Assessment of heavy metal pollution in lung and kidney of broiler and it’s correlation of water and animals feed

A R Anshar¹,², H Maheshwari² and H S Darusman¹

¹Division of Pharmacology and Toxicology, Department of Anatomy, Physiology and Pharmacology, Faculty of Veterinary Medicine IPB University (Bogor Agricultural University, Bogor Indonesia)
²Division of Physiology, Department of Anatomy, Physiology and Pharmacology, Faculty of Veterinary Medicine IPB University (Bogor Agricultural University, Bogor Indonesia)
³Veterinary Medicine Study Program, Faculty of Medicine, Hasanuddin University, Jalan Perintis Kemerdekaan KM 10, Makassar, Indonesia

E-mail: ameliaanshar@gmail.com

Abstract. Cadmium is non-essential anthropogenic environmental pollutant present in soil, water, air and food. Consistency of consuming cadmium leads physiological disorders in chickens and also in humans as the highest food chain. The aim of this study was to analyze the profile of cadmium content in environmental samples (feed and water) by correlating the degree of contamination in chicken body. For this study, 30 sample of feeds and water and 60 organs (lung and kidney) have been examined. The results showed level of cadmium in feed between 0.009 - 0.202 mg / kg and 0.0068 - 0.0096 mg / l of cadmium in the water. Cadmium in the lungs and kidneys was positively contaminated by cadmium with a range of 0.438 - 0.655 mg / kg and it was significantly different (p <0.05) among the organs. A strong positive correlation was found between cadmium and water levels in renal (r = 0.925). In contrast, a weak positive correlation (r = 0.624) was found in the relationship between cadmium in feed and lung. As the conclusion, cadmium concentration in the poultry feed and drinking water increased significantly to the concentration of cadmium deposited in organs.

1. Introduction

Poultry sectors specially broiler in Indonesia according to Directorate General of Animal Husbandry and Animal Health in 2017 showed broiler have progressed during last 5 years with increase 4.54% from previous year. In addition, public awareness of the urgency of food safety is also increasing. Recently, increasing of the incidence of poisoning cases due to heavy metal contamination in foodstuffs [1]. This is supported by the development of industry sectors in large-scale that directly have a negative impact. Cadmium (Cd) is one of the non-essential anthropogenic metals that is toxic to the body at even low concentrations due to its accumulative nature [2,3].

Consumed cadmium will not show health disorders drastically seen first or second days after consumed contaminated food, but the appearance of clinical disorders will appear in the long term [4]. This is due to the cadmium nature that tends to accumulate in the individual body and has a fairly high half-life of 7 to 16 years [5]. Indonesian National Standard (SNI) 7387: 2009 sets cadmium exposure standard in drinking water 0.003 mg / l, in chicken bran 0.2 mg / kg and 0.5mg / kg poultry or gan. Limit tolerance of cadmium consumption in its use chronically so as not to cause health problems is 0.0002 mg / kgBB / day.
The accumulation of cadmium in chickens in large quantities will show decrease or inhibition of weight gain and bone growth and may decrease egg production [6], liver damage, heart failure, brain damage and disorders of the reproductive organs (ovaries and testes) is carcinogenic, interferes with the cardiovascular system, damage to the nervous system, damages the endocrine glands, liver and kidney damage, prostate, and pancreas [7–15].

Most of cadmium metal contamination occurs in broilers through the feed. Chicken feed consists of several types of mixtures such as grains, animal flesh and others [6]. Cadmium may also be derived from supplementation in phosphate minerals and calcium supplementation of 0.5 mg / kg. Meanwhile, groundwater and air contaminated by cadmium metal due to decreased environmental quality will have an impact on environmental health.

Based on the phenomenon that susceptible chicken feed is contaminated by cadmium metal, it is interesting to study the process of environmental pollution related to chicken health status. Therefore, it is deemed necessary to conduct a study to analyze the profile of cadmium content in feed and chicken water by correlating the degree of cadmium contamination in organs.

2. Materials and methods
Sampling technique using Simple Random Sampling procedure. The study used ± 30 chickens. Feed samples were taken as much as 50 g at each flock where the chicken samples were previously taken. Water is taken from the well as much as 150 ml. In organs are taken such as lung and kidney.

