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Assessment on Physiological Effects of Heat Stress among Palm Oil Mill in Tropical Climate Condition

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ABSTRACT

Background: Palm oil industry contributes majority revenue for manufacturing industry in Malaysia. The process in palm oil mill involves lot of steam consumption and high pressure to maintain good quality of palm oil. In palm oil mill, the workers handle machine directly and consequently exposed to high temperature due to steam which contribute to heat stress. A preliminary study aimed to determine the prevalence of heat stress among palm oil mill workers that involved measurement of heat exposure in working environment and physiological measurement. **Objective:** This paper is briefly determine the assessment on physiological effects of heat stress among palm oil mill workers in tropical climate condition. **Results:** The result indicates most of the work unit in palm oil mill exceeded the TLV permitted. However, the physiological of the workers shows the result within considerable values**. Conclusion:** The workers are exposed to extreme heat, but the evidence indicate that the physiological parameters is not affected drastically indicating adaptive and acclimatize at the level of heat. Therefore, there are need new heat stress index to predicting an accurate heat stress index for acclimatize workers in tropical climate condition.

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INTRODUCTION

The annual report of Malaysia Palm Oil Board (MPOB) 2012 stated that palm oil industry in Malaysia generated revenue of approximate RM 71 billion in 2012 [1]. Instead in generating billions of revenue, the important issue that need to take in consideration is safety and health issues among the palm oil workers. One of the hazards inside palm oil mill towards workers is exposed to high temperature which was contributed from palm oil mill process such as sterilization process that required high temperature approximately 140-145˚C in order to produce good quality of palm oil. Consequently, the workers may experience symptoms of heat stress such as to heat edema, heat fatigue, prickly heat, heat syncope, heat cramps, heat exhaustion and heat stroke [2]. Heat stress is defined as the net heat load on the body with contribution from both metabolic heat production and external environmental that imposed on the workers [3].

Protecting the safety and health among the workers is important as highlighted in Occupational Health and Safety Act (1994), under clause 25(2) (h) that employers have a duty to take every precaution reasonable in the circumstances for the protection of a worker [4]. This includes developing policies and procedures to protect workers that expose to extreme air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities that may potentially induce heat stress. In this study, the objective is to determine the level of heat exposure, metabolic load and the classification of heat stress with the measurement of physiological parameters namely body core temperature, systolic and diastolic blood pressure and pulse rate at among workers in palm oil mill. The finding from this study is to determine whether current index is able to determine accuracy of heat stress level among those working in tropical climate.

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MATERIALS AND METHODS

Study Location:

A cross sectional study was carried out among palm oil mill workers in two selected government link company (GLC) palm oil mills. Two of this mills located in the northern state of peninsular Malaysia. The selection of two mills because of difference of technology that had used in their process, which are mill 1 is using traditional sterilizer (Continuous Sterilizer) while mill 2 already using advanced sterilizer (Horizontal Sterilizer). A set of questionnaire was distributed to the respondents after explanation about the study and consents form needed to be signed by them. The questionnaire set consists of questions which is demographic data, including age, height, weight, work unit, salary, current disease, heat related illness, and others. The study had investigated and monitored seven of this work area due to produces mostly heat exposure toward the workers. The sources of heat for these two palm oil mill is generated from steam produce by the boiler. The work units are identical for both palm oil mill as shown in Figure 1.

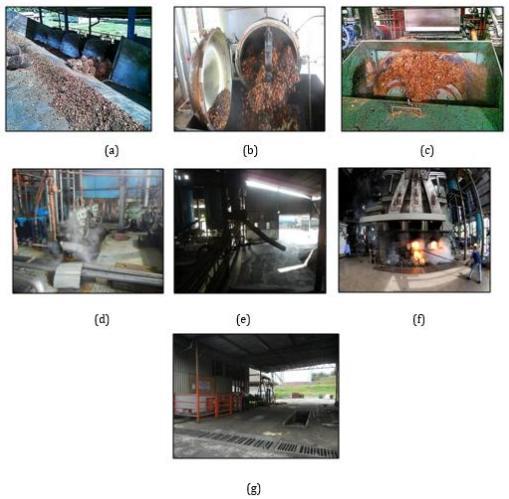

Fig. 1: Selected Work Units in Palm Oil Mill. (a) Loading Ramp ,(b) Sterilizer, (c) Press Station, (d) Oil Room, (e) Kernel Plant, (f) Boiler and (g) Workshop.

The measurement were be made according to American Conferences Government Industrial Hygienist (ACGIH) 1992-1993 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices (1992). These TLV's are based on the assumption that nearly all workers acclimatized, fully clothed workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38°C (100.4° F). They are also based on the assumption that the WBGT of the resting place is the same or very close to that of the workplace. These TLV's apply to physically fit and acclimatized individuals wearing light summer clothing [5].

