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THE PRESENCE OF PLUMBUM (Pb) AND CADMIUM (Cd) HEAVY METALS OF BROILER CHICKEN

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Abstract

The level of meat production from purebred chickens in East Java Province from 2009 to 2019 reached 510,535.29 tons. The existence of heavy metal contamination in chickens are dangerous for human health due to the lack of good facilities and infrastructure on broiler farms including land and locations that must be environmentally friendly, and when rearing chickens in paying attention to the needs of water and feed for broiler chickens that are not polluted by heavy metals. The objective of this study was to describe the levels of heavy metals in chicken meat at X Chicken Farm in Kertosari Village, Pakusari District, Jember Regency. This research was a type of descriptive research. The subjects of this study were 20 samples of broiler chicken, well water, and 4 respondents. The sampling technique used purposive sampling. Data analysis used descriptive to describe the use of chicken feed, sources of drinking water, and the presence of heavy metal levels of Pb and Cd in chicken. The result indicate that as many as 20 samples of chicken meat contained levels of heavy metals Pb and Cd below the quality standard values according to Indonesian Nasional Standard (SNI) 7387:2009), namely (pb 0.3/kg) and (Cd <0.0200) while for water drinking water used comes from drilled wells containing Pb 0.001 mg/l and Cd 0.001 mg/l..

Keywords: Broiler Chicken; Heavy Metals; Plumbum (Pb); Cadmium (Cd); Drilled Wells

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INTRODUCTION

Broiler chicken business is a business related to cultivation activities so the breeders should understand it. The level of meat production from purebred chickens in East Java Province from 2009 to 2019 has been higher, reaching 510,535.29 tonnes (Central Bureau of Statistic, 2020). Based on research by (Pratama et al., 2015), the consumers prefer the chicken rib than the thigh because the rib has a large amount of meat and its texture is denser than the texture of the other chicken parts such as the thigh. According to the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 31 of 2014 concerning Guidelines on how to properly cultivate broiler and laying hens, the infrastructure in broiler farming that must be considered such as land, location, energy sources, building size, and when rearing is the need for water and broiler chicken feed.

Plumbum (Pb) and Cadmium (Cd) are heavy metal environmental pollutants which are toxic. The heavy metal Pb has properties as a calcium antagonism and can inhibit calcium metabolism. The standard adult blood lead level from the World Health Organization (WHO) is 20 µ/dL. Pb can enter the body through the respiratory tract, absorption and digestive tract (consumption). As much as 90-95% of Pb that enters the body is absorbed and accumulates in the bones. Lead levels in the blood can significantly interfere with the function of osteoblasts, osteoclasts and chondrocytes, causing osteoporosis (Moelyaningrum & Pujiati, 2015). Exposure to high Pb in the environment will cause calcium metabolism in the process of remineralization of teeth by calcium and phosphorus in saliva cannot take place optimally, demineralization will continue so as to increase the risk of dental caries. Children who have low blood lead levels (<10 µg/dL) rarely suffer from dental caries compared to children who are exposed to high blood lead levels (≥10 µg/dL) (Pb lead and dental caries journal). Cd levels can accumulate in the human body over time through consumption of foods containing cadmium and lead to the risk of chronic toxicity in case of excessive intake. Cadmium (Cd) is the second most widespread heavy metal pollutant in the world.

Broiler chicken are usually often consumed by humans. The presence of Pb and Cd in chickens can cause health problems, one of the factors that can

cause Pb contamination in chickens is derived from dietary factors. Based on research by (Dwiloka et al., 2012), significantly Pb content in liver and gizzard broiler chicken can be affected by the type of feed. The period of raising broiler chicken to harvest is 35 days.

Based on Dwiloka et al., (2012) research results, there are heavy metal contents of Cd, Fe and Zn in fresh broiler rib and thigh and have values above the Maximum Residu Limit (MRL) based on the standards of the Ministry of Health of the Republic of Indonesia, INS-01-6366, WHO-JEFCFA and the World Health Organization. The content of the heavy metal Cd in chicken rib is relatively high at 0.9746 ppm. It is due to the feed given to chicken contains high levels of Cd and Fe and the possibility of heavy metal contamination from the air. Based on research results (Sulistiawati et al., 2018)that the heavy metals Pb, Cd, Mg, and Zn contained in the blood of beef cattle raised around the landfill have high Residue Maximum Limit (MMR) values of 15.0187 mg/kg, 0.9647 mg/kg, respectively, 421.5435 mg/kg and 3.8823 mg/kg (BMR 0.2; 0.0052; 99 and 13 in mg/kg).

Pollution of livestock meat by heavy metals can pose a danger to human health. The results of research on Cd intake dose and exposure duration had a very significant effect on Cd levels in the liver. Poisoning caused by Cd can be acute and chronic. Chronic toxicity of Cd can damage the body's physiological systems. The toxic effects of heavy metal can block the work of enzymes thereby disrupting the body's metabolism, causing allergies and causing other health symptoms that are harmful to the human body (Kafiar et al., 2013). Based on the background of the existing problems, the researchers were interested in conducting further research entitle Presence of Heavy Metals Pb and Cd in Broiler Chicken. This study aims at examining the levels of metals in broiler chicken at chicken farms in Pakusari District, Jember Regency.

RESEARCH METHOD

The research design was quantitative descriptive. The research site was conducted at a broiler farm located in Krajan Subdistrict, Kertosari Village, Pakusari District, Jember Regency. The sample population of all broiler chickens was 10,000 and well water. The broiler chicken samples were taken when the chickens were ready to be harvested from 2 cages with 10 broiler chickens each randomly so that the total sample was 20 chicken with a meat weight of 100 grams

per sample. Water sample was taken from drilled wells used as drinking water in broiler farms. The sampling technique was purposive sampling technique. The inclusion criteria in this study were: broiler weight 1-1.5 kg; agile; have sparkling eyes; the condition of the cloaca and rectum being large, tender, reddened, and moist, red comb, has a soft skin and fresh. Sample laboratory testing used the AAS Graphite Furnace method which refers to the Indonesian National Standard (SNI) 354.5:2011. Data analysis was narrated descriptively. Ethical Exemption No. 64/KEPK/FKM-UNEJ/VI/2021 from the Health Research Ethics Commission, Faculty of Public Health, University of Jember.

RESULTS AND DISCUSSION

Heavy metal content of Pb and Cd in drilled wells as drinking water for broiler chickens

Provision of drinking water using an automatic gallon type or nipple which is always available at all times. The content of heavy metals Pb and Cd in drilled well water can be seen in table 1, the physical condition of the drilled well in table 2 and the amount of drinking water consumption for broiler chicken for 10,000 chicken in table 1 below:

Table 1. Content of Heavy Metals Pb and Cd in Drinking Water Sources for Broiler Chicken

Source of drinking water	Pb Heavy Metal	Heavy Metals Cd
Bore Well Water	0.001mg/L	0.001mg/L

Source: Primary Data, 2022

Based on table 1, the results of laboratory tests on drinking water for chicken on x broiler farms in Kertosari Village, Pakusari District, Jember Regency were obtained with results of a heavy metal content of Pb of 0.001 mg/l and a heavy metal content of Cd of 0.001 mg/l.

Table 2. Physical Conditions of Bore Well Water in Broiler Farms

Physical condition	Qualify	Not eligible
Well Distance		√
Well Floor	√	
Strainer and pipe	√	
Water Resistant Coating	√	
Well Depth	√	
Wastewater Disposal Channel (SPAL)	√	

Source: Primary Data, 2022

Based on table 2, the results of observation regarding the physical condition of the borehole water for the variable distance of the well did not meet the requirements because the distance between the well and the pollutant source, namely catfish ponds, had a distance of less than 10 meters. In other physical condition variables, such as well floors, filters and pipes, watertight layers, well depths and sewerage meet the requirements.

