Determining The Pattern of Pesticide Residue Contamination and The Improvement of Production, Quality, and Milk Safety of Dairy Cattle with Probiotic-based Lignochloritic Bacteria

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ABSTRACT

Agricultural waste is a substitute for forage as the main feed of dairy cattle, especially during the dry season. The quality of agricultural waste in Indonesia is very low, with the high content of lignocelluloses which limits digestibility of feed. On the other hand, bioaccumulation of pesticides in plants that occurs during lignifications process caused the highest number of residues found in hay and straw that is lower in security as animal feed. The research objective was to determine the pattern of pesticide residue contamination in dairy products and dairy feed, as well as the improvements to the production, quality, and safety of dairy product. The result showed that forage products, concentrates, and milk were detected to contain 6 harmful organochlorin pesticide residues, namely lindane, heptachlor, eldrin, diendrin, aldrin and DDT. The number of aldrin, DDT, and dileldrin in diendrin milk was as high as between 5.76 to 19.2 ppb. The mechanism of contamination patterns of each pesticide differs, and sources of contamination derived from concentrates, forage, and other resources such as drinking water. The application of probiotic-based lignochloritic bacteria 1% of the total concentrate feed has increased milk production 30-50% of control, increasing the average fat content of 4.0% and lower organochlorin residues in milk between 60-100%.

Key Words: Probiotic, Lignochloritic, Pesticide, Residue

INTRODUCTION

Pesticide bioaccumulation in plant occurred during lignifications process so that the highest amount of residue was in straw, and it reduced the level of its safety for cattle feed. Organochlorin pesticide residue was detected in a significantly high level in rice straw waste. Indraningsih et.al. (2003) has reported that even in organic rice straw, the contamination level of DDE and endosulfan were as high as 6.2 and 75.2 ppb although these numbers were not identified in the soil. Pesticide residue was also detected in some cattle consuming corn waste; lindane was present for about 0.25 ppb in cow serum where the cattle were given regular feed from organic farming pattern. Dieldrin and heptachlor were present in cow fat and meat raised from staple food and sugarcane feed. Pesticide was identified as well in cow meat raised by grazing system.

Bioaccumulation of pesticide residue was commonly found in fat tissue of biota. Since the main source of pesticide residue waste is from feed, it is likely that milk from dairy product also contains pesticide residue. A study result by Prihartini, *et.al.* (2007c) showed three lignochlorin isolates that have high potential of lignin and organochlorin degradation interconnections. Isolate potential supports the formation of probiotics for further lignin degradation in order to increase the level of nutrition digestion and detoxification of pesticide residue inside rumen. Furthermore, inoculums formula as the result of this process is considered safe, stable, and effective due to its interconnection characteristic of lignin and organochlorin degradations from isolate. This would guarantee high efficiency in rumen fermentation.

RESEARCH METHOD

Pesticide Residue Profile for Dairy Product and Cattle

This study applied survey method which aimed at showing pattern of pesticide residue contamination of dairy product and feed.

Sampling

Milk samples were derived from 3 milk center areas in Malang regency; they were from Dau, Pujon, and Jabung, each area required 20 cattlemen. Each cattleman should own at least 5 lactating dairy cows. Forage sample and concentrate consumed by cattle was collected by the time the researcher conducted milk sampling. It was expected that this method might help to find out the source of contamination, whether it was from forages or concentrate. Furthermore, by this sampling, the researcher would likely to trace the pattern of pesticide contamination in milk. Milk samplings were conducted on day 3 and 7 after feed sampling, as it was predicted that the effect of cattle feed consumption or rumen fermentation product reached their optimum number by the 3^{rd} and 7^{th} day of consumption.

The sampling for cattlemen utilized purposive sampling by considering area distribution, livestock ownership, types of forages, and concentrates usage. Elephant grass forage type was commonly used by the breeders to feed their dairy cattle and the kind of concentrate used was concentrated milk pap produced by KUD (Village Unit Cooperatives).

Laboratory Analysis

The analysis of milk fat content was measured according to Berger (1970) method. The content measurement of pesticide residues in forages and concentrates as well as milk was carried out according to Ishii *et al.* methods (1994) in the Laboratory of Agricultural Environment, Environmental Research Institute of Agriculture.

Analysis and Statistical Test

The data were analyzed by regression analysis to generate mathematical model of pesticide residue pattern and the effect of pesticide residue contamination of forages and concentrates on milk.

