

# Food safety of milk and dairy product of dairy cattle from heavy metal contamination

**E Harlia, KN Rahmah and D Suryanto**

Faculty of Animal Husbandry, Universitas Padjadjaran, 45363 Sumedang, Indonesia

Corresponding E-mail: harliaelin@yahoo.co.id

**Abstract.** Food safety of milk and dairy products is a prerequisite for consumption, which must be free from physical, biological and chemical contamination. Chemical contamination of heavy metals Pb (Plumbum/Lead) and Cd (Cadmium) is generally derived from the environment such as from water, grass, feed additives, medicines and farm equipment. The contamination of milk and dairy products can affect quality and food safety for human consumption. The aim of this research is to investigate contamination of heavy metals Pb and Cd on fresh milk, pasteurized milk, and dodol milk compared with the Maximum Residue Limits (MRL). The methods of this researched was through case study and data obtained analyzed descriptively. Milk samples were obtained from Bandung and surrounding areas. The number of samples used was 30 samples for each product: 30 samples of fresh milk directly obtained from dairy farm, 30 samples of pasteurized milk obtained from street vendors and 30 samples of dodol milk obtained from home industry. Parameters observed were heavy metal residues of Pb and Cd. The results showed that: 1) approximately 83% of fresh milk samples were contaminated by Pb which 57% samples were above MRL and 90% samples were contaminated by Cd above MRL; 2) 67% of pasteurized milk samples were contaminated by Pb below MRL; 3) 60% of dodol milk samples were contaminated by Pb and Cd above MRL.

Key words: food safety, Pb, Cd, residue

## 1. Introduction

The quality of cow's milk is influenced by many things, including genetic, feed and management. The feed and drinking water used should be free from heavy metal contamination. Livestock farming management such as sanitation of cages, workers and equipment should be guaranteed hygiene and meet food safety requirements. Dairy cattle generally feed grass and concentrate. The main source of contamination of Pb and Cd derives from air and water pollution that contaminates soil. Furthermore, all plants grown on contaminated soil will accumulate the metals in all parts (roots, stems, leaves and fruit) [11] Pb and Cd can accumulate in enormous amounts in plants such as rice, grass, some leguminous species for feed, and vegetable [9]. Most of Cd accumulates on crops, grains and grains products [10]. Milk is an ideal source of macroelement (Ca, K and P) and microelement (Cu, Fe, Zn, Se), however addition of heavy metals might contaminated milk and dairy products reaches levels that are harmful to humans [7]. Heavy metals such as zinc (Zn), copper (Cu), chromium (Cr), arsenic (As), cadmium (Cd), and lead (Pb) are potential bioaccumulative toxins of the dairy production system as soils tend to act as long term sinks or these metals through absorption onto metal oxides, particularly iron and manganese oxides, clay minerals, soil organic material, and other forms of humified natural organic material [4]. Residue of Pb and Cd contained in the food can accumulate in the livestock and



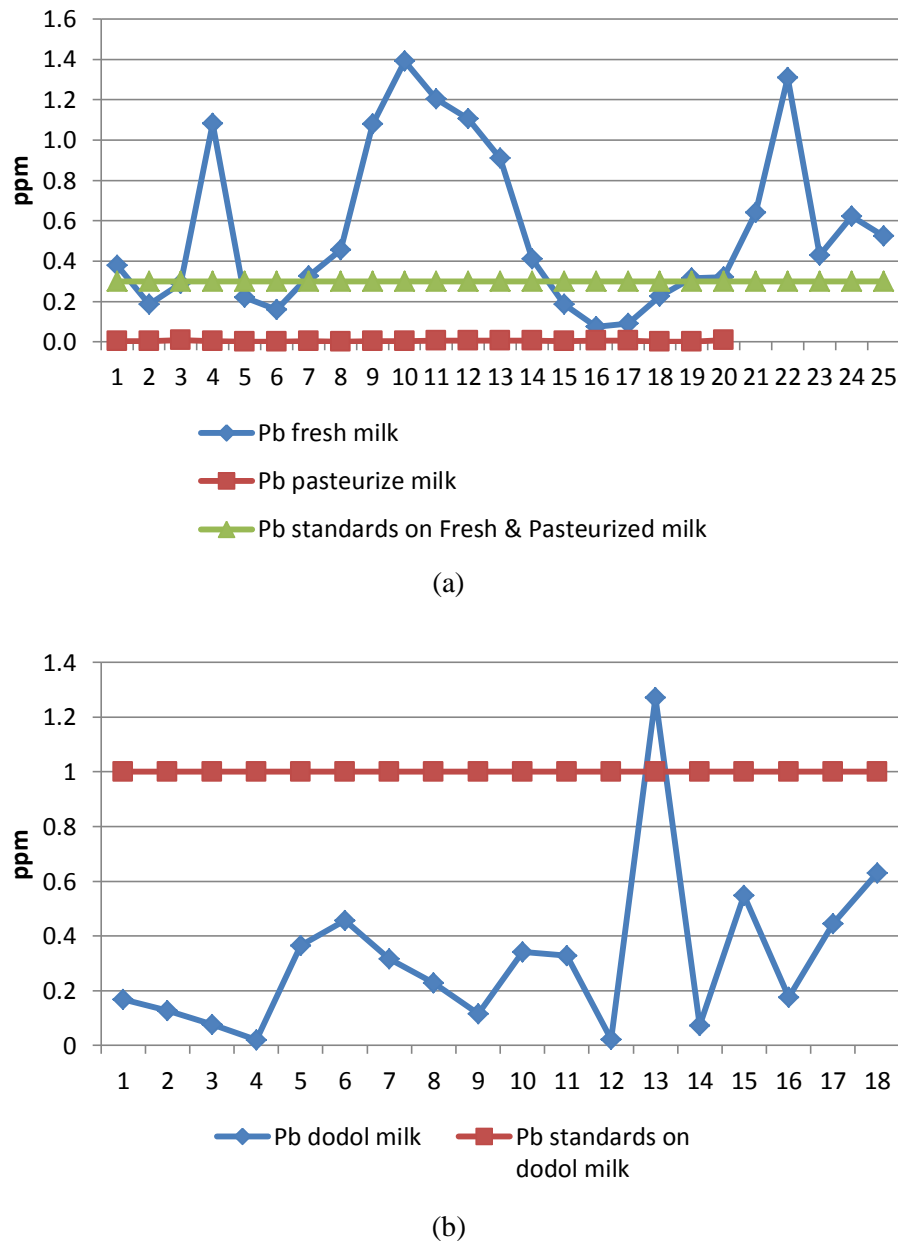
human organs, in the long run can disrupt livestock and humans health. In order to prevent the accumulation of Pb and Cd on the body is by maintaining the balance of mineral intake. Government establishes Maximum Residual Limits (MRLs) to prevent contamination of heavy metals in foods. MRLs in milk and dairy products are regulated on INS (1998) while Cd is regulated on EPA (1985). Pb standards for milk and dairy products are below 1.00 ppm (INS) and Cd maximum limit is below 0.01 ppm (EPA). Food safety on milk and dairy products is an absolute requirement that must be fulfilled by farmers. In addition on affecting human health, it also impacts on domestic and global trade and the economies of countries involved in such trade [5]. Milk and dairy products must be of good quality and free from heavy metal contamination. Therefore, this research is aimed to detect food safety on milk and dairy products based on heavy metals (Pb and Cd).

## **2. Materials and Methods**

Materials used in this research were fresh milk and dairy products. Fresh milk was obtained from 30 dairy farmers in Pemulihan Subdistrict Sumedang Regency, pