back, 8 for waist and 7.5 for the leg. The method adopted for threshing is hand beating and the result observed with excellent threshing efficiency 98.05% with 1.95% of unthreshed grain and 6.8 kg/h output capacity. To avoid excessive postural discomfort the minimum duration of rest pauses should be 20 min. Threshing of millet by using traditional methods can be categorized into the 'moderate' work (Astrand and Rodahl (1986).

Keywords: millet, tradition threshing, physiological and psychophysical responses

1. Introduction

Minor millet, a group of small-grained cereals, in which Kodo (*Paspalum scrobiculatum*) and little millet (*Panicum sumatrense*) are important millet grains mainly grown in Madhya Pradesh. Kodo and little millet are “Kharif” crops, with sowing occurring in early June (Parmanand *et al*, 2015) [4]. It has a relatively short growth period, ranging from 120-180 days. They are the staple food of the millions inhabiting the arid and semiarid tropics of the world. The grain of Kodo and little millet being nutritionally superior to rice and wheat (Guru *et al*, 2018) [3]. Practically devoid of grain storage pests, the Kodo and little millet have indefinite storage life. Millets are good sources of minerals such as calcium, iron, zinc, copper, and manganese. Millets play a very specific role in human nutrition because of their multiple qualities. It is also rich in fiber. They have a high content of calcium and are suitable for diabetic patients. The most important characteristic of millet is its unique ability to tolerate and survive under the adverse condition of continuous or intermittent drought as compared to most other cereals like maize and sorghum. With the high importance of millets in rural life, the processing methods of rural people still need to explore. Women are the backbone of the agricultural workforce but worldwide her hard work has mostly been unpaid (Tiwari *et al*., 2014) [6]. She does the most tedious and back-breaking tasks in agriculture, animal husbandry, and homes. Women are playing a significant role in agricultural development and allied fields. Kodo and little millet are Kharif season crop becomes ready to harvest in September and October. After harvesting it is kept some days for open sun drying. Traditionally, the threshing of Kodo and little millet is done by different methods such as manually beating with a stick, bullock drawn stone roller and tractor-drawn stone roller. In many areas, the crop is threshed underfoot by humans or animals. Traditional methods of threshing little millet threshing are shown in Figure 1 respectively. The threshing methods also adversely affect the health of rural people especially farm women in agricultural works. This paper presents the identification of traditional methods of threshing of millet crop and winnowing. The ergonomic method is adopted to evaluate the effect of the traditional threshing method on human health.

2. Materials and Methods

2.1 Selection of subjects and Experimental conditions

The study was carried out at the College of Agricultural Engineering, JNKVV (India). The farm area of the college was earmarked for conducting the experiments. Five randomly selected healthy female subjects participated in the study for traditional threshing and winnowing (Fig.1). The selected female subjects were in the age group of 25 to 45 years. The age group was selected for the study because according to Reinberg *et al.* (1975) the peak of muscle strength for both males and women is reached between the age of 25 to 35 years. The anthropometric data were collected keeping in view that they were free from any physical abnormalities and were in sound healthy. The subjects were made acquainted with experimental protocol to ensure their full co-operation. Basic anthropometric data of subjects who participated in the experiment are presented in (Table 1) The weather during the experiment period was clear with the mean dry bulb temperature and relative humidity varying between 23.0-37.0^{o}C and 18.5- 48.1%, respectively.

2.2 Protocol for measurement of physiological responses and psychophysical responses

2.2.1 Measurement of physiological cost of work

2.2.1.1 Heart rate (beats/min)

The polar heart rate meter was used to measure the average heart rate during rest and working condition (beats/min).

ΔHR(beats/min) = Average working heart rate – Average resting heart rate during rest. …………………………..eq.2.1

2.2.1.2 Oxygen consumption rate (l/min)

The oxygen consumption rate is defined as that it is the volume of oxygen (at 0^{o}C, 760 mm Hg) or amount of oxygen consumed by the heart rate of the operator and it is expressed as liter per minute and is given by the formula equation (singh *et al*. 2008)

OCR (l/min) = 0.0114 x AWHR – 0.68………………. eq.2.2

Where,
OCR = Oxygen consumption rate, l/min
AWHR = Average working heart rate, bpm

2.2.2 Psychophysical measurement

Psychophysical measurements A 10-point Visual Analogue Discomfort (VAD) scale (Huskisson, 1983; Legg and Mahanty, 1985) was used in this experiment to assess the overall discomfort as well as body part discomfort experienced by the subjects during traditional threshing and winnowing. It consisted of a 70 cm long graduated scale with its left and right ends marked as 0 and 10 representing 'no discomfort' and 'extreme discomfort', respectively. A sliding pointer was provided on the scale to mark the level of discomfort. During a preliminary study, it was reported by the subjects that they felt maximum discomfort in the arm, shoulder, Back, waist and leg while operating experiment for a longer duration. Therefore, the body part discomfort data were collected for these body parts only.

2.3 Experimental procedure

Selected subject was asked to report at the sight at 8:30 am and have a rest for 30 min before starting the trial. After arrival in the field, each subject was given a warm-up exercise for 10 min and then was asked to take a rest for 20 to 30 minutes so that her physiological responses attained resting level. The subject then started experiment (trial) as per the requirement of the treatment. During initial 5 min of rest, the subject was advised to keep quiet and refrain from any physical movement. After 5 min she was asked to indicate her overall discomfort rating as well as body part discomfort rating on the 10-point VAD scale. Heart rate data for the entire duration of after 20 min. were recorded.

2.4 Data analysis

Data on physiological and psychophysical responses of all 5 subjects were averaged to get mean values for each treatment. The data were then subjected to detailed statistical analysis to know the effect of traditional threshing and winnowing on physiological and psychological responses.

Fig 1: Traditional threshing and winnowing performed by selected subjects

2.5 Terminology

2.5.1 Threshing efficiency

The threshing efficiency was estimated by using the formula and expressed in per centage (IS: 6284 – 1985, 1986).

$$\text{Threshing efficiency (\%)} = \frac{(A-H)}{A} \text{X100}$$

Where,
A = Total grain input per unit time by weight, kg
H = Weight of un-threshed grain per unit time at all outlets, kg

2.5.2 Unthreshed grain:

The per cent of' unthreshed grain was estimated by separating by the whole grains attached to the threshed earheads of known quantity manually using the following formula (Anon., 1983) [1]

Unthreshed grain (%) = $\frac{H}{A} X100$

Where,
H = Weight of unthreshed grain per unit time at all outlets kg
A = Total grain input per unit time by weight kg

2.5.3 Output capacity

The output capacity was estimated by weighing the total grain (whole and damaged) received per hour at main grain output of the thresher (Anon., 1983) [1]

Output capacity (kg/h)= $\frac{Q}{M} X100$

Where,
Q = Weight of threshed grain(kg)
M= Time taken (h)

3. Results and Discussion

3.1 Physical characteristics

Physical characteristics of selected women involved in threshing experiment are presented in Table 1 and it is reveals that the mean age of women workers was 31.6 yrs, having weight 55.6 kg with 1627 mm stature. Thus, the mean handgrip strength was 28.1 kg. respectively**.**

Table 3.1: Physical and physiological characteristics of the subjects participated in the experiment

Sno.	Age(yrs)	Weight(Kg)	Stature(mm)	Hand grip strength(kg)
S_1	23	50	1582	28.0
S_2	31	53	1642	29.0
S_3	40	58	1665	27.0
S_4	28	54	1625	29.5
S_5	36	61	1621	27.3
Mean	31.6	55.2	1627	28.16
SD	6.7	4.3	30.6	1.07

Table 3.2: Heart rate and Oxygen consumption response of subjects during threshing operation

Subjects	Heart rate beats min^{-1}	ΔHR beats min^{-1}	OCR, l/min	ΔOCR, l/min
S_1	97.8	26.7	0.64	0.33
S_2	108.2	33.7	0.77	0.48
S_3	101.0	23.9	0.71	0.45
S_4	105.1	29.4	0.70	0.34
S_5	100.2	24.8	0.68	0.34
Mean	102.46	27.70	0.70	0.38