RESULTS AND DICUSSION

Contamination Profile of Pesticide Residue in Feed and Milk

The study results of contamination profile of pesticide residues in forages, concentrates, and dairy products in Malang are presented in Figure 1.2 and 3. Figure 1 shows the six types of organochlorine pesticides detected in elephant grass forage; they are Lindane, Heptachlor, Aldrin, Dieldrin, Endrin and DDT 4.4. Residue content varied; Lindane pesticide was detected on its maximum of 928.4 ppb. Lindane was found in its highest level although in the elephant grass cultivation, farmers did not apply any pesticide. It might happen since the soil and water have been contaminated with pesticide residues from crop farming systems with intensive use of pesticides. In Malang regency, most farmers still use pesticide from lindane and dieldrin types.

Therefore, it could be concluded that soil and water pollutions in farming land in Malang regency was quite high where pesticide residue exists in grass feed although farmers did not use any pesticide in its growing system. Besides, organichlorin residue in forage or straw was not derived from direct usage or contact with pesticide. The residue presented as the result of the long process of metabolism inside the soil, water, as well as air circulated throughout the entire planting processes, thus, the residue lost its original form, structure, and fate (Indraningsih, 2003; Pakdesusuk *et al*., 1998, Glasgen *et al*., 1999).

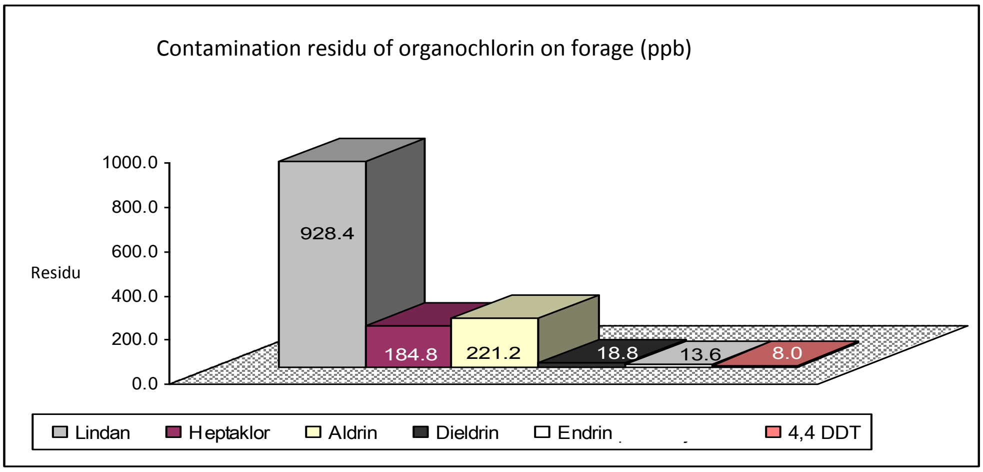

Figure 1. Profile of Pesticide Contamination in Forages

Figure 2 exhibits a very high contamination of 6 types of pesticide residue in concentrate feed. The highest amount of contamination is Heptachlor pesticide as much as 12.30 ppb or 0.06 ppm, exceeding the highest safety limit of food product by Hazzard that is 0.01 ppm. It is in line with Zigterman and Allison (2005)'s assertion that the maximum chlorine residue in food product is 0.001 ppm.

