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Paulus Sukapto, Harjoto D., Yumanto, and Romy Marbun

ABSTRACT

Participatory ergonomics (PE) is an effective and efficient method to improve the employees concern towards workplace accidents in order to work more productively. The success of PE is determined by participation, organization, ergonomic methods and tools, as well as job design concept. The implementation of this method was conducted in the Upper Production Department (the division producing the top part of shoes) which consists of seven work stations. Each work station is measured concerning its risk score (RS). The measurement result shows that Dering and Pouching Stations have RS of more than the determined limit, therefore they need an improvement. The improvement results are protector for Pouching Machine and material clamp for Dering Machine.

Keywords: participatory ergonomics, risk score, job safety analysis

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IMPROVING THE QUALITY OF BREAD USING CASSAVA FLOUR SUBSTITUTION AND α-AMYLASE

Tatik Khusniati, Elisa Purnamasari, Supli Effendi, and Trisanti Anindyawati

ABSTRACT

Bread in Indonesia generally used wheat flour as a basic material and it is an imported flour product up to now. On the other hand, cassava flour can be used as wheat flour alternative for substitution. This research was aimed to improve the quality of bread using cassava flour substitution and α-amylase. Variables used were wheat and cassava flour with comparison: 100:0, 95:5, 90:10, 85:15, and α-amylase with concentration: 0, 0.5, 1.0, 1.5%, respectively. The contents of water, ash, protein, carbohydrate, and salt were determinated by modifying the AOAC method. The pH of bread dough was measured and α-amylase activities were determined by Iodine method. The dough and substituted-bread volumes were measured, and organoleptic tests were conducted by training 20 panelists. Statistical analysis used factorial completely randomized experimental design (FCRD). The results show that the highest values of water, ash, protein and carbohydrate were found in bread of A_4B_2 (25.13%), A_1B_1 (0.97%), A_1B_2 (8.62%), A_4B_2 (47.89%), sequentially ($P<0.05$). A_2B_4 was bread with the best organoleptic value and biggest volume than the others with nutritional contents of water (25.10%), ash (0.87%), protein (7.98%), carbohydrate (46.89%), and salt (2.17%). The values of these nutritional contents was in scope of bread SNI standard. Cassava flour substitution and α-amylase affected significantly to organoleptic values of bread produced ($P<0.05$). The α-amylase activities of all treated bread were not significantly different ($P<0.05$). Based on volumes of bread dough and bread as well as organoleptic tests, the best bread is A_2B_4 (95% wheat flour using 5% cassava flour and 1.5% α-amylase).

Keywords: α-amylase, wheat, cassava, flour, bread, quality

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STRUCTURAL CHARACTERIZATION OF FRACTIONATED GLYCOLIPID BIOSURFACTANTS SYNTHESIZED BY *Pseudozyma aphidis* YB205

Martha Sari, I Made Artika, and Wien Kusharyoto

ABSTRACT

Fractionation and structural characterization of glycolipid biosurfactant produced by yeast *Pseudozyma aphidis* strain YB205 was conducted. The yeast strain was grown in a nutrient broth with crude oil as the carbon sources and the glycolipid biosurfactant produced was isolated. The crude glycolipid was fractionated using column chromatography followed by complete separation and purification using extraction technique employing different organic solvents. The fractions were subjected to activity test using oil displacement assay followed by chemical identity test using thin layer chromatography. In order to elucidate its chemical structure, the most active fraction was subjected NMR and FTIR analysis. Results showed that six major fractions were generated all of which showed biosurfactant activity. Four fractions is fractions 2, 4, 5, and 6 showed glycolipid characteristics and fraction 6 showed the highest biosurfactant activity. Combination of NMR and FTIR spectroscopy spectra indicated that chemical structures of fraction 6 belonged to glycolipid species.

