Bioconversions of Palm Kernel Cake and Rice Bran Mixtures by *Trichoderma viride* Toward Nutritional Contents

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***Abstract*—**The objective of the research is to examine the mixtures of palm kernel cake and rice bran of fermented by *Trichoderma viride.* Completely randomized design in factorial pattern 4 x 4 was used in this experiment. factor I is the doses of inoculums ; D1 = 0%, D2 = 0,1% , D3 = 0,2%, D4 = 0,3%, and complement factor II is mixtures of palm kernel cake and rice bran : T1=20:80% ; T2=40:60% ; T3=60:40% ; T4=80:20%. The treatment each of three replicate. Fermentation was conducted at temperature 28 ^{o}C as long as 9 days. Determining the best of the mixtures be based on the crude protein increased and the crude fibre decreased.
The results showed that the combination of product mix is the best fermentation inoculums doses 0.3% in mixture of palm kernel cake and rice bran ; 80%: 20%, which produces dry matter of 88,12%, crude protein 17.34%, ether extract 5,35%, crude fibre 23.67%, and ash 6.43%. When compared with a mixture of palm kernel cake and rice bran; 80%: 20% without of fermentation is crude protein increase 29.58% and crude fibre decreased 22.53%.

Keywords*— bioconversions, palm kernel cake, rice bran, *Trichoderma viride.

I. INTRODUCTION

Palm kernel cake (PKC) is a waste palm oil processing plant in Lampung Province which is very abundant quantity, cheap price, and not competes with human needs and yet underutilized as animal feed ingredients broiler. Feed ingredients derived from agro-industry waste are usually very limited use in poultry rations, because the material generally contains high crude fibre. Rice bran is a by-product of rice milling is very potentially be used as animal feed ingredients that do not compete with human needs.

PKC crude fibre is high (16-23%), is necessary to consider its use as a broiler feed ingredient because it is difficult to digest (Siregar, et al., 2003) although the crude protein content is high enough that 11,30-17,00% (Sukaryana , 2001). The use of rice bran as livestock feed ingredients are faced with constraints of low crude protein content of about 7.6% and crude fiber height 12,4-27,8% (Tillman, et al., 2005), although its energy content is good enough 1500-1650 kcal/kg (Kumajas, 1997). Therefore, the necessary efforts to overcome the weaknesses of the two materials through bioconversions process.

Bioconversions are a process carried out by micro organisms to convert a compound into a product that has a chemical structure related or often called microbial transformation. Bioconversions are a process of converting or changing an organic material into other useful products and has added value by taking advantage of events and the biosynthesis or the formation biolysis or solutions. Bioconversions feed material can be made with fermentation technology. Fermentation technology is one alternative and inexpensive method to improve the nutritional value of a waste. With fermentation can also change the feed material becomes difficult to digest easily digested, producing aroma and unique flavours, and can eliminate toxins from the original material.

Fermentation with the fungus *Trichoderma viride* has been used in various substrates, especially the high crude fiber such as PKC. This fungus lives on suitable substrates containing starch such as rice bran. PKC weaknesses that do not contain starch will be helped by the rice bran which contains starch, so the PKC and the substrate mixture of fermented rice bran will be optimal. The presence of starch in the substrate used by the fungus as a source of energy for growth and development. Growth and development of good moulds spurred enzyme cellulose producing mould in significant amounts that can be used to reorganize and reduce coarse fibre. In addition, the high population of fungus could increase crude protein content of the substrate as the mould is a source of single cell protein.

Thus, if the PKC is mixed with rice bran is expected to be a suitable medium for the fungus to the good fermentation process by increasing the nutritional value of these substrates. Therefore, this study aims to examine the influence of inoculums dose and the balance of the mixture PKC - Rice Bran best fermentation to improve nutritional content.

II. LITERATURE REVIEW

A. Potential PKC and Rice Bran

Indonesia is a leading producer of palm oil in the worlds second largest after Malaysia. In the future Indonesia is expected to become the largest palm oil producer in the world because of its development continues to increase. In 1995 the

oil palm plantation area is 2.025 million hectares, and in 2005 the plantation area of 2.70 million hectares with oil production of 9.90 tons / year (PTPN VII, 2006).