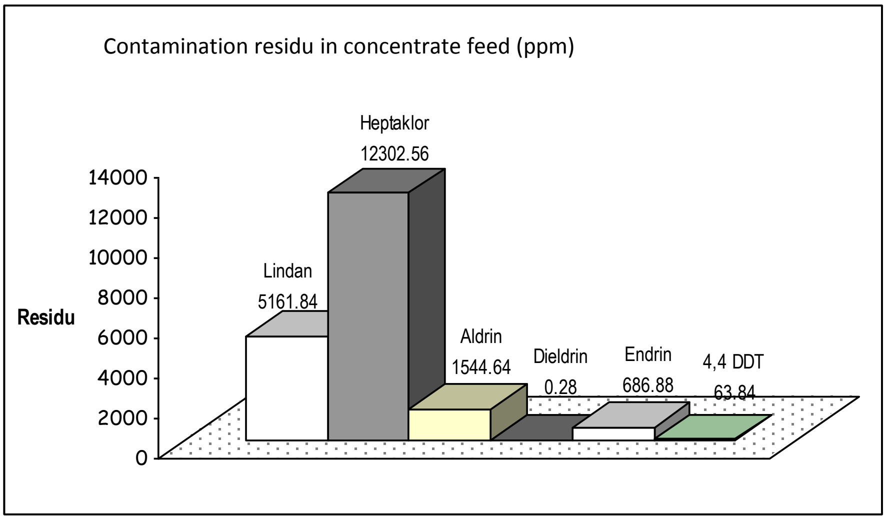

Figure2. Graphic of Pesticide Contamination in Concentrate Feed

The high level of pesticide residue in concentrate was predicted due to its raw materials which were mostly compiled from farming products and their residues. Feed materials used in the formulation of dairy cow concentrate feed produced by KUD both in research target area or in most area in Malang regency were derived from: corn, pollard, rice bran, soybean residue, *kapuk* seed peanut meal and beer dregs. Several materials such as corn, rice bran, and soybean residue were about 70% of the total material used; whereas most of the farming systems of corn, rice, and soybean utilized several types of pesticides intensively.

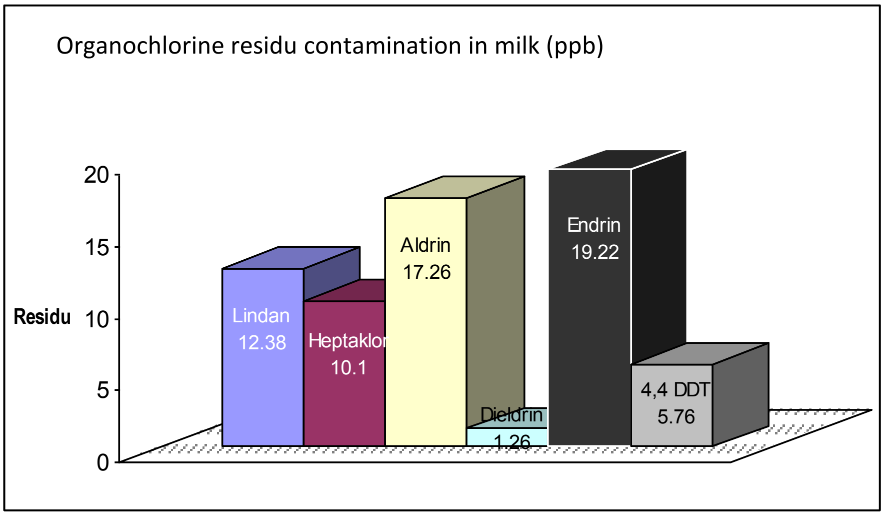

Figure 3. Profile Graphic of Pesticide Contamination in Milk Product

Figure 3 showed the contamination of 6 types of organochlorin pesticide residues that was still high and higher than the recommended ISO standards for food products in the amount of 10 ppb. While organochlorin compounds detected were compounds that were not easily degraded. It is dangerous to humans who consume it because it would remain in the body and interfere with human health.

Some organochlorin pesticide such as aldrin, endrin, and DDT were relatively high although the amount of the substance in the feed was less or undetected. Aldrin, endrin, and DDT pesticides are soluble in the water and bound with soil particles which are brought later to the water absorbance process and existed in dairy cattle water source. Therefore, contamination resource was not only from forage and concentrate. Pesticide with high persistency like aldrin, endrin, and DDT might infiltrate food chain by only small amount and experience biological magnification up to a dangerous level. If aldrin enters human tissue, it would be converted directly to dieldrin and dissolved in body fat (Ishii *et al.*, 1994; Glasgen *et al.*, 1999 and Zigterman and Allison, 2005).

Relationship Pattern of Pesticide Contamination between Forage and Concentrate and Milk

The study result proved that there were 6 types of pesticide that significantly affected the relationship pattern between lindane and heptachlor from forage and concentrate towards dairy milk, as presented in **Table 1.** Observing the regression line pattern, the pesticide contamination in milk in **Figure 4, Table 2** explained the presence of lindane and heptachlor pesticide contamination in milk. The level was affected by pesticide content from forages and concentrates.

Table. 2. Regression Line and Pesticide Contribution of Forages and Concentrates towards Milk's Pesticide Contamination

Types of Pesticide	Regression Lines	Contributions	
		K	H
Haptaclor	Y = $0.001x_1$-$0.591x_2$ + 13.69	46.91	53.09
Lindan	Y = 3.020 + 0.001x1 + 0.018x2	87.65	12.35
Aldrin	Y = -$0.004x_1$ -$0.148x_2$ + 65.436	88.71	11.29