Keywords: *P. aphidis* YB205, fractionated glycolipid, ODA, FTIR, NMR

Teknologi Indonesia 39 (3) 2016: 137–142

EXPRESSION OF THE FLUORESCENT PROTEIN MTURQUOISE2 IN THE PERIPLASM OF *Escherichia coli*

Ira Handayani and Wien Kusharyoto

ABSTRACT

Many variants of cyan fluorescent protein (CFP) have been developed as fluorescent tags which are widely used as donors in Förster resonance energy transfer (FRET) experiments. Recent improvement of CFP variants resulted in mTurquoise2, a brighter variant with faster maturation, high photostability, longer mono-exponential lifetime and the highest quantum yield measured for a monomeric fluorescent protein. Here, the authors describe the expression of mTurquoise2 targeted for secretion via the general secretory (Sec) translocation pathway into the highly oxidizing periplasm of *Escherichia coli*. The use of signal peptide MPB*1, a modified signal sequence of maltose binding protein was investigated. The His6-tagged fluorescent protein was expressed in *E. coli* NiCo21(DE3) and purified by means of immobilized metal ion affinity chromatography (IMAC) on TALON™ matrix. In SDS-PAGE and Western blot analysis, a single band corresponding to a molecular mass of approximately 28 kDa was observed, which correlated with the predicted molecular mass based on the amino acid sequence of mTurquoise2.

Keywords: mTurquoise2, fluorescent protein, periplasm, Sec-pathway, translocon

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ENZYMATIC HYDROLYSIS OF THE FEC 25 AND ROTI CASSAVA STARCH (*Manihot esculenta*) VARIETIES BY α-AMYLASE FROM A MARINE BACTERIUM (*Brevibacterium* sp.)

Nanik Rahmani, Ade Andriani, Sri Hartati, and Yopi

ABSTRACT

Cassava (*Manihot esculenta*) is one of the food sources that is familiar for Indonesian society. Carbohydrates of cassava can be enzymatically hydrolyzed into small oligosaccharides that can be used as a material for functional food components production. Starch from the FEC 25 and roti cassava starch have been hydrolyzed by α-amylase from marine bacterium, *Brevibacterium* sp. for maltooligosaccharides production. The best hydrolysis reaction condition of the FEC 25 cassava starch were starch concentration of 6.0% (w/v), the ratio of α-amylase and starch 1:1, 50 mM of sodium phosphate buffer pH 6.6, the reaction temperature at room temperature (30oC) and the reaction time of 8 hours with the highest reducing sugar value of 21.675 ppm. While the best hydrolysis of the Roti cassava starch were starch concentration of 6% (w/v), the ratio of α-amylase and starch 1:1, 50 mM of sodium phosphate buffer pH 6.6 and the reaction temperature at 50oC, the reaction time of 8 hours with the highest reducing sugar value of 13.278 ppm. The results of maltooligosaccharides analysis using thin layer chromatography (TLC) showed that the type of maltooligosaccharides formed on hydrolysis the FEC 25 cassava starch are glucose, maltose and maltotriosa, while Roti cassava starch are glucose, maltose, maltotriose, and maltopentaose. The formation of maltooligosaccharides showed that both of cassava starch can be hydrolyzed by α-amylase from marine bacterium *Brevibacterium* sp.

Keywords: α-amylase, *Brevibacterium* sp., cassava, marine bacterium, maltooligosaccharides

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THE CHARACTERISTICS OF VETIVER GRASS AS A PHYTOREMEDIATOR PLANT IN DOMESTIC GREYWATER TREATMENT

Jovita Tri Astuti and Lies Sriwuryandari

ABSTRACT

Source separation of domestic wastewater into greywater (GW) and blackwater (BW) streams is important in decentralizing treatment due to its different characteristics. GW is generated from bathroom, washing machine, kitchen sink, and vehicle washing. Meanwhile, BW is produced from toilet, urinal or bidet. In developing countries, untreated wastewater is widely used in agricultural and risk to human health and living organisms. The appropriate treatment is required to prevent water degradation. Phytoremediation is a sustainable way to mitigate pollution with using plant. This study was conducted to observe the characteristics of vetiver grass as phytoremediator for GW. There are two factors of treatment. First is growth media (M), i.e. tap water (TW) as control (M_0) and GW (M_1). The second is vetiver (V), i.e. without (V_0) as control and with planting (V_1). Three glass aquariums are used for each treatment as replicates. Eight individual stem bases of vetiver were placed at aquarium and allowed hydroponically growing. At harvesting (49th day), vegetative organs were collected and observed separately, i.e. root, stem and leaf. Pollutant removal was calculated by comparing the content before and after treatment of media with vetiver. Cultivation of vetiver in GW (M_1V_1) could increase the root number, total root length, and total root diameter as much as 54%, 92.2%, and 51%, respectively. Individual root length was in the range of 2.3-78.5cm and root diameter was 0.35-2.10mm. Compared to the initial, stem number increased 99%, while leaf number increased 4 times. Root/Shoot (R/S) ratio was 0.80±0.14. Pollutant removal of GW by vetiver achieved 72.86% BOD_5; 65.51% COD; 66.55% TN; 67.67% TP; 80.77% Fe; 71.43% Zn; 60% Pb; 65.81% detergent, and 100% phenol. Vetiver could reduced TPC 29.13%, MPN coliform 78.18%, and MPN fecal coli 91.54%. After treated with vetiver, GW complied to criteria of water Class IV that can used for irrigation in agricultural.

