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# THE RELATIONSHIP OF HOT WORK CLIMATE ON PHYSIOLOGICAL RESPONSE IN TRADITIONAL CLOVER LEAF OIL REFINING WORKERS

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## ABSTRACT

In the clove leaf oil refining process which uses steam, it produces a hot temperature residue which affects clove leaf oil refinery workers. Exposure to a hot working climate can have an impact on human physiological responses such as an increase in body temperature, pulse rate, blood pressure and weight loss. as a result of producing quite a lot of sweat fluid. This research aims to investigate the physiological responses of clove leaf oil refinery workers to exposure to a hot working climate. In the clove leaf oil refining process, which utilizes steam, the production of hot temperature residue affects the workers. Exposure to such conditions can lead to various physiological responses, including increased body temperature, pulse rate, blood pressure, and weight loss due to significant sweating. Employing a quantitative research design with a cross-sectional analytical approach, data were collected from all 22 workers using a total sampling technique. The primary data collected were subjected to analysis using paired simple t-tests and the Pearson correlation test to explore relationships between variables. The findings reveal significant increases in physiological responses post-work, including elevated body temperature, pulse rate, systolic and diastolic blood pressure, and a reduction in body weight. The obtained p-values for all variables were <0.05, indicating statistically significant differences between pre-work and post-work conditions. Furthermore, the Pearson correlation test analysis between heat stress data and post-work physiological responses, including body temperature, pulse rate, systolic and diastolic blood pressure, as well as body weight, revealed moderate to strong correlations (r). These results underscore the detrimental impact of hot working climates on the physiological well-being of clove leaf oil refinery workers. Such findings highlight the urgent need for implementing appropriate measures to mitigate heat-related health risks in occupational settings, safeguarding the health and safety of workers.

**keywords:** essential oils; hot work climate; physiological responses

## INTRODUCTION

Indonesia is an agricultural country that is rich in spice plants, one of which is cloves. In Indonesia, cloves are mostly used as raw materials for cooking spices, cigarettes and are used to extract oil through a refining process, according to(Gunawan, 2020)Indonesia is one of the regions that produces and exports essential oil from cloves with a high export value reaching US$400 million per year. Essential oil or also known as essential oil, etherial oil or volatile oil is oil produced from the process of distilling clove leaves, whether carried out traditionally or modernly. One area in Indonesia, especially the island of Bali, has a clove leaf refining center located in Kayuputih Village, the village It has soil conditions in the high and medium plains located between 400 and 550 meters above sea level with an area of 383,165 Ha/M2 which is very suitable for growing clove trees which will later be used as raw material for the process of refining essential oil from clove leaves.

Based on the results of a preliminary study conducted by the author, there are three (3) clove leaf refining centers for extracting essential oil which are carried out traditionally, where the total number of workers from the three clove oil refining centers is 23 workers, all of whom are male and are still in a relationship. family. The clove leaf oil refining process carried out in Kayuputih Village still uses a fairly traditional method by using raw materials from the local area. According to(Affifah et al., 2016),

there are several methods of distilling clove leaves to obtain essential oil, namely using the steam distillation method and steam distillation with water. Steam distillation produces oil with an essential oil content of 91-95% eugenol which is usually called strong oil. The process of distilling clove leaves in Kayuputih village generally takes more than 8 hours depending on the size, isolation system and volume of raw materials, and the volume of steam used during the distillation process.

The process of refining clove leaves to extract the oil produces hot residue which can affect clove leaf distillation workers. According to Suma'mur (2014), workers who are exposed to high temperatures while working in a room with a hot work environment have the potential to cause danger resulting in work accidents and work-related illnesses, based on the results of initial measurements that the author carried out on the environmental work climate. clove refinery workers range from 28.5°C to 29.5°C, the working environmental climate conditions of clove refinery workers exceed the threshold value (NAB) for medium category workers where the NAB is permitted based on Minister of Manpower and Transmigration Regulation No.Per.5/MEN/2018 is 28.0 °C.