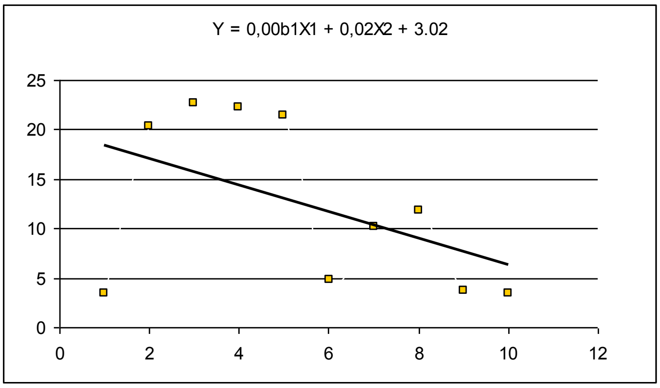

Figure 4. Regression Line and Pesticide Contribution of Forages and Concentrates towards Milk's Pesticide Contamination

Each type of pesticide has different pattern. Lindane's contribution to milk was affected by its amount from concentrate feed as much as 87.65% and from forages as high as 12.35%; whereas heptachlor in milk was affected by its amount from forages and concentrates as much as 53.10% and 46.90%. Aldrin contribution in milk was determined by aldrin concentrate 88.71% and forages 11.29%.

Based on the result from the previous chapter, dieldrin, endrin, and DDT pesticides were detected in large amount, especially in milk, although the percentage in forages and concentrates were low. It could be explained since the result of regression analysis did not give significant effects or contribution. Therefore, it can be assumed that the three pesticide contamination was caused by other factors including drinking water. Pesticide contamination in the soil, crops, and cattle might occur through a complex and dynamic mechanism of the physical processes, including chemical mechanisms and biological absorption, volatilization, both chemical and biological degradation, the flow rate of the soil surface, as well as the leaching to the consumption of the plant. Naturally, pesticide binds soil particles, especially organic matter and soil minerals (Koskinen and Harper, 1990) with various mechanisms depending on the surface area and the characteristics of the pesticide (Kookana and Aylmore, 1993).

These results became the basis theory that the future projected formula cannot be made in the form of biostarter for fermented feed but it must be in the form of probiotics to improve rumen fermentation, which can degrade pesticide contamination from various sources entering the body of the livestock either from feed, drinking water, or air.

The Effects of Probiotics Addition towards Milk Production and Fat Level

A study result on probiotics addition treatment on milk production and milk fat level was presented in graphic shown in Figure 5. Milk production increased significantly that was about 2-3 liters from the control or between 30-50% rises from the control.

This result indicated that probiotics improve nutrient digestibility in the rumen, especially polysaccharides as ruminant energy source, thus, increasing the proportion of propionic acid for the milk production and probiotics with its ability to synthesize NH3 into proteins. As the result, it intensifies protein synthesis of microbial rumen which further increases milk production.

An increase in milk production would generally lower the fat content of milk, as also occurred in this study. However, a decrease in milk fat content was not significantly different between the control and probiotic treatment sample that is an average of 4% for dairy products and milk from Jabung KUD, and 3,9% for dairy products from public farms. The fat content of milk is affected by the proportion of acetic acid as the product of crude fiber synthesis in forages. With the increasing digestion, polysaccharides tend to increase propionate proportion and lower acetate level. However, the milk fat content of the resulting treatment was still far higher than the standard fat of dairy company.

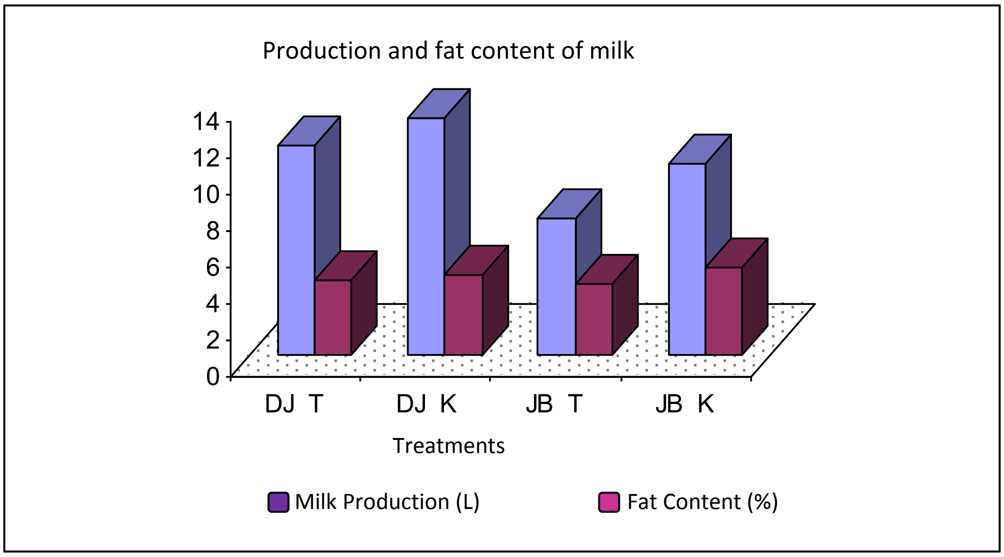

Figure 5. The Effect of Probiotics Addition towards Organochlorin Residue Content of Milk

The Effects of Probiotics Addition towards Organochlorin Residue Content

The study result of organochlorin residue detection on dairy cow milk product was presented in Figure 6.