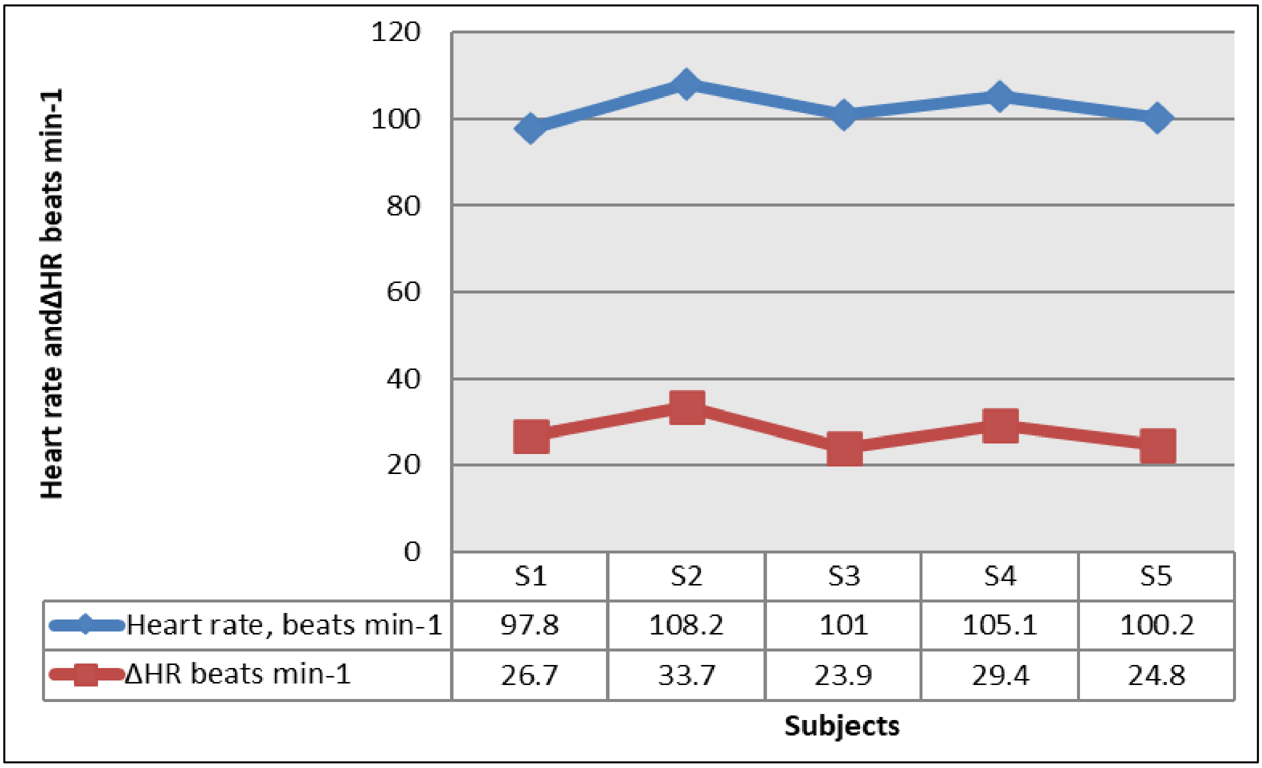

Fig 2: Heart rate and ΔHR beats min^{-1} of subjects

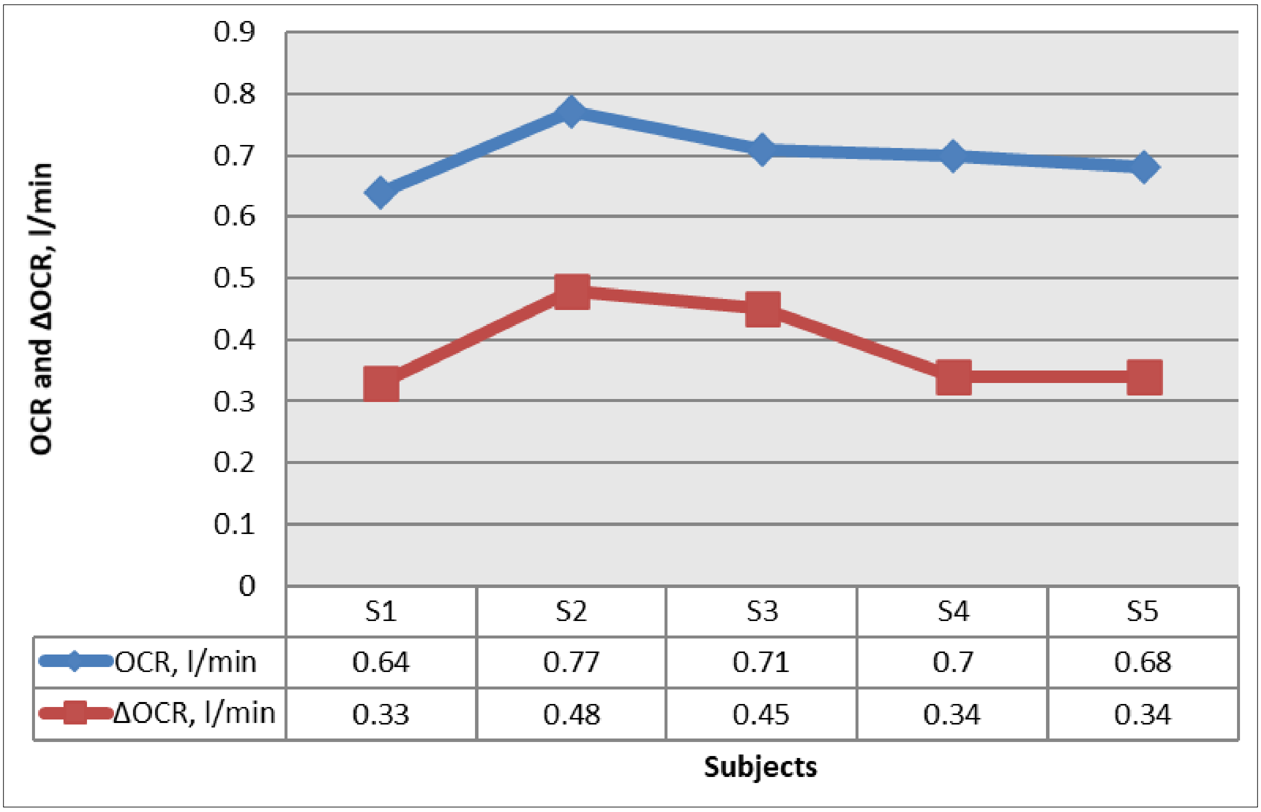

Fig 3: OCR and ΔOCR, l/min of selected subjects

3.2 Physiological responses

Physiological response viz heart rate and oxygen consumption rate of selected 5 subjects were measured for threshing activity and results are presented in Table 3.2. It was determined that the heart rate of S_1, S_2, S_3, S_4 and S_5 were 97.8, 108.2, 101.0, 105.1 and 100.2 beats/min respectively. Heart rate is a good way of measuring physiological stress particularly applicable for static work condition. Fig. 2 shows that ΔHR of S_1, S_2, S_3, S_4 and S_5 were 26.7, 33.7, 23.9, 29.4 and 24.8 beats/min. Although threshing was moderately heavy work prolonged sitting in a particular posture might have resulted in fatigue in localized muscles referred to as "static muscular fatigue". This might be the reason for the rise in heart rate observed. Thus, the oxygen consumption rate of S_1, S_2, S_3, S_4 and S_5 were 0.64, 0.77, 0.71, 0.70 and 0.68 l/min respectively. The environment heat load may be one of the reasons for increase in oxygen consumption rate of 5 subjects. Fig. 3 shows that the ΔOCR of S_1, S_2, S_3, S_4 and S_5 were 0.33, 0.48, 0.45, 0.34 and 0.34 l/min. respectively.

3.3 Overall discomfort rating of subjects

The overall discomfort ratings of the subjects on the 10 point VAD scale after the day's work is presented in table 3.3. A maximum overall discomfort rating of 9.0 was observed in S_3 followed by 8.5 in S_4 respectively. S_5 and S_1 have same rating 8.0. the least overall discomfort rating was observed in S_2 with a 7.5 rating. Static exertion combines force, posture and duration to create a condition that quickly fatigues our muscles which increases the chances of acquiring cumulative trauma disorder. When awkward posture is for long-duration chances of high discomfort risk is more.