Oil palm plantation area in Lampung in 2003 covering 28,448 hectares. From that area, PT. Perkebunan Nusantara VII is located in Lampung Province has resulted in a total production of fresh fruit bunches (FFB) processed 709,487 tonnes of the oil palm (Crude Palm Oil = CPO) as much as 148,864 tones and palm kernel (Palm Kernel = PK) as much as 34,817 tons. Palm kernel oil is processed into kernel cake (Palm Kernel Oil = PKO) as much as 11,543 tons and PKM (Palm Kernel Meal = PKM or Palm Kernel Cake = PKC) as much as 15,968 tons (PTPN VII, 2006). PKC eligible to serve as animal feed based on nutritional content. In addition, the waste does not contain toxic or hazardous substances anti nutrition for livestock. Specialized in birds, however, a high SK (NDF high-yield β-galactomannans (1.4)-D mannans) and a sharp shell are toxic factor from the PKC (FAO, 2005).

Research Osei and Amo (1987) which uses PKC 0, 5, 7.5, 10, 12.5, and 15% in broiler feed conversion rate indicates a real different ration at a distance of 10% to 12.5%. On the use of PKC 12.5% in the feed led to increased conversion rates, so a decline in the ration of feed efficiency. This is caused by the decrease in metabolic energy content and crude fiber increased feed.

Rice bran is a byproduct / waste from rice milling process. According to research results that approximately 8 - 8.5% by weight of rice bran rice is. In the rice bran there are some materials such as aleurone and pericarp layers as well as broken rice, small rice. Nutrients contained in rice bran include good quality protein, roughly 9 to 12%, starch 15 to 35%, fat 8 to 12% and crude fiber, 8 to 11%. With crude fiber content higher than corn or other energy sources will cause the rice bran is given in limited amounts depending on the type of cattle. As a commodity that is limited availability because it depends on the rice harvest and perishable nature and the main requirement for farmers who make their own feed mix that encourages high prices of rice bran in the market.

B. Bioconversions

Bioconversion is a process of converting or changing an organic material into other useful products and has added value by taking advantage of events and the biosynthesis or the formation biolysis or solutions. Bioconversions feed material can be made with fermentation technology. Fermentation technology is widely used to increase the nutritional value of a waste, such as through fermentation using molds. Reports of previous studies showed that the fermentation technology can increase the protein content in cassava (Kompiang, 1994), kernel coconut (Sinurat et al., 1995), sago (Kompiang et al., 1997), PKC (Supriyati et al., 1998), and the mixture heaps-chicken droppings (Sjofjan et al., 2002).

One of the technologies is developed BALITNAK fermentation technology using micro organisms. Micro-organism that can grow in certain conditions and change the chemical composition of oil palm waste to be better. One of the micro organisms used in fermentation of *Trichoderma viride* is because it's easier to grow in the waste oil and fermentation best results. In the fermentation process will produce amylolytic enzyme, proteolytic, and that makes a substance lipolytic waste food oil better. Also, xylanase enzymes produced and cellulose can reduce fibre content. Fibre is broken down into simple carbohydrates would thus increase the energy that can be metabolized by the cattle.

Food components in terms of quantity and variety are essential for the growth of moulds. Carbohydrates, especially sugar used as energy source, other components are carbon-containing peptides, amino acids, and organic acids. The use of carbon components as an energy source by the fungus was 70% to 30% growth and metabolic processes, molds can obtain the source of nitrogen from KNO3 and urea (Frazier and Westhoff, 1988).

C. Trichoderma viride

The fungus *Trichoderma viride* is a single-celled fungus that can reproduce by splitting them and describe the active cellulose contained in the soil. *Trichoderma viride* has characteristics as follows: (1) growth is very rapid (25 mm / day) in a Petridis containing PDA medium temperature incubations at 25 ° C, (2) can produce such antibiotics; trichodrimia, suzukulin, alametchine, and several other compounds have all broad spectrum activity against fungi and bacteria, (3) Can be used in the production of cellulase.