Keywords: domestic wastewater, greywater, phytoremediation, pollutant removal, vetiver grass

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THE IMPLEMENTATION OF PARTICIPATORY ERGONOMICS PROGRAM IN THE EFFORTS TO IMPROVE CONCERN TOWARDS WORKPLACE ACCIDENTS (CASE STUDY OF SHOE INDUSTRY)

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ABSTRACT

Participatory ergonomics (PE) is an effective and efficient method to improve the employees concern towards workplace accidents in order to work more productively. The success of PE is determined by participation, organization, ergonomic methods and tools, as well as job design concept. The implementation of this method was conducted in the Upper Production Department (the division producing the top part of shoes) which consists of seven work stations. Each work station is measured concerning its risk score (RS). The measurement result shows that Dering and Pouching Stations have RS of more than the determined limit, therefore they need an improvement. The improvement results are protector for Pouching Machine and material clamp for Dering Machine.

Keywords: participatory ergonomics, risk score, job safety analysis

ABSTRAK

Ergonomi partisipatif (PE) adalah metode yang efektif dan efisien untuk meningkatkan kesadaran pekerja terhadap kecelakaan di tempat kerja untuk dapat bekerja dengan lebih produktif. Tingkat keberhasilan PE sangat dipengaruhi oleh partisipasi, organisasi, metode ergonomi dan perlengkapannya serta konsep perancangan pekerjaan. Implementasi dari metode ini dilakukan pada Departemen Produksi Bagian Atas (divisi yang memproduksi bagian atas dari sepatu) yang terdiri dari tujuh stasiun kerja. Setiap stasiun kerja diukur dengan menggunakan nilai risiko (RS). Hasil pengukuran menunjukkan bahwa stasiun kerja Dering dan Pouching memiliki RS melebihi batas sehingga diperlukan perbaikan. Hasil dari perbaikan yang dilakukan berupa pelindung untuk mesin Pouching dan penjepit material untuk mesin Dering.

Kata kunci: *ergonomi partisipatif, nilai risiko, analisis keamanan kerja*

INTRODUCTION

Participatory Ergonomics (PE) is recognized as a means for improving ergonomics aspects of work and workplaces.[1] PE refers to encourage workers to take part in the system design progresses early and completely to increase their autonomy and direct influence on all aspects of the work that they are going to perform.[2] The success in PE implementation may lower the absence level of the employees, lower turnover, reduction in material losses, improvement in industrial relations environment, and increase in productivity.[3,4,5]

PE implementation can be performed by quality circle method, namely by the implementation of quality control group method to obtain continuous improvement. In this case, the operator may learn about principles of ergonomics and the procedures in the analysis and ergonomics implementation.[6,7,12]

Moreover, PE implementation encourages the employees and the company to become better due to improvements in the work environment in order to produce improvement in quality and increase in productivity. The employees involved in the PE are those having high work motivation, therefore they are capable to find the solution and identification on influencing factors in the work environment. Employees who acknowledge ergonomics problems in their workplaces can be spirited to perform improvements, especially based on ergonomics method. In the end, they receive new work design because they have already involved from the beginning to the final concept.[3,13,14,15]

1. Research Context

Nowadays, the number of accidents in shoe industry is still quite high. It is hoped that employees and company will be able to minimize the number of accidents or to make it completely nil. Therefore, their work productivity will be increasing. Many efforts have been performed, however, they have not obtained satisfactory outcome yet. One of the methods capable to decrease the workplace accidents level is to involve the operators and management.