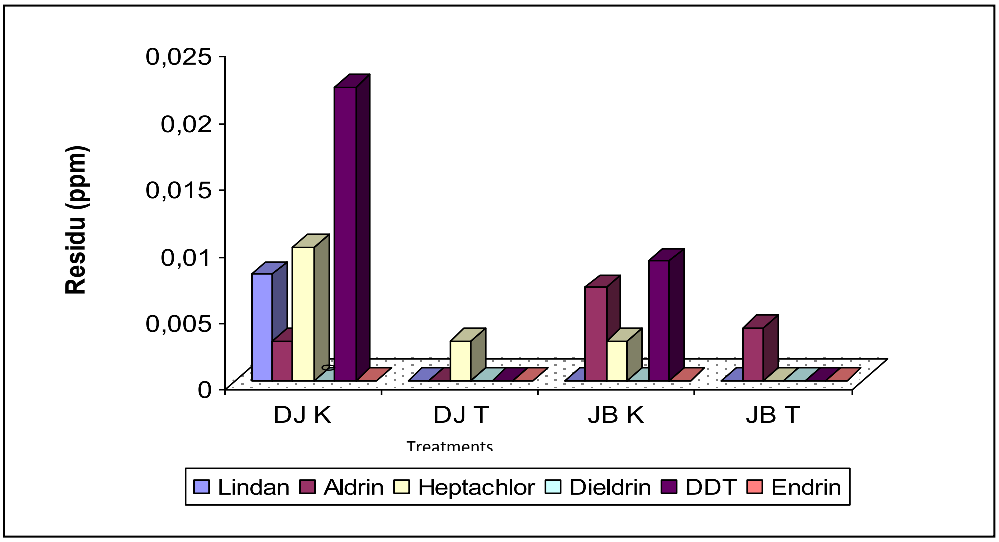

Figure 6. Organochlorin Residue Content in Milk

Residue content graphic in Figure 11 portrays that an addition in probiotics by 1% from concentrate feed might degrade Lindan, Aldrin, Dieldrin, DDT and Endrin up to 100%. The result of the real research of this was able to eliminate 5 pesticide residue types within 7-day incubation. It means that probiotics activity is higher in the anaerobic condition and the probiotics association with rumen microbe increases organochlorin degradation inside the rumen so that pesticide residue will no longer be detected in milk.

Aero bacteria and fungus which have oxidative ability in their enzyme systems are generally able to degrade organochlorin through the mechanism of mineralization (Bogan, Lamar and Hammel, 1996; Bogan and Lamar, 1996). A study result by Prihartini, *et al.* (2006) states that isolates has positive interconnection properties to degrade lignin and organochlorin. The degradation of lignin is as fast as organochlorin.

The result of the study is in accordance with previous assertion where microbes capable of degrading organic material such as lignin can also degrade synthetic organic materials. Mineralization of organochlorin 2,4-DCP and 4-CP was high on the media using organic lignin materials, while high 2,4-DCP can be generated from organic matter such as straw after 21 day incubation. Organochlorin mineralization is also high on fermented hay; the growing microflora will remodel organic materials from straw to produce initial seed in biological and enzymatic processes during organochlorin compound degradation (Benoit *et al.,* 1996).

CONCLUSIONS AND SUGGESTION

Conclusions

The conclusions formulated from the research are:

1. Feed and dairy or milk product was detected to contain 6 types of organochlorin pesticide residue such as lindan, heptachlor, aldrin, endrin, diendrin, and 4.4 DDT. Pesticide contamination source in milk was not only from feed, but also from some other sources. Pesticide has undergone changes from its original compounds into more harmful compounds.
2. Probiotics addition in concentrate feed for 1% could increase milk production by 30-40% per-day and reduce organochlorin pesticide residue in milk for about 60-100%.

Suggestion

The recommended suggestion is that the best probiotics usage level in feed is 1% from the overall concentrate feed.

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