The fungus *Trichoderma viride* is a potential to produce cellulase in relatively large quantities in order to degrade cellulose. Benefits such as a source of mold are to produce cellulase complete with all components required to hydrolyze crystalline cellulose in total protein produced cellulose is high enough. *Trichoderma viride* types known to produce cellulase enzymes are very good is the type of QM 9124 QM 9414 and which has been developed at Natick Laboratories Massachusetts USA.

Wood (1985), *Trichoderma viride* destroy the microorganisms that high levels of cellulose and has the ability to synthesize several essential factors to dissolve the cellulose is strongly bound by hydrogen bonds. *Trichoderma viride* grown at a temperature of 30 °C, with a pH of 5.5 and relative humidity from 60 to 70 percent. Further stated that the *Trichoderma viride* cellulase enzymes can produce an enzyme complex that could hydrolyse pure cellulose can not dissolve into glucose. *Trichoderma viride* is rich in C1 factor (conversion of cellulose from the cellulose active and Cx (enzymes that hydrolyze the glycoside chain and reducing sugars) with the amount of each 50 units.

Larry (1997), *Trichoderma viride* is one that is cellulolytic mold because it can produce cellulase. In colony growth in first will look clean white surface and mycelium dull, sparse hair and be like. As an adult, which is produced conidia ends of certain mycelium divided into round or square shape, the color chartreuse. According to Sukaryana (2007), the exponential growth phase fungus *Trichoderma viride* achieved on day 9. On the first day the number of viable

spores was 8.6 x 105 CFU / ml, and then increased further until day 9, where the number of viable spores reached 6.0 x 1014 CFU / ml.

Sukaryana (2001) research results showed that fermentation with *Trichoderma viride* using the old 8-day fermentation and inoculums dose of 0.2% in the PKC can improve crude protein content of 36.97%, lower levels of 24.56% crude fibre, and increase the energy content metabolic by 27.24% compared with the PKC without fermentation. Solid substrate fermentation of rice bran by using *Trichoderma viride* with a 6-day old fermentation and inoculums dose of 0.2% was able to improve the quality of feed (Kumajas, 1997).

III. MATERIALS AND METHODS RESEARCH

Research material used is PKC, rice bran, and *Trichoderma viride* inoculums. Research methods using Complete Random Design (RAL) factorial pattern of 4 x 4. Factor I is the dose of inoculums; D1 = 0%, D2 = 0.1%, 0.2% = D3, D4 = 0.3%, and factor II is a balance mixture of PKC and bran; T1 = 20:80%; T2 = 40:60%; T3 = 60:40%; T4 = 80:20% each. Treatment is repeated 3 times.

Implementation of the balance of mixed fermentation research PKC - Rice Bran is; T1 = 20:80%; T2 = 40:60%; T3 = 60:40%; T4 = 80:20%, respectively balance mixture of water plus 50% (volume / weight), stirring rate and then sterilized at a temperature of 120 ^{o}C for 15 minutes, then cooled. After reaching room temperature inoculated with the inoculums that were made before much: 0; 0.1; 0.2; 0.3% mix well. Enter into a plastic bag that had been hollowed out both sides of it to get aerobic conditions. Then incubation at room temperature 28 ^{o}C for 9 days. Each combination of treatment is repeated 3 times. After each incubation time is reached, the fermentation product dried in the sun until the constant weight obtained. Further testing nutritional value. Nutritional Values measured were: dry substance content, crude protein, crude fat, crude fibre, and ash with proximate analysis.

IV. RESULTS AND DISCUSSION

Results proximate analysis of each treatment is presented in Table 1.

1. The Influence of Inoculums Dose and Blend Ratio between PKC - Rice Bran Against Dry Material

Based on the results of the print range, that the dose of inoculums and mix ratio PKC - Rice Bran is very real impact on reducing levels of dry material. The results of fermentation influence on levels of dry material by *Trichoderma viride* varied between 86.51 percent to 93.58 percent. There is interaction between the inoculums dose Mixed PKC ratio - Rice Bran.