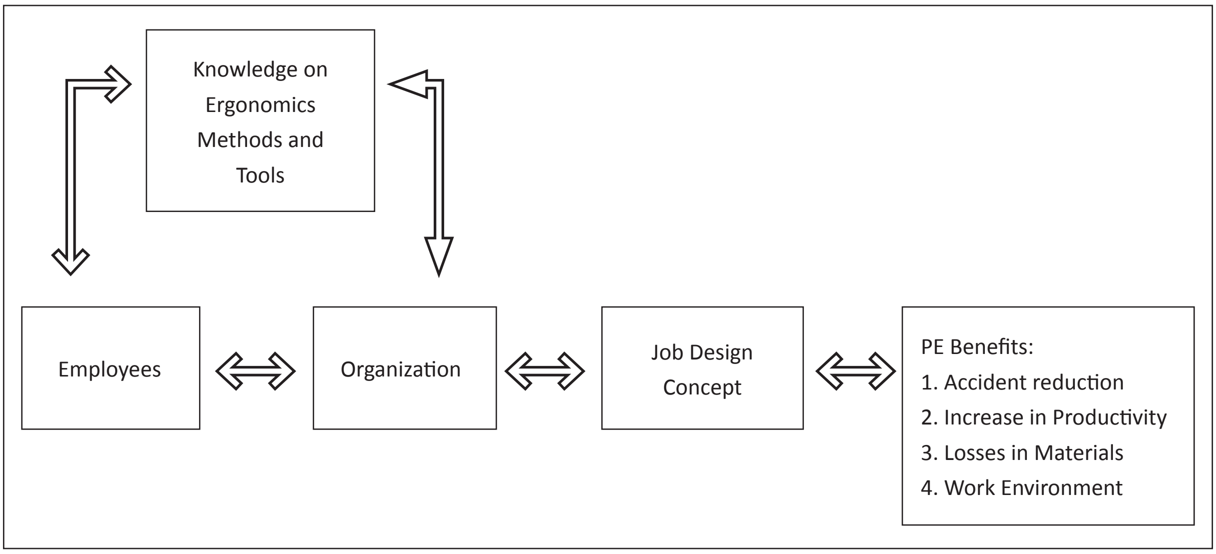
2. Description on the PE Program

PE is an interaction between employees and management by using knowledge and facilities to plan, implement, and evaluate the process with other resources, and to produce a suitable work design concept. Therefore, systematically it will lower workplace accidents level and its consequences.[8] In the PE implementation, employees need to perform interactions with organizations by using knowledge and work method and ergonomics tools in order to produce a design concept. Most workplace PE interventions involve forming an ergonomics team which guides the intervention process. This group usually includes employees, managers, ergonomists, and health and safety personel.[9] The health and safety personel provides knowledge on ergonomics methods and tool. The team produces the design concept which may help to improve industrial relations environment. Therefore, it can give benefits such as accident reduction and increase in productivity. The PE Model is described in Figure 1.

Research and Measurement of Object

2.1 Research Object

PT Primarindo Asia Infrastruktur, Tbk. is a sport and casual shoe company whose products are sold in local and international markets. The company is located at Gedebage, in the eastern part of Bandung city center. The company manufactures sport shoes under the brand Tomkins. Meanwhile, for its international market, the company does not have a specific brand because they manufacture



Source: Sukapto, 2007[8]

Figure 1. PE Model to Improve Safety in the Workplace

shoes based on customers' orders. In 2013, PT Primarindo Asia Infrastruktur, Tbk. has 2,285 employees. There are six departments in this company, namely the Material, Cutting, Upper Manufacturer, Compounding, Rubber, and Assembling. The research of the PE implementation was focused on the Upper Production Department which has seven workstations.

The layout of the workplace in the Upper Production Department is presented in Figure 2. In order to acknowledge the working conditions of the department, physical environmental condition, i.e. lighting, noise, temperature, and humidity of the workplace were measured. The light intensity on the working table was measured using a Digital Instruments LX-1180. The noise in the workplace was measured using Digital InstrumentsRS-232. Workplace temperature and humidity were determined using a TFA Digitatales Thermo-Hygrometer. The result of the environmental condition determinations is presented in Table 1.