Table 3.3: Overall discomfort and body part discomfort ratings of subjects

Subjects	Overall discomfort	Arm	Shoulder	Back	Waist	Leg
S_1	8.0	8.5	9.0	8.0	6.5	8.0
S_2	7.5	9.0	9.5	6.0	8.0	9.0
S_3	9.0	9.0	10.0	9.5	7.0	8.5
S_4	8.5	9.5	8.0	8.0	9.0	5.0
S_5	8.0	10.0	9.0	8.5	8.0	7.0
Mean	8.2	9.2	9.1	8	8	7.5

3.4 Body Part Discomfort

Table 3.3 represents the different body part discomfort ratings of selected subjects on the 10-point VAD scale. Maximum discomfort in arm reported by S_5 with 10.0 rating and least rating 8.5 in S_1. Women felt severe to very severe pain in arms which is due to more strain because while beating crops they used one wooden mallet to hit the crop. Maximum shoulder discomfort was observed in S_3 with a 10.0 rating and minimum in S_4 with an 8.0 discomfort rating. The least intensity of shoulder discomfort was higher as compared to arm discomfort rating. The maximum Back discomfort rating observed in S_3 with 9.0 rating and the least back discomfort was 6.0 in S_2. The pain was observed in the back due to adoption of prolonged strenuous sitting posture for a long hour. In waist, the maximum discomfort occurred in S_4 and the least waist discomfort 6.5 in S_1. Waist discomfort may arise from static loading of muscles in this region because of slightly bent posture during the operation of threshing. The maximum leg discomfort was observed in S_2 with a 9.0 rating and least leg discomfort in S_4 with a 5.0 rating. Continuous sitting on the field, bending of legs for hours may lead to many musculoskeletal and neurological disorders.

3.5 Threshing methods
Kodo and little millet crops are harvested manually and transported to the threshing yard, where it is threshed by beating process either by beating the crop manually with sticks or by treading under the bullock feet, a practice followed by small and marginal farmers. Table 3.4 1 shows the evaluation of traditional method of threshing for millet crop. The straw that remains after threshing was used as a source of material for traditional houses. The husk on the Kodo and little millet are tightly attached with the endosperm thereby making its removal difficult during de-husking operation. The moisture content during threshing time is 12.15% and threshing efficiency was observed 94.05% with 1.95% and the output capacity found 6.28 kg/h. An indigenous mill named Jatta is popular for the de-husking of millets. All the processing method of Kodo and little millet was done by the women.

Table 3.4: Evaluation of tradition processing (threshing) of millet

Operation / process	Result
Moisture content at the time of threshing	12.15%
Threshing efficiency	94.05%
Output Capacity	6.28 kg/h
Unthreshed grain	4.95%

4. Conclusion
Today women play a diverse role in agricultural operations. Often they can handle two or more tasks simultaneously. Traditional threshing of millet crop is common in all growing areas across the country particularly in the case of marginal and small landholders. The process of threshing by beating is mostly carried out by farm women. The traditional method of threshing influences the physiological and postural workload as evidenced by heart rate and oxygen consumption experienced by the subjects. Postural discomfort will increase with time of operation during the day. The maximum discomfort occurred in the arm, shoulder and waist during threshing operation. To avoid excessive postural discomfort the minimum duration of rest pauses should be 20 min. Ergonomic intervention programs can be implemented to reduce the overall static and postural load of workers. There is ample scope for improvement in work station design, small tool design and working conditions from an ergonomic point of consideration intending to provide maximum comfort to the women worker for promotion of their health and well being and consequently enhancement of productivity. Threshing of millet by using traditional methods can be categorized into the 'moderate' work (Astrand and Rodahl (1986) [2].

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6. Reference
1. Anonymous. The test code and procedure for power grain threshers part 12. Regional Network for Agricultural Machinery, UNDP Philippines 1983, 227-232.
2. Astrand P, Rodahl K. Text book of work physiology : physiological bases of exercise Ilird edition McGraw Hill Book Co. New York 1986, 669-674.
3. Guru PK, Chhuneja NK, Dixit A, Tiwari P, Kumar A. Mechanical transplanting of rice in India: status, technological gaps, and future thrust, ORYZA-An International Journal on Rice 2018;55(01):100-106.
4. Parmanand, Verma A, Guru PK. Ergonomic evaluation of developed pedal-operated millet thresher for threshing of finger millet, International Journal of Agricultural Science and Research (IJASR), 2015;5(6):15-24.
5. Shrivastava A, Mehta CR, Pandey MM Accessibility Index of Indian Tractors—A Case Study Agricultural Mechanization in Asia, Africa & Latin America 2010;41(3):17-22.
6. Tiwari PS, Pandey MM, Gite LP, Shrivastava AK. “An ergonomics intervention in operation of rotary maize sheller” Indain Journal of Agricultural Science. 2014;87(7):791-795.