Based on data from(ILO, 2016), Centers for Disease Control and Prevention in 2013 there were many cases of workers being exposed to hot temperatures in the workplace where in 13 cases there was 1 worker who died, 7 cases where workers experienced symptoms of heat strain with moderate and heavy workloads. Exposure to hot working climates can have an impact on human physiological responses, according to(Wulandari & Ernawati, 2018), states that physiological responses are the response of living creatures to stressors such as environmental conditions, stimulants that change the environment of an organism are responded to by various systems in the human body such as an increase in body temperature, blood pressure and pulse rate.

According to research conducted by (Sunaryo & Nourma, 2020) on the work climate with hot temperatures starting from the emergence of energy sourced from heat that enters the environment or workplace then becomes a hot pressure, it becomes Additional workload for workers. Such conditions affect health and energy/stamina workers when connected with heavy workloads worked, working climate conditions with temperature Heat can aggravate the physical and mental health conditions of workers and have an impact on health problems in physiological workers. In research (Pradana et al., 2016), states that the working environment is hot on PT machine parts. PLN (Persero) West Kalimantan caused an increase in systolic, diastolic blood pressure and pulse rate before and after exposure to heat based on data analysis using the Wilcoxon statistical test with a confidence level of 95%, this is in line with research conducted by(Rahadian, 2018),conducted at PT pulse rate where the higher the heat pressure, the higher the pulse rate and blood pressure of the workers.

Based on the problem identification above, work climate measurements will be carried out, examining the physiological response of workers before and after exposure to heat and analyzing to find out whether the hot work climate factors play a role in influencing the physiological response of workers so that with this research it is hoped that appropriate control efforts will be obtained. in the clove leaf oil refining work environment.This research aims to investigate the physiological responses of clove leaf oil refinery workers to exposure to a hot working climate. In the clove leaf oil refining process, which utilizes steam, the production of hot temperature residue affects the workers. Exposure to such conditions can lead to various physiological responses, including increased body temperature, pulse rate, blood pressure, and weight loss due to significant sweating.

## METHOD

This research uses a quantitative research design with a cross-sectional analytical approach. This research was conducted at three (3) traditional clove leaf oil refinery centers in Kayuputih Village, Banjar District, Bali in September 2023. The population in this study were clove leaf oil refinery workers. The sampling technique in this research used a total sampling technique from all 22 workers. The data collected is primary data. The measuring tools and methods used in this research are digital temperature, temperature thermometer, blood pressure meter, weight scale, stopwatch, body meter and palpation method for measuring pulse. The data analyzed in the research is data before and after work consisting of body temperature, pulse, blood pressure (systolic and distolic) and body weight. Data analysis in this research is in the form of univariate analysis to describe the characteristics of the research and bivariate analysis using the paired simple t test and the Pearson correlation test to look for close relationships between the variables in this research.

## RESULTS

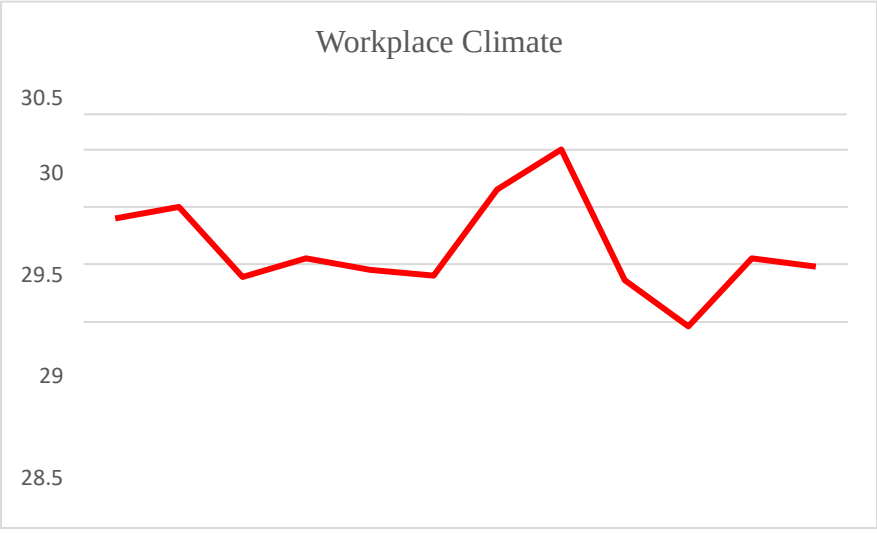
Analysis resultsUnivariate was carried out to determine the characteristics of respondents in the form of age, length of service and body mass index and the results of workplace climate measurements. The results of the analysis are displayed in the table and graph below:

Table 1.
Characteristics of respondents based on age, length of service and body mass index

| Variable | N | Average | SB | Range |
|---|---|---|---|---|
| Age (years) | 22 | 32.94 | 6.72 | 20-45 |
| Years of service (years) | 22 | 6.95 | 2.35 | 2-14 |
| Body mass index (kg/m2) | 22 | 23.35 | 1.51 | 20.90-26.00 |

The characteristics of respondents based on age had a mean of 32.94 ± 5.59 with an age range of 20-45 years. Based on work experience, the mean is 6.95 ± 2.35 with a work period range of 2-14 years. Meanwhile, based on body mass index, the average is 23.35 ± 1.51 with a body mass index (BMI) range of 20.90-26.00 kg/m2

Graph 1. Working climate at three clove leaf oil refineries




Based on the results of temperature measurements in the work environment from point 1 to point 12 carried out at three clove leaf oil refineries, the results showed that the lowest working environment

temperature was 28.46 °C and the highest was 30°C with an average temperature of 29.14 °C, the working environment for refining clove leaf oil at all measurement points exceeds the allowable NAB value, based on the Regulation of the Minister of Manpower and Transmigration of the Republic of Indonesia Number PER.13/MEN/X/2011 concerning threshold values The temperature limit in a workplace that works continuously for 8 hours per day must not exceed 28°C. The results of bivariate analysis were carried out to carry out a paired sample t-test to determine the differences between research variables in the form of physiological responses, namely body temperature, pulse rate, blood pressure (systolic and diastolic), and the respondent's weight before and after work. Meanwhile, the Pearson correlation test is used to find the level of relationship between the independent variable and the dependent variable in this research. The bivariate test results are presented in the table below:

Table 2.
Test of Differences in Research Variables Before and AfterWork

| Variable | Before | | After | | p value |
|---|---|---|---|---|---|
| | Average | SB | Average | SB | |
| Body Temperature (°C) | 36.69 | 0.13 | 37.70 | 0.34 | 0,000 |
| Pulse Rate (bpm) | 82.54 | 5.70 | 105.57 | 7.71 | 0,000 |
| Systolic (mmHg) | 118.86 | 7.05 | 131.14 | 5.54 | 0.003 |
| Diastolic (mmHg) Body | 71.90 | 4.23 | 74.79 | 3.29 | 0.045 |
| Weight (Kg) | 64.27 | 5.60 | 63.24 | 5.45 | 0,000 |

Table 2, It is known that the results of checking the body temperature of workers before work is 36.69 °C while the average body temperature of workers after work is 37.70 °C, so it is known that there is an increase in body temperature before and after work due to the hot work environment in the leaf oil refining process clove. The average result of checking workers' pulses before work is 82.54 beats per minute (bpm) while the average pulse rate after work is 105.57 beats per minute (bpm), so it can be seen that there is an increase in pulse rate before and after work due to the work environment. heat in the process of refining clove leaf oil. The average result of workers' systolic blood pressure examination before work was 118.86 mmHg and the average after work was 131.14 mmHg, so it can be seen that there was an increase in workers' systolic blood pressure after work.