Figure 2. The Layout of the Workplace in the Upper Production Department

2.2 Measurement Results

The Upper Manufacturer Department is the department producing upper parts of shoes. The manufacturing process is started from Sewing Division, Orisol, Hot-Molding, Cold-Molding, Plong, Dering to Pouching Division. The lighting system in this department is not sufficient because natural lighting from the sun does not reach the entire building satisfactorily. Therefore, it needs additional local lighting on each work station.

The lighting in this department mostly relies on local lighting on each work station. Therefore, in overall department, it has sufficient lighting level. However, in terms of noise, there is a compressor producing very high noise level in the outer part of the department, which influences noise level. In addition to the compressor machine, noise level in this department is increasing due to the existing production machines. Dering station, Pouncing station, and Plong station are the ones having quite high noise level, but are still under the standard limit of 85 dB.

Although there are only few machines causing heat in this department, the average temperature in this department is considered high. There are also plants around the department, but they only function as mere decoration because they cannot help much in making a better temperature in this department. The department needs to install a turbine ventilator so that the hot air could be disposed out. Alternatively, additional exhaust and ventilatlion system are recommended to improve the air flow in this department.

The installation of heat retainer on the ceilings or roof covered with heat retainer may

Table 1. Physical Measurement Results on Upper Manufacturer Department

Work Station	Lighting (lux)	Minimum Lighting Standard (lux)	Noise (dB)	Maximum Noise Standard (dB)	Temperature (°C)	Maximum Temperature Standard (°C)	Humidity (%)
Sewing	339.2	300	78.8	85	32.8	30.6	59.1
Orisol	338.2	300	78.2	85	32.6	30.6	58
Hot-Mold	245.4	200	71.2	85	35.2	30.6	62.8
Cold-Mold	246.2	200	71.5	85	34.1	30.6	61.9
Plong	322.6	200	81.7	85	33.2	30.6	61
Dering	323.5	200	84.6	85	33.4	30.6	61.2
Pouncing	332.4	200	84.8	85	31.3	30.6	59.3

also be another alternative to decrease the high temperature in this department. The impact of physical measurement becomes the benchmark to measure the risk level for each work station.

In order to realize concern towards work-place accidents, the following phases may be followed: a) measurement of risk levels on each work station; b) improvement in stations having the highest risk by applying the PE Model; and c) outcome in the form of work design suitable for the employees. The measurement phase of risk level is done by stipulating the Job Safety Analysis (JSA) and calculating Risk Score (RS) for each work station.

Job Safety Analysis and Risk Score

The Upper Manufacturer Department consists of seven stations, namely the Sewing, Orisol, Hot-Mold, Cold-Mold, Plong, Dering, and Pouncing. The phases for Risk Score (RS) calculation in the Sewing Station are performed as follows.

The Sewing Station functions to combine two or more upper pattern pieces by forming simple sewing patterns. The work process in the Sewing Station can be seen in Figure 3. The flow of the process occurring in this station can be seen in Figure 4.

The RS calculation is performed in two phases. The first phase is performing Job Safety Analysis (JSA), namely defining the work steps performed in work place and identifying the existing hazards on each work process. The second phase is determining the score to become the parameter in the RS calculation, namely C which shows the consequence value due to accident, E which is the exposure score on the hazard causing the accident, and P as the possibility score which shows the frequency of accidents in certain period. The guidance for each C, E, and P scores can be found in the table on the various literatures concerning work safety, for example Brauner.[10] The number of RS can be calculated by multiplying the three parameters. The RS calculation output in Sewing Station can be seen in Table 2.

Figure 3. Sewing Station

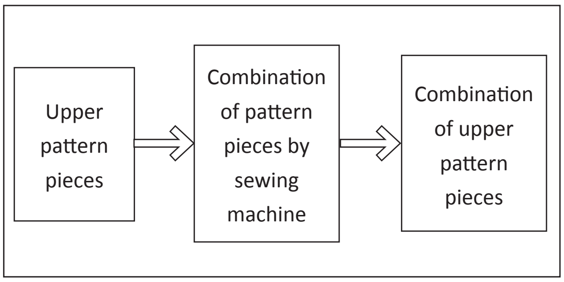


Figure 4. Work Process in Sewing Station

Table 2. JSA Worksheet and RS of Sewing Station

				Risk Score			
No	**Work Step**	**Hazard**	**Effect**	**C**	**E**	**P**	**RS**
1	Taking material from the box						
2	Positioning the materials on the machine needle						
3	Stepping on the machine pedal to operate the machine and moving the materials in accordance with the sewing pattern	Needle on the machine	Worker's hand may be punctured by the machine needle	5	3	10	150
4	Taking and checking the process output						
5	Cutting excess threads on the materials by using scissors or cutter	Cutter or scissors	Operator's hand may be cut by the cutter or scissors	1	2	6	12
6	Putting the process output into the box						