Environmental Measurement:

All the measurement used portable heat stress monitors, QUESTemp°34 Thermal Environmental Monitor from Quest Technology, USA. The equipment measured the dry-bulb temperature (DB), natural wet-bulb temperature (NWB) and globe temperature (GT). This instrument can calculate both the indoor and outdoor WBGT index according to established ACGIH Threshold Limit Value equations but in this study the task had involved indoor WBGT index. This information and type of work being performed, WBGT are important on determine how long a person can safely work or remain in a particular hot environment. The calculation in this study only using indoor WBGT which is had separate and integrated measurement parameters. The integrated calculation as shown in Formula 1:

The WBGT for indoor conditions with no solar loads

$$WBGT = 0.7\ NWB + 0.3\ GT \qquad \text{Formula 1}$$

Time weighted average (TWA) was monitored over an average of 60 minutes. Each of the measurement lasted for an average of 8 hours with the equipment placed as near as possible to the workers. The equipment was placed approximately at 110 cm of height supported using a tripod. Before each measurement, the equipment was calibrated using the portable calibrator to ensure that the sensor is accurate (±0.4 0 C). The

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natural wet bulb temperature sensor coated with wick cloth need to be submerged in distilled water for approximately 10 minutes before each measurement. The globe sensor is enclosed in black copper enclosure while dry bulb is naturally ventilated. Measurement of NWB, DB, GT and WBGT were recorded by data logging at 1-min intervals. Figure 2 shows the equipment used for data collection.

Fig. 2: Measurement of WBGT at sterilizer work unit.

Workload and Work Rest Regimen:

The metabolic work-load assessment was ranked into three category which was light work (up 200kcal/hour), medium work (200-350kcal/hour) and heavy work (350-500kcal/hour). Apart from that, a videotape was use to evaluate the metabolic work-load assessment. Table 1 below shows the threshold limit value of work and rest regime. This table based on the assumption that the workers acclimatized, fully clothed workers, with adequate water and salt intake [5].

Table 1: Permissible Heat Exposure Limit Threshold Limit Value.

Work/rest regime	Work Load		
	Light (°C)	Moderate (°C)	Heavy (°C)
Continuous work	30.0	26.7	25.0
75% Work, 25% rest	30.6	28.0	25.9
50% Work, 50% rest	31.4	29.4	27.9
25% Work, 75% rest	32.2	31.1	30.0

Physiological Measurement:

There is recruitment from 30 respondents for each palm oil mill to take part in physiological measurement. Physiological parameters were measured for those working at the selected work unit. The heart rate, blood pressure (systolic and diastolic), body core temperature and pulse rate were measured for each respondent. Measurement for blood pressure, body core temperature and pulse rate were taken before the start of the work shift, during the work shift and after completion of each work shift as shown in Figure 3. While a polar heart rate was attached to chest of each respondent for 8 hours according working session.

Fig. 3: Measurement of Physiological Parameters.

Results:

WBGT indoor measurement:

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As shown in Table 2, the result from both palm oil mill showed that four of the work section namely Sterilization, Press station, Oil room and Boiler ranging from 29.4°C to 33.1°C had an average WBGT exceeding the threshold limit value of heat stress exposure. The lowest temperature average was recorded at the kernel plant (26.1°C) in Mill 1.Mill 2 showed slightly high compare to Mill 1 as the boiler recorded the highest result of average WBGT, 33.1°C, followed by press station (32.9°C), sterilization (32.6°C) and 30.3°C for oil room. In Mill 2, loading ramp and workshop contributes the lowest average WBGT (27.0°C). The overall work load assessment for falls under medium work category (200-350kcal/hour).

Table 2: Exposure profile for heat stress at various work sections for Mill 1 and Mill 2.

Palm Oil Mill (Work stations)	WBGTin (°C)	
	Mill 1	Mill 2
Loading Ramp	27.1	27
Sterilizer	29.4*	32.6*
Press Station	30.2*	32.9*
Oil Room	30.4*	30.3*
Kernel Plant	26.1	27.1
Boiler	32.2*	33.1*
Workshop	27.4	27

* WBGTin is above the standard ACGIH, Threshold Limit Value (TLV) = 28.5°C as the metabolic workload for all workers in each section are medium.

Physiological result:

Table 3: Descriptive values for physiological parameters (body core temperature, diastolic BP, systolic BP and heart rate for Mill 1 and Mill 2.