The existence of a borehole water source on the farm was close to the Pakusari Final Disposal Site (Landfill) which had a distance of 145 meters. The floor of the well on the farm has a height of 25 cm and a diameter of 1.5 m. The watertight layer of the well is 3 meters deep from the surface of the well and the layer is watertight. Making wells was also equipped with a strainer and using PVC pipes for water pump lines. The depth of the well is approximately ≤30 meters deep and the sewage canal is made watertight and the water canal is smooth and there is no garbage in the sewage canal. The physical condition of the borehole water source was not cloudy, odorless, tasteless, and colorless.

Table 3. Consumption of Drinking Water for Broiler Chickens

Age To-(Day)	**Consumption of drinking water (liters/10,000 head/day)**
1	428
7	1120
14	2380
21	3332
28	3773
35	4560

Source: Primary Data, 2022

Based on table 3. Provision of drinking water when the Day Old Chicken arrives is given 2% sugar water with the aim of providing energy to the DOC during the trip. Drinking water was given continuously or can be called ad libitum. Then the next day the sugar water was replaced with drinking water with the addition of vitamin to accelerate growth and vitamin to increase endurance in chicken.

Drinking water is one of the important things in raising broiler chickens, since the body composition of chickens consists of 64% water. The frequency of giving drinking water to

broiler chickens by breeders was carried out all the time and the amount met the needs of livestock. The provision of drinking water for chickens used an automatic pipe system so that the need for water was always there. It is in line with research by (Moelyaningrum & Pujiati, 2015), drinking water was given all the time and could not be empty, otherwise the feed tube cannot be completely filled.

Drinking water for livestock must also meet the quality standards for drinking water for chickens, according to Poultry World 2020 the maximum lead level in drinking water for livestock chickens is 0.02 mg/L. Meanwhile, the level of cadmium heavy metal found in well water used as drinking water for livestock is 0.001 mg/L (Cunha et al., 2020).

Existence of Pb and Cd Heavy Metal Levels in Broiler Chicken Breast Section

The results of the detection of heavy metal levels of Pb and Cd in broiler chicken rib were taken from farm X in Kertosari Village, Pakusari District, Jember Regency are as follows:

Table 4. Heavy Metal Content of Pb and Cd in Broiler Chicken Samples

Sample	Pb (mg/kg)	Cd (mg/kg)
Sample 1	<0.8100	<0.0200
Sample 2	0.0243	<0.0200
Sample 3	<0.8100	<0.0200
Sample 4	<0.8100	<0.0200
Sample 5	<0.8100	<0.0200
Sample 6	<0.8100	<0.0200
Sample 7	<0.8100	<0.0200
Sample 8	<0.8100	<0.0200
Sample 9	<0.8100	<0.0200
Sample 10	0.0103	<0.0200
Sample 11	<0.8100	<0.0200
Sample 12	<0.8100	<0.0200
Sample 13	0.0438	<0.0200
Sample 14	<0.8100	<0.0200
Sample 15	<0.8100	<0.0200

Sample	Pb (mg/kg)	Cd (mg/kg)
Sample 16	<0.8100	<0.0200
Sample 17	<0.8100	<0.0200
Sample 18	<0.8100	<0.0200
Sample 19	<0.8100	<0.0200
Sample 20	<0.8100	<0.0200

Based on table 4, the results of laboratory tests for Pb and Cd levels in broiler chicken using the AAS destruction test method at the Center for Enviromental Health Engineering and Disease Control Laboratory in Surabaya. Based on the results of the laboratory test, the content of the heavy metal Lead (Pb) in 20 samples of chicken was below the detection limit of <0.8100 mg/kg. Likewise the results obtained for the content of the heavy metal Cadmium (Cd) in 20 samples of chicken meat were below the detection limit of <0.0200 mg/kg. According to SNI 7387:2009 concerning Maximum Limits of Heavy Metal Contamination in Food, the content of heavy metal content in the rib part of the broiler chicken sample was below the quality standard value set for meat food products and their processed products. Where the limit for metal content in meat for the heavy metal Lead (Pb) was 1.0 mg/kg and the heavy metal Cadmium (Cd) was 0.

According to FAO/WHO through JECFA, the normal limit for tolerance of Cd metal levels in food that enters the human body is 400-500 μg or 0.4 mg per week in people weighing 60 kg. This provision was determined with the assumption that the concentration of Cd in food that entered the human body was approximately 4.5% and would remain in the body. The concentration of heavy metal Cd was <0.01 mg/kg, so the Maximum Weekly Intake (MWI) value or the safe limit for human consumption with a body weight of 60 kg per week based on the MTI is 80 mg/week.

This is in line with research (Megabuana et al., 2020) showed that the average Pb content of chicken meat was 0.76 mg/kg. The source of pollution is the presence of heavy metals in breast broiler meat samples caused by environmental pollution. Environmental pollution in the broiler X breeding area can be caused by the location of the farm which was close to the Pakusari Landfill and there were

rice fields around the farm. Based on research by (Anshar et al., 2018) there is a relationship between the presence of contamination of feed and drinking water sources of chicken with the content of the heavy metal cadmium in broiler chicken body. It can be attributed to the content of heavy metals in polluted farm well water. Study by (Qadriyah et al., 2019) indicated that the distance between the community well and the landfill was 0-500 meters in the area where the final waste processing in Jember Regency contained the heavy metal Cd. The location of farms surrounded by rice fields can also add to heavy metal pollution in the area due to the use of agricultural fertilizers containing phosphates. On research by (Korish & Attia, 2020) that the litter used in broiler livestock had Pb content during the grower phase and Cd content during the finisher phase. The presence of these heavy metals in the litter was due to animal feces being contaminated with heavy metals caused by the consumption of chicken feed.

The content of heavy metals present in animal manure can accumulate in soil and water as a result of disposal of the remaining use of chicken litter and the use of compost made from chicken manure. Pollutant sources in the livestock area can cause livestock feed and drinking water to be contaminated hence it is the cause of the presence of metal levels in chicken, especially parts of chicken. The presence of metal levels in the body of chicken can be caused by consumption of drinking water, where from the results of the study in table 3 there was a metal content of Pb and Cd in the drinking water and consumption of drinking water was the most consumption compared to consumption of feed.

Consumption of drinking water containing high levels of metals over a long period of time can accumulate in the bodies of livestock. It is supported by research (Anshar et al., 2018) that the relationship between the presence of heavy metal Cd in feed and water to the presence of metal Cd in chicken organs showed a positive correlation. Drinking water in chicken has a higher correlation than chicken feed. Explanation on US EPA (2006) inside (Anshar et al., 2018) that the heavy metal content of Cd in water was much more easily absorbed by the body than the heavy metal cadmium in feed (5% in water and 2% in feed). It indicates that drinking water has a greater effect on the presence of metal levels in broiler chicken meat. Heavy

metal compounds enter the digestive tract of animals through contaminated food and drink and the respiratory tract through contaminated dust particles. The toxicity of heavy metals can also be influenced by several factors, including the length of exposure to heavy metals (such as feed, water or air), the amount of metal ingested, the age of the animal and the species, the condition of the animal's body immunity and the ability of the body's tissues to consume these metals. .

The heavy metal Cd enters the digestive tract of livestock by ingesting feed and drink through the contaminated food chain and through the respiratory tract through dust particles contaminated with heavy metals. Furthermore, the heavy metal Cd will be absorbed through the blood which will be distributed into the tissues. Two organs that can accumulate heavy metals are the liver and kidneys (Ukpe, 2018).

Accumulation of heavy metals in animal bodies can cause damage to intestinal epithelial cells and pathophysiology in the form of inhibition of enzyme activity in poisoned animals, heavy metals such as Cd can cause barriers to enzymatic activity which can inhibit livestock production and reproduction. The pathophysiological effect of inhibition of enzymatic activity is to cause disturbances in the metabolism of nutritional elements, causing growth disturbances in animals. According to Research Mathaiyan et al., (2021), that the average concentration of Pb found in edible parts of broiler chickens such as breast, liver, neck and kidney has a high lead content.

Consumption of chicken containing heavy metals below the quality standard value when consumed for a long time can cause concentrations of heavy metal levels of Pb and Cd to increase as an effect of the bioaccumulation process. Exposure to cadmium heavy metal that enters the human body has a half-life of 7-16 years, so it will be difficult to reduce the accumulation of cadmium heavy metal in the body. The heavy metal Cd has a high toxicity causing toxic effects which are influenced by the level and duration of exposure. Cadmium which accumulates in the human body can cause toxic effects such as nephrotoxicity, carcinogenicity, teratogenicity and reproductive endocrine toxicity. A single dose of the heavy metal cadmium can induce gastrointestinal disturbances, whereas repeated exposure will cause disturbances in kidney function. If it continues to be consumed can cause

clinical fanconi kidney syndrome which can eventually lead to kidney failure and can develop into chronic kidney disease (Qadriyah et al., 2019).

The heavy metal Pb is a dangerous metal for broilers because it can have a toxic effect in the body if it accumulates excessively and is not easily excreted from the body (Hester, 2016). Then it will be distributed through red blood cells or albumin. Most of the amount of lead present in red blood cells will bind to high molecular proteins in the body, while low molecular proteins will bind to hemoglobin. Most of the lead that enters the body will bind to hemoglobin rather than the red blood cell membrane (Andjelkovic et al., 2019).

Heavy metal toxins will be absorbed into the body and distributed through the bloodstream and reach the organs where the effects will occur. Lead toxicity, also known as lead poisoning, can be either acute or chronic. Acute can cause loss of appetite, headache, hypertension, abdominal pain, impaired kidney function, fatigue, difficulty sleeping, arthritis, hallucinations and vertigo. Chronic exposure can cause mental retardation, birth defects, psychosis, autism, allergies, dyslexia, weight loss, hyperactivity, paralysis, muscle weakness, brain damage, kidney damage and can even cause death. Based on Widyasari et al., (2013) chronic exposure to Pb can result in lethargy, fatigue, irritability, loss of libido, gastrointestinal disorders, infertility in males, menstrual disorders and spontaneous abortion in women and teratospermia. Lead will be absorbed and retained by soft tissues and bones but will slowly be excreted through the kidneys (Suganya et al., 2016). According to research by (Moelyaningrum & Pujiati, 2015) 90-95% of lead that enters the human body can accumulate in the bones and in small amounts settles in the brain.

The half-life of the heavy metal lead in blood is around 25-30 days and 10-30 years in bone and 40 days in soft tissue (Schrenk & Cartus, 2017). On research by (Jaiswa et al., 2017)showed that the presence of heavy metal lead levels in broiler drinking water of 200 mg/L for 42 days continuously would cause performance disturbances in chickens such as decreased growth rate, weight loss, progressive muscle weakness, nervous system damage, lethargy, leg paralysis, diarrhea, regurgitation, anorexia, drooping wings and paralyzed legs. The effect of lead exposure on humans could cause nervous system

disorders that have a high risk of reducing intelligence (IQ) and behavioral disorders in infants and children.

CONCLUSION

Pb and Cd levels in broiler chicken as many as 20 chicken samples were below the quality standard value set by SNI 7387:2009 concerning Maximum Limits of Heavy Metal Contamination in Food, the content of heavy metal content in broiler chicken samples for Cd was 0.3 mg/kg and Pb 1.0 mg/kg.

Drilled well water on this farm was obtained with a heavy metal content of Pb of 0.001 mg/l and a heavy metal content of cadmium of 0.001 mg/l. Laboratory test results for levels of Pb and Cd metals.

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