The average results of workers' diastolic blood pressure examinations before work were 71.90 mmHg and the average after work was 74.79 mmHg, so it is known that there was an increase in workers' diastolic blood pressure before and after work. Meanwhile, the average body weight of workers before work is 64.27 kg, while the average body weight of workers after work is 63.24 kg. There has been a decrease in body weight before and after work due to the hot working environment in the clove leaf oil refining process. Based on the results of the t difference test, it can be seen that the results of the analysis of research variables (body temperature, pulse, systolic blood pressure, diastolic blood pressure and body weight) of workers before and after work, obtained a p value for all variables <0.05, which is indicates that there is a significant difference between before work and after work. To determine the level of relationship between research variables, it is necessary to carry out a Pearson correlation test. The results of the Pearson correlation test are presented in the table below:

Table 3.
Pearson Correlation Analysis Test Results for Research Variables After Work

| Variable | R | Relationship Level |
|---|---|---|
| Heat Pressure (°C)<br>Body Temperature (°C) | 565 | Currently |
| Heat Pressure (°C)<br>Pulse Rate (bpm) | 703 | Strong |
| Heat Pressure (°C)<br>Systolic (mmHg) | 486 | Currently |
| Heat Pressure (°C)<br>Diastolic (mmHg) | 540 | Currently |
| Heat Pressure (°C)<br>Body Weight (kg) | -469 | Currently |

The results of the Pearson correlation analysis of heat stress data with body temperature after work obtained a correlation coefficient (r) of 565 with a medium category relationship level based on (Sugiyono, 2014), so it can be concluded that the work hypothesis (Ha) is accepted or there is a relationship between heat stress and body temperature. workers after work, the value of the correlation coefficient (r) which has a positive sign is the direction of the relationship between heat pressure and body temperature which is a positive relationship, this means that the higher the heat pressure, the higher the worker's body temperature and conversely the lower the heat pressure, the higher low body temperature of workers. The results of the Pearson correlation analysis of heat stress data with the worker's pulse rate obtained a correlation coefficient (r) of 703 with a strong category relationship level, with a positive sign of the correlation coefficient. The results of the Pearson correlation analysis of heat stress data with workers' systolic blood pressure obtained a correlation coefficient (r) of 486 with a medium category relationship level, with a positive sign of the correlation coefficient. The results of the Pearson correlation analysis of heat stress data with workers' diastolic blood pressure obtained a correlation coefficient (r) of 540 with a medium category relationship level, with a positive sign of the correlation coefficient. Meanwhile, Pearson correlation analysis of heat stress data with workers' body weight obtained a correlation coefficient (r) of -469 with a medium category relationship level, with a negative sign of the correlation coefficient, the value of the correlation coefficient (r) which was negative means that the higher the heat stress, the higher low weight loss of workers.

## DISCUSSION

The mean age of respondents was 32.94 ± 5.59 years with an age range of 20-45 years. The average age of clove leaf oil refinery workers is still considered to be a very productive age for work, in accordance with the provisions of the Indonesian Ministry of Health in 2021. Several studies in other fields have also used a productive age range of between 31 to 44 years with an average age of 37.11 years as done by (Yusuf M et al., 2016), the age range is 20 to 41 years with an average age of 32.50 years by(Saputra et al., 2020), and based on research conducted by (Saputra et al., 2023) it was found that the age of respondent was at 20-50 years, in three studies the age range was still said to be very productive and muscle strength was still optimal enough to work. Research conducted by (Maudy et al., 2021), states age is the length of a respondent live until this research is carried out, along with Increasing age makes skills will decrease so that one's performance will reduced and will begin to feel the onset of complaints on health problems.

The average working period of clove leaf refinery workers is 6.95 ± 2.35 years with a working period range of 2-14 years, with a fairly long working period the workers are classified as very skilled and reliable in their work, according to research conducted by(Adiningsih, 2014), assumes that workers with a long period of service are skilled at work but the heat exposure they receive is greater which results in

the emergence of health problems, this is in line with research conducted by(Fajrin, 2014), which states that the longer the duration a person is exposed to heat, the higher the possibility of that person experiencing health complaints, a person can experience subjective complaints starting when the working period reaches one year. Based on research conducted by (Pusparini et al., 2016) the length of work will have a good influence positive on performance when with the longer the service life Someone is getting more and more experienced in carrying out his work and on the contrary exerts a good influence negative when with more Length of service will arise health problems

Based on the results of body mass index (BMI) calculations, the average BMI value was 23.35 ± 1.51 kg/m2 and the range of BMI values was in the range of 20.90 to 26.00, so that clove leaf oil refinery workers were included. as a category of normal-bodied workers according to the Indonesian Ministry of Health in 2021 and indicated a healthy physical condition at the time of the research. According to (Wulandari & Ernawati, 2018), said that workers whose nutritional status is poor will show an excessive physiological response to hot working climates and this is caused by the workers' cardiovascular system being unstable and disturbed, while based on research conducted by (Astuti et al., 2022) BMI that is less can increase the risk of contracting the disease because decreased immune system work, easy to weak, tired, lethargic.