Variables	N=30 Mean ± SD	
	Mill 1	Mill 2
Body core temperature (before shift)	35.60 ± 0.48 ℃	36.05 ± 0.69 ℃
Body core temperature (after 2 hours)	35.93 ± 0.5℃	36.29 ± 0.57 ℃
Body core temperature (after 8 hours)	36.16 ± 0.60 ℃	36.51 ± 0.50 ℃
Systolic BP (before shift)	105.17 ± 6.62 mm Hg	108.80 ± 7.83 mm Hg
Systolic BP (after 2hours)	110.13 ± 6.80 mm Hg	115.03 ± 8.56 mm Hg
Systolic BP (after 8 hours)	113.13 ± 7.25 mm Hg	117.67 ± 8.09 mm Hg
Diastolic BP (before shift)	82.93 ± 8.29 mm Hg	85.17 ± 7.28 mm Hg
Diastolic BP (after 2hours)	86.40 ± 7.54 mm Hg	87.47 ± 8.30 mm Hg
Diastolic BP (after 8 hours)	91.17 ± 6.78 mm Hg	92.38 ± 8.96 mm Hg
Heart rate (before shift)	92.87 ± 5.89 bpm	94.33 ± 6.91 bpm
Heart rate (after 2hours)	93.80 ± 7.20 bpm	98.13 ± 6.92 bpm
Heart rate (after 8 hours)	99.50 ± 6.12 bpm	101.50 ± 7.36 bpm

**significant at p<0.01*

Table 3 showed the mean difference for three physiological parameters studied at three different times in two different mill. As shown in Table 3, the body core temperature among the palm oil mill workers did show any increasing trend for both mill. Workers in mill 2 shows an increasing trend of body core temperature slightly higher compared to mill 1 beginning from the time the workers started to work up to the time immediately after finishing the day task. For blood pressure trend, a clear trend of systolic and diastolic blood pressure level was observed among those working in both of the palm oil mills. Both palm oil mills did not indicate a clear trend of blood pressure (systolic & diastolic) increment due to exposure to extreme heat. However, all of the measurements shows that the systolic blood pressure not exceeding the normal systolic blood pressure level compared to normal population. Result from diastolic blood pressure level also were within the normal range. The heart rate results show that a slight increase of the heart rate was observed after 2 hours during performing their work shift. Comparing between mill 1 and mill 2, the heart rate elevation was observed to be higher in mill 2 after 2 hours during their work shift. Measurement after end of the shift indicate that workers are sluggish to reduce their pulse rate back to normal.

Discussion:

The result represent a preliminary study on the assessing the heat exposure and the physiological effect among Malaysia workers. As the results based on ACGIH method indicate that the heat stress level at two types of palm oil mill exceeded the threshold limit value permitted for 75% work with 25% rest time. Based on the level of calculated metabolic load and the heat level, all of the workers are considered as having heat stress. However, based on the physiological parameters, there was no major increase of body core temperature. This finding shows that the workers regardless of their heat exposure and metabolic load, had adapted the extreme heat and the body had acclimatize to the level of the heat. This can also be supported by the slight increase from normal of systolic blood pressure without any visible trend before and after a complete work shift. The diastolic

blood pressure of did not shows any visible increase of blood pressure over time. The finding also shows that mill 2 workers having higher heat level had a better control of their blood pressure level.

A better trend to indicate exposure to heat is the heart rate per minutes. The findings shows that heart rate can easily fluctuate due to influence of external heat exposure. The trend indicate that an increase of pulse rate leading to an increase of the heart rate. Although there is an increase of pulse rate, the increase is considered normal and suggested that the Malaysian workers in tropical climate adapted and acclimatize efficiently to extreme temperature. As the two result indicate, the current standard suggested by ACGIH for workers does not suit well to tropical climate as well for Malaysian workers. It is requirement to develop new index to measure the heat stress accurately among the tropical climate workers.

Conclusion:

The result indicate that heat level in both of the mill exceed the threshold limit value suggested for medium work (75 % work with 25% rest regime). The physiological parameters show no increase of core body temperature with slight increase in systolic blood pressure. The heart rate shows a trend of increment with the duration of working near extreme heat. Although the heat is beyond the limit permitted, tropical climate workers does not show sign of acute heath effect. More information is required on development for new heat stress index to predict an accurate model for tropical climate workers.

Ethical Considerations:

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REFERENCES

[1] Malaysia Palm Oil Board (MPOB), 2012. The annual report MPOB 2012. Retrieved January 20th, 2014 from http://www.mpob.gov.my/.
[2] Khogali, M., 1992. Heat in Jeyaratnam, Journal Occupational Health in Developing Countries. New
[3] York: Oxford University Press
[4] NurIzzate, S., 2013. Association Between Occupational Heat Exposures and Physiological Changes among Palm Oil Mill Workers. Journal of Scientific and Industrial Research. JSIR (CSIR).
[5] Occupational Safety and Health Act, 1994. Law of Malaysia Act 514. Retrieved January 20th, 2014 from http://www.dosh.gov.my/index.php?option=com_docman&view=docman&Itemid=180&lang=en.
[6] ACGIH-American Conference of Governmental Industrial Hygienists, 1999. Threshold Limit Values for Chemical Substance and Physical Agents and Biological Exposure Indices. (pp. 89-96). Cincinnati: ACGIH.