The Sewing Station has the largest RS score for 150. The score is resulted from the hazard in the form of sewing needle on the machine which may puncture the operator's hand when conducting the process. The main cause of this high number of RS score in this station is the high possibility of accident and number of accidents occurring in this station. This is because when operating the machine, the operator must perform the sewing process by holding the material's position on the machine sewing area where the operator's fingers position is very close to the needle.

Therefore, the operator must focus when operating the machine because if they are off guard, their fingers may get punctured.

In addition, there is also another possibility of the operator's hand or finger to be cut by cutter or scissors when cutting the excess thread on the process output materials. In Figure 5, it can be seen the operator's hand position when operating the sewing machine.

With the same calculation for the Sewing Station, the RS for Orisol, Hot-Mold, Cold-Mold, Plong, Dering, and Pouncing Stations can also be calculated. The results for the RS calculations can be seen in Table 3.

According to Fine,[11] the risk level can be grouped into low zone (RS ≤ 89), medium zone (89 ≤ RS ≤ 199), and high zone (RS > 199). The high zone RS describes that the danger of work condition is high, therefore it requires improvement. Therefore, the Dering and Pouncing work stations have the highest RS score, which is larger than 199. Hence, they require improvement immediately. The improvement process is conducted by using the PE model.

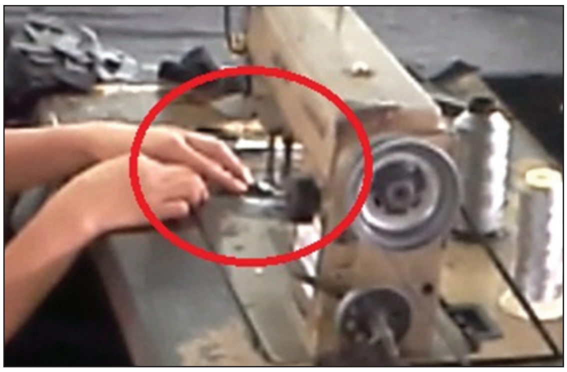


Figure 5. Operator's Hand Position on the Sewing Machine

3. Design Concept by PE Program

Pouncing and Dering Stations are the stations with high RS, therefore, they require immediate improvement to decrease the accident numbers.

According to Vink et al.,[4] the making of design concept on the work system improvement is performed with the interaction amongs the operator, ergonomics, management, and designer. The operator, ergonomist, and designer will periodically continue to perform discussion until they produce a concept which fits to the operator in performing their duties. The process of improvement of idea concept, idea selection, making of prototype, and finally prototype testing will be last for three months. The design concept in the Pouncing and Dering Stations produced is as follows.

3.1 Pouncing Station

The station has the highest RS, namely 300 and the hazard risk is in the machine presser and pedal, which are too sensitive. The chance of accident in this station is very high because when performing a process, the operator's hand is always on a dangerous position, which is exactly under the machine presser part when positioning the component. In this situation, if the machine pedal is accidentally touched by the operator's foot, the hand may be hit by the presser and will cause the operator to suffer bone fracture on their palm or fingers. The design concept produced

Table 3. Risk Score (RS)

Station	Risk Score
Sewing	150
Orisol	60
Hot-Mold	180
Cold-Mold	180
Plong	30
Dering	300
Pouncing	300

by this PE program to minimize the accidents are as follows.

1) Making a relay system. This relay system is added by installing a switch or a button which functions as a protection to the machine pedal, it means that although the machine pedal is stepped on by the operator, the pressing process will not occur if the additional switch or button is not being pressed.
2) Installing a clamp to the machine. With the clamp, the operator's hand position is expected not too long on the dangerous position. Figure 6 shows a clamp which may be installed on the machine.
3) If the installment of relay and clamp is performed, there will be a slight modification on the work steps. In Table 4, it can be seen that numbers 4 and 5 are the new work steps needed if the machine relay and clamp addition are performed.
4) Installing a protector or barrier on the pressing steel area in which the operator's fingers or hand will not be exactly positioned on the machine pressing area. Figure 7 shows the protector or barrier on the machine.

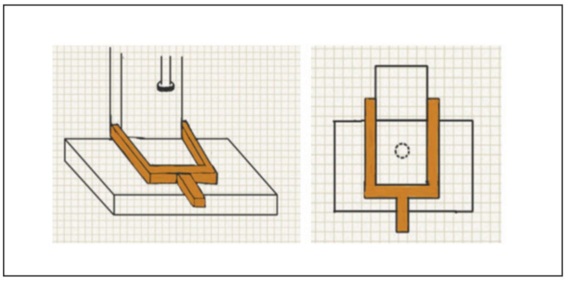


Figure 6. Pouncing Machine Clamp

Figure 7. Protector/Barrier for the Machine

5) Requiring the operator to wear ear protector, such as earplug or earmuff during performing the process. This is because the machine produces a quite high noise level which potentially cause hearing impairment to the operator.

3.2 Dering Station

The station has the highest risk score, namely 300 and its hazard risk is the machine presser. The efforts made to prevent workplace accidents on the Dering Machine are as follows.

1) Providing an auxiliary apparatus in the form of a clamp to hold the material's position towards the pressing iron in which the operator is not required to hold the material's position by their hands. With the existence of the clamp, the operator's hand position will not be too long in a dangerous position. Figure 8 shows the material's clamp for Dering Station.

   If the provision of clamp apparatus is performed, there will be a slight modification on the work steps. In Table 5, it can be seen that step number 2 is the new work step.
2) Installing protector or barrier on the pressing steel area that the operator's fingers or hands will not be positioned exactly on the machine pressing area. Figure 7 shows the protector or barrier on the machine.

Table 4. Modification of Work Steps on the Pouncing Station

No	Work Steps
1	Taking material from the box.
2	Positioning the material on the machine presser.
3	Positioning the non-ring component on the material.
4	Clamping the machine clamp on the material.
5	Pressing and holding the relay button on the machine by hand.
6	Stepping on the machine pedal to put the component on the material.
7	Taking the process output and putting it into the box.

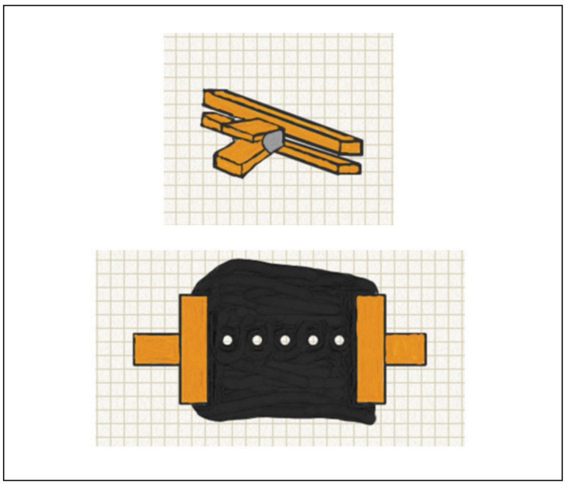


Figure 8. Material Clamp in Dering Station

Table 5. Modification on Work Steps in Dering Station

No	Work Steps
1	Taking material from the box.
2	Clamping the material on the clamp apparatus.
3	Positioning the ring component on the material's hole.
4	Positioning the material's hole on the machine presser.
5	Stepping on the machine pedal to put the component on the materials.
6	Taking the process output and putting it into the box.

3) Requiring the operator to wear ear protector such as earplug or earmuff during performing the process, because the machine produces a quite high noise level which has the potentiality to cause hearing impairment of the operator.

CONCLUSIONS AND RECOMMENDATION

Conclusion

1) The Pouncing and Dering Stations have the highest risk level (RC is larger than 199) and improvement of work system using PE is required.
2) Success in the implementation of PE program is very dependable to the employees' interaction, ergonomist experts, and the company. The interaction process requires sufficient time to obtain a concept fits to the employees.
3) The design concept produced in the Pouncing Station is a machine protector, while in the Dering Station is a material clamp.

Recommendation

In order the PE implementation to perform well, it requires kind interaction among the employees, ergonomists, and the management which is performed continuously and consistently.

ACKNOWLEDGEMENT

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