The results of temperature measurements in the work environment from point 1 to point 12 carried out at three clove leaf oil refineries showed that the lowest work environment temperature was 28.46 °C and the highest was 30 °C with an average temperature of 29.14 °C. , from all temperature measurement points exceeding the NAB which is permitted in accordance with the Republic of Indonesia Manpower and Transmigration Regulation Number PER.13/MEN/X/2011 concerning the temperature threshold value in workplaces that work continuously 8 hours per day must not exceed 28°C. According to Seodirman (2014), the hot working climate received by workers if it exceeds the established tolerance can cause physiological disorders and (NIOSH, 2016) states that the human body which is continuously exposed to hot climates automatically causes physiological responses such as increased pulse rate, increased temperature. body, excessive sweating and so on, this condition is called heat strain as an effort to maintain normal body temperature, body temperature can return to normal when the sweat that comes out of the body evaporates through the evaporation method, although heat strain is only a symptom that arises due to heat but if not If treated quickly, it will cause illnesses due to acute or chronic heat exposure.

The average results of checking body temperature before and after work for clove leaf oil refining workers were 36.69°C and 37.70°C, and based on the paired simple t-test, the result was p = 0.000 (<0.005), p. This indicates that there is a significant difference between the worker's body temperature before work and after work. Based on the Pearson correlation test of heat stress data with body temperature after work, a correlation coefficient (r) of 565 was obtained with a medium category relationship level, so it can be concluded that there is an increase between body temperature after work is caused by the hot work climate from the clove leaf oil refining process which affects workers' body temperature, this is in line with research conducted by Soedirman (2014), which states that the accumulation of heat from the work environment can cause an increase in body temperature which is reflected by an increase in body temperature. rectal temperature and with a body temperature that can reach >38°C, it can also be concluded that the worker has experienced heat strain. The results of this study are in line with research conducted by (Wulandari & Ernawati, 2018) which states the results of physiological examinations state that there is an increase with an average body temperature before work of 36.73 ° C and increases to 38.13 ° C after work.

The results of measuring the pulse rate before work and the pulse rate after work were 82.54 bpm and 105.57 bpm and based on the paired simple t-test, the result was a p value = 0.000 (<0.005), this indicates that there is a significant difference between The worker's pulse rate before work and after work, based on the Pearson correlation test of heat stress data with body temperature after work, obtained a correlation coefficient (r) of 703 with a strong category relationship level, so it can be concluded that the increase in body temperature after work is due to the hot work climate. from the clove leaf oil refining process which affects workers' body temperature, this is in line with research conducted by (Asyik, 2018), who obtained the average pulse rate in the first measurement before work was 77.7255, in the next measurement after being exposed to heat the average was 109.27, it was seen that there was a difference in the average value between the measurements before and after exposure to heat was 31.5445, and the test results Statistically, the value of p = 0.000 (<0.05) is obtained, which means there is a significant relationship between the worker's pulse rate before and after work. Soedirman (2014) explains that workers who are exposed to heat will experience an increase in their pulse rate. The pulse rate can change due to an increase in cardiac output or cardiac output required by the working muscles.

This increase in cardiac output will increase the pulse frequency which will improve performance. the heart to circulate blood to the skin which aims to increase the evaporation of sweat in order to maintain body temperature. Hot working climates can cause additional load on blood circulation and blood pressure, while doing work heavy physique in hot environments, heart will pump more strongly and the blood will get the extra burden of having to carrying oxygen to that part of the muscle is working. In addition, to be able to carries heat from inside the body to skin surface, heart will increase The burden of having to pump more blood much more, so the pulse frequency and blood pressure is increasing by (Juariah et al., 2018), and based on the results of research conducted by (Jaya et al., 2020) found results in the Preparation Room at PT-X hot work climates can cause physiological responses of workers before and after work, that is, it affects improvement and increased pulse rate of workers before and after work with strong test values

The average result of workers' systolic blood pressure examination before work was 118.86 mmHg and the average after work was 131.14 mmHg, so it could be seen that there was an increase in workers' systolic blood pressure after work. The average results of workers' diastolic blood pressure examinations before work were 71.90 mmHg and the average after work was 74.79 mmHg, so it could be seen that there was an increase in workers' diastolic blood pressure before and after work. Based on the paired simple test, the result was a p value = <0.005, this indicates that there was a significant difference between systolic and diastolic blood pressure before and after work, based on the Pearson correlation test, heat pressure data with systolic and diastolic blood pressure after work obtained a coefficient correlation (r) of 486 and 540 with a strong category relationship level for the two research variables. The results of this research are in line with research conducted by (Rahma Shintyar et al., 2015), in the results of the chi-square test between heat stress and blood pressure, it can be seen that the value of p = 0.001 where p < 0.05 means that there is a relationship between heat stress and an increase in blood pressure in motor vehicle parking workers in the basement of Plaza Center Point Medan and the results of this study is also in line with research conducted by (Asyik, 2018) , which obtained the results of data analysis using the chi-square test showing that the value (p value = 0.000) because the p value < 0.05 shows that there is a relationship between heat stress and increased blood pressure in PT workers. Phillips Seafood Indonesia.

Based on the results of research conducted by (Dewi & Ramdhan, 2022) statistical test results on blood pressure diastolic has p value = 0.043, meaning there is a significant relationship between heat pressure with diastolic blood pressure construction sector workers Depo Light project Rail Transit (LRT)

Jabodebek. This research is also In line with research conducted by (Permana et al., 2019) regarding The relationship of work climate with blood pressure and body temperature of home industry workers Relationship Sandal Making significant with a p value of 0.001 (P<0.05), In addition, this research is also in accordance with done by (Hidayatullah, 2016) About the difference in blood pressure levels workers are exposed to the above hot work climate and under NAV on textile production where obtained p value 0.000 (P<0.05) which indicates that there is a relationship between heat pressure with blood pressure on workforce.

The results of measuring body weight before work and body weight after work were 64.27 kg and 63.24 kg and based on the paired simple t test, the results obtained were p = 0.000 (<0.005), this indicates that there was a significant difference between weight workers' bodies before work and after work, based on the Pearson correlation test of heat stress data with body weight after work, a correlation coefficient (r) of -460 was obtained with a medium level relationship, so it can be concluded that weight loss after work is caused by the hot working climate of clove leaf oil refining process, the results of this research are supported by(Wulandari & Ernawati, 2018)According to him, physiological responses to hot climates apart from body temperature, pulse and blood pressure can also be seen from the amount of sweat produced by the body, sweat production can result in weight loss in workers. Based on research conducted by (Adinda Pitaloka et al., 2021) heat exposure occurs when the body absorbs or produces more heat than it receives through the process Thermal regulation, an increase in excess body temperature can result in a decrease in yield performance, illness and death. Prolonged heat exposure also affects cognitive function Workers who if not improved the work environment will result in physical condition workers such as loss of body fluids that have an impact on weight loss.

## CONCLUSION

Based on the results of the research that has been carried out, it can be seen that the working climate conditions of clove leaf oil refinery workers are lowest at 28.46 °C and the highest at 30 °C with an average temperature of 29.14 °C. There is an increase in physiological responses such as an increase in body temperature, pulse rate, systolic blood pressure, diastolic blood pressure and a decrease in body weight in workers after work due to the hot working climate. It can be seen from the results of the p value for all variables that the value is <0.05, where This indicates that there is a significant difference between before work and after work. Based on the results of the Pearson correlation analysis of heat stress data with body temperature after work, pulse rate after work, systolic and diastolic blood pressure after work and body weight after work, a correlation coefficient (r) was obtained with a moderate to strong level of relationship, indicating that there is a relationship between climate. hot work with physiological responses in clove leaf oil refinery workers.

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