Testing and determining levels of heavy metal cadmium is referred to the Indonesian National Standard (SNI) 01-2354.5-2011. Weigh ± 10 g organs (± 100 ml of water) into the Erlenmeyer, add 5 ml of HNO₃ and 1 ml of HClO₄ to stand by one night. The next day heated at 100°C for 1 hour 30 minutes, the temperature was increased to 130°C for 1 hour, then the temperature was increased again to 150°C for 2 hours 30 minutes (until yellow vapor runs out, if there is yellow steam, heating time add more). After the yellow vapor runs out, the temperature is increased to 170°C for 1 hour, then the temperature is increased again to 200°C for 1 hour (white steam is formed). Destruction is complete with the formation of white precipitate. Add aquadest until the mark is tarred, then homogenized. Filter the sample using paper Whatman no.42 into a 100 ml reaction tube, then sample ready for analysis using SSA with wavelength of 228.8 nm.

The data were analyzed using Anova One Way, T test and simple linear regression analysis. The results of the analysis are expected to provide an overview of the relationship between contamination occurring in the feed and water to the degree of contamination of heavy metal cadmium in chickens to be consumed by the community.

3. Results and discussion
3.1. The farms condition
Observations in this study from Sidrap and Pinrang were used in this study is Lawhman MBAI 202 Platinum broiler strain. The farm that comes from Sidrap district has an outside area slightly larger than the previous stable. Wide area of the farm reach 910 m² with number of chicken population about 6000 until 7000 tail. The age of the cage when 9-year-old sampling is established since 2008. Location perched at Sereang sub-district of Maritengngae Sidrap district with distance 7.9 km from district center of Watang Pulu district Sidrap. surroundings of the farm are quite far from Sidrap district axis road, with the condition around the farm surrounded by paddy fields and close to the rice mill. The characteristics of the environment will greatly support the quality of the air, so that will affect the health of livestock.

Farm from Pinrang district has an area of 862 m² and is located in Corowali sub-district, Paleteang sub-district, Pinrang district. The livestock population reaches about 4000 to 5000 broilers. These farm began to be operated since March 2006 and is located 8.1 km from Pinrang district government. This is right on the side of the road connecting Corowali urban village and Mamminasae urban village. The farm area is flowed by irrigation connected by the river Saddang, so that the water content in the wells of drinking water sources of livestock will be affected by the flow of irrigation around the farm.
3.2. Cadmium in chicken

The samples of muscle and liver indicate that cadmium content was detected in each organ tested with different cadmium concentrations. Mean of cadmium concentration in chicken presented in Table 1 and Table 2 there is different significantly (p <0.05).

**Table 1.** The cadmium metal deposits (Mg / Kg) in broiler from Sidrap District

| Samples | Cd Concentration | Lung | Kidney |
|---------|------------------|------|--------|
| 1       | 0.547*           | 0.514* |
| 2       | 0.589*           | 0.522* |
| 3       | 0.6*             | 0.531* |
| 4       | 0.552*           | 0.519* |
| 5       | 0.539*           | 0.512* |
| 6       | 0.593*           | 0.522* |
| 7       | 0.609*           | 0.61*  |
| 8       | 0.559*           | 0.52*  |
| 9       | 0.605*           | 0.609* |
| 10      | 0.567*           | 0.521* |
| 11      | 0.548*           | 0.516* |
| 12      | 0.538*           | 0.511* |
| 13      | 0.478*           | 0.49*  |
| 14      | 0.547*           | 0.512* |
| 15      | 0.549*           | 0.519* |

Mean 0.561±0.033* 0.528±0.034b

Description: *cadmium concentration calculated per wet weight of mg / Kg, value obtained from 3 replicates, *cadmium residue above normal threshold > 0.5 ppm (SNI 7387: 2009), limit detection = 0.001 mg / Kg. The same superscript letter on the line showed results are not significantly different (p > 0.05)

**Table 2.** The cadmium metal deposits (Mg / Kg) in broiler from Pinrang District

| Samples | Cd Concentration | Lung | Kidney |
|---------|------------------|------|--------|
| 1       | 0.488            | 0.528* |
| 2       | 0.457            | 0.499 |
| 3       | 0.498            | 0.532* |
| 4       | 0.478            | 0.527* |
| 5       | 0.505*           | 0.539* |
| 6       | 0.494            | 0.531* |
| 7       | 0.394            | 0.498 |
| 8       | 0.469            | 0.499 |
| 9       | 0.477            | 0.516* |
| 10      | 0.528*           | 0.565* |
| 11      | 0.499            | 0.539* |
| 12      | 0.477            | 0.522* |
| 13      | 0.476            | 0.499 |
| 14      | 0.478            | 0.526* |
The observation of cadmium metal in chickens in Sidrap and Pinrang districts showed a significant difference in each organ (p < 0.05). The cadmium concentration in Sidrap from the lowest concentration to the highest concentration in kidney 0.528 ± 0.034 mg / kg and lung 0.561 ± 0.033 mg / kg, while in Pinrang in the lung was 0.524 ± 0.023 mg / kg and kidney 0.581 ± 0.0276 mg / kg. In Sidrap district, lung has the highest concentrations. The lungs are susceptible organs to be contaminated because the respiratory system is the main route of cadmium entry. As much as 10% to 50% of air inhaled and contaminated by cadmium in CdO forms will be adopted, depending on the nature, particle size and duration of exposure [16].

The accumulation of cadmium in the kidney is high enough and descriptive of the results of measurement of cadmium levels in the kidney in Sidrap and Pinrang districts showed a high enough value (0.528 mg / kg) compared to cadmium in the liver in the 2 regions (0.493 mg / kg and 0.523 mg / kg). This is supported by the results of research conducted by Tampel et al. (2003) where the highest heavy metal accumulation in bone, followed by kidney and liver tissue and reproductive organs (ovarian tissue) [17–19]. Ecotoxic researchers explain that in the process of cadmium metabolism is distributed by blood to various tissues with the accumulation rate primarily being in the kidneys at the highest concentrations and then in the liver with relatively lower concentrations [20,21]. Nangkiawa et al. (2015) states the liver of one estuary accumulates a heavy metal compound because all the digestive results will be absorbed into the liver via the hepatic portal vein circulation and will enter the hepatocytes [22]. In hepatocite, cadmium will induce the synthesis of albumin and metallothionein proteins [23], which will then bind and isolate cadmium, thereby retaining the toxic effects of cadmium in the cell. However, when liver cells where cadmium is isolated die, whether through normal turnover or due to cadmium damage the cadmium-metallothionein complex will be released into the bloodstream and then accumulate in the liver and kidneys [24,25].

3.3. Correlation of cadmium in feed and water to the deposits in organs
The contamination in feed as well as in chicken drinking water sources is done by linear regression analysis to obtain information about the relationship between free variables and bound variables from samples from Sidrap district (Table 3) and Pinrang district (Table 4).

Table 3. Correlation between cadmium content in feed and water with cadmium content in chicken from Sidrap District

| Organs   | Feed   | Water   |
|----------|--------|---------|
|          | r      | R%      | r      | R%      |
| Muscle   | 0.716  | 51.32%  | 0.87   | 75.72%  |
| Liver    | 0.628  | 39.47%  | 0.925  | 85.57%  |
| Minimum  | 0.628  | 39.47%  | 0.87   | 75.72%  |
| Maximum  | 0.716  | 51.32%  | 0.925  | 85.57%  |

Description: r is the correlation value of the T test, whereas R% is the coefficient of determination. The red box showed the highest correlation value.

Based on the results witnessed a positive relationship between cadmium metal in feed and water to chicken organs. Correlation of feed and organ in Sidrap regency got result that lung has highest correlation 0.716 with determination coefficient R = 51.32% and lowest possessed by kidney organ equal to 0.628 (39.47%). Cadmium metal in drinking water has the highest correlation in renal organ with a value of 0.925. This means having a very close relationship between cadmium content in water and kidney (with determination coefficient reaching 85.57%). It is described in US EPA that the content
of cadmium metal in water is much more readily absorbed by the body than cadmium in feed (5% in water and 2% in feed). The correlation value of drinking water and lung and kidney, respectively 0.87 (R = 75.72%) and 0.925 (R = 85.57%).

| Organs   | Feed  | Water  |
|----------|-------|--------|
|          | r     | R%     | r     | R%     |
| Muscle   | 0.624 | 38.94  | 0.77  | 59.36  |
| Liver    | 0.879 | 77.32  | 0.896 | 80.37  |
| Minimum  | 0.624 | 39.47  | 0.77  | 59.36  |
| Maximum  | 0.879 | 77.32% | 0.896 | 80.37  |

Table 4. Correlation between cadmium content in feed and water with cadmium content in chicken from Pinrang District

The correlation of cadmium metal in Table 4 showed a positive result. The highest correlation value was found in the association between water and cadmium content that was able to deposited in chicken kidney of 0.925 with determination coefficient value reach 85.72% and followed by correlation value of lung 0.647 (R = 41.91%).

4. Conclusion
Cadmium metal contamination in feed and livestock water increased significantly to the concentration of cadmium metal deposited in chicken body tissues. A total of 60 organs examined consisted of 30 lungs and 30 kidneys contaminated by cadmium metal with a range of 0.478-0.609 mg / kg and a significantly different cadmium content (p <0.05) each organs. A strong positive correlation was found in the relationship between cadmium and water levels in kidney (r = 0.925), whereas a weak positive correlation (r = 0.628) was found in the relationship between cadmium metal content in feed and chicken kidney.

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