The results of Duncan multiple range test (Table 2) shows, the levels of dry material obtained at the highest inoculums dose (D1) with a mixture ratio between PKC - Rice Bran (T4). This is because the treatment D1T4 is not experiencing fermentation.

Table 1. Results Proximate Analysis of Each Treatment.

Treatment	Dry Matter	Crude Protein	Extract Ether	Crude Fiber	Ash
		……..……..…. % ……..……..			
D1T1	89,65	10,39	6,44	33,58	11,35
D2T1	90,97	12,18	9,39	32,44	13,59
D3T1	90,35	11,53	9,42	31,51	13,20
D4T1	90,85	12,21	7,50	31,37	13,87
D1T2	90,80	11,11	6,52	32,23	9,82
D2T2	91,15	13,37	9,80	31,46	10,88
D3T2	89,61	13,50	9,42	29,40	11,20
D4T2	90,41	13,08	8,35	28,53	10,74
D1T3	91,78	12,63	7,43	31,31	8,18
D2T3	88,72	14,40	9,32	29,77	8,65
D3T3	87,43	14,84	7,44	28,30	8,39
D4T3	89,54	14,15	5,68	25,57	8,41
D1T4	93,58	13,38	7,79	30,55	5,89
D2T4	87,75	16,10	8,12	28,70	6,26
D3T4	86,51	16,50	7,77	25,38	6,41
D4T4	88,12	17,34	5,35	23,67	6,43

Description: The results of the analysis in proximate Livestock Food Science Laboratory Diponegoro University Faculty of Animal Husbandry (2009).

Table 2. Duncan Multiple Range Test Influence of Inoculums Dose and Mixture Ratio between PKC - Rice Bran against Dry Matter (in percent)

Inoculums Dose	Mixture Ratio PKC - Rice Bran			
	T1	T2	T3	T4
D1	89,65 Cc	90,80 Dd	91,78 Dd	93,58 Dd
D2	90,97 Dd	91,15 Dd	88,72 Bb	87,75 Aa
D3	90,35 Dd	89,61 Bb	87,43 Aa	86,51 Aa
D4	90,85 Dd	90,41 Dd	89,54 Cc	88,12 Bb

Description: The same superscript in horizontal rows (capital letters) or Vertical (Lowercase) indicates not significantly different ($P<0.05$).

2. The Influence of Inoculums Dose and Blend Ratio between PKC - Rice Bran Protein Against Violent Content

Based on the results of the print range, that the dose of inoculums and mix ratio PKC - Rice Bran is very real effect on crude protein content. The results of fermentation influence on crude protein content by *Trichoderma viride* varied between 10.39 percent to 17.34 percent. There is interaction between inoculums dose and the ratio between the mixture with PKC - Rice Bran.

The results of Duncan multiple range test (Table 3) shows, increasing the crude protein content obtained at the highest inoculums dose of 0.3 percent (D4) on the ratio between the Mixed PKC - Rice Bran T4. The results of this study in line with the results of research Kumajas (1997), *Trichoderma viride* that grow and breed in an ideal substrate. The higher the dose of inoculums population more mold, and in turn more and more mycelium is formed as well as it will increase the total nitrogen content proportionally, because the crude fiber degradation. When compared with a mixture of rice bran PKC and 80%: 20% who did not have fermentation (D1T4) an increase in crude protein content of 29.58%.

Table 3. Duncan Multiple Range Test Influence of Inoculums Dose and Mixture ratio PKC - Rice Bran Protein Against Violent Content (in percent)

Inoculums Dose	Mixture Ratio PKC - Rice Bran T1	T2	T3	T4
D1	10,39 Aa	11,11 Aa	12,63 Bb	13,38 Bb
D2	12,18 Bb	13,37 Bb	14,40 Cc	16,10 Dd
D3	11,53 Aa	13,50 Bb	14,84 Cc	16,50 Dd
D4	12,21 Bb	13,08 Bb	14,15 Cc	17,34 Dd

Description: The same superscript in horizontal rows (capital letters) or Vertical (Lowercase) indicates not significantly different (P<0.05).

3. The Influence of Inoculums Dose and Blend Ratio between PKC - Rice Bran Fatty against Violent Content

Based on the results of the print range, that the dose of inoculums and mix ratio PKC - Rice Bran is very real impact on crude fat levels. The results of the influence of fermentation studies on crude fat by *Trichoderma viride* varied between 5,35 percent to 13,83 percent. There is interaction between the inoculums dose Mixed PKC ratio - Rice Bran.

Table 4. Duncan Multiple Range Test Influence of Inoculums Dose and Mixture Ratio between PKC - Against Rice Bran Crude Fat Content (in percent)

Inoculums Dose	Mixture Ratio PKC - Rice Bran T1	T2	T3	T4
D1	6,44 Aa	6,52 Aa	7,43 Bb	7,79 Bb
D2	9,39 Dd	9,80 Dd	9,32 Dd	8,12 Cc
D3	9,42 Dd	9,42 Dd	7,44 Bb	7,77 Bb
D4	7,50 Bb	8,35 Cc	5,68 Aa	5,35 Aa

Description: The same superscript in horizontal rows (capital letters) or Vertical (Lowercase) indicates not significantly different (P<0.05).

The results of Duncan multiple range test (Table 4) shows, the crude fat obtained at the lowest dose of inoculums (D4) with a mixture ratio between PKC - Rice Bran (T4) and not significantly different inoculums at a dose level of 0.2 per cent decline in crude fat during the fermentation process to prove, that in addition to utilizing *Trichoderma viride* also used fat carbohydrates for growth and development. This is because the mold has been the rapid growth phase (exponential phase) of the mycelium grows rapidly, which in turn lead to increased energy needs, then the utilization of fat for growth and development of molds start to decline.

4. The Influence of Inoculums Dose and Blend Ratio between PKC - Rice Bran Fibre against Violent Content

Based on the results of the print range, that the dose of inoculums and the ratio between the mixtures PKC - Rice Bran is very real effect on crude fiber content. The results of fermentation influence on crude fiber content decreased by *Trichoderma viride* varied between 23.67 percent to 33.58 percent. There is interaction between the inoculums dose mixed PKC ratio - Rice Bran.

The results of Duncan multiple range test (Table 5) shows, the decline in crude fiber content obtained at the highest inoculums dose (D4) with a mixture ratio between PKC - Rice Bran (T4). That means 0.3 percent inoculums dose sufficient to degrade the crude fiber. This is in line with the results of research Kumajas (1997), that 0.3 percent is the optimal dose of *Trichoderma viride* for the fermentation process. However, for a decline in crude fiber which it will take longer (Ferdiaz, 1988).

Table 5. Duncan Multiple Range Test Influence of Inoculums Dose and Mixture Ratio between PKC - Rice Bran Fibre Against Violent Content (in percent).

Inoculums Dose	Mixture Ratio PKC - Rice Bran T1	T2	T3	T4
D1	33,58 Dd	32,23 Dd	31,31 Dd	30,55 Dd
D2	32,44 Dd	31,46 Dd	29,77 Cc	28,70 Cc
D3	31,51 Dd	29,40 Cc	28,30 Cc	25,38 Bb
D4	31,37 Dd	28,53 Cc	25,57 Bb	23,67 Aa

Description: The same superscript in horizontal rows (capital letters) or Vertical (Lowercase) indicates not significantly different (P<0.05).

V. CONCLUSIONS

Based on our research and discussions will be drawn a conclusion that the combination of product mix is the best fermentation inoculums dose of 0.3% in a mixture of rice bran PKC and 80%: 20%, which produces dry ingredients 88.12%, 17.34% crude protein , 5.35% crude fat, crude fibre 23.67%, and 6.43% ash content. When compared with a mixture of rice bran PKC and 80%: 20% who did not experience an increase in fermentation crude protein content decreased 29.58% and 22.53% crude fibre. There is a very real interaction (P <0.05) between the inoculums dose and the PKC and the balance a mixture of rice bran to the dry ingredients change, crude protein, crude fat, crude fibre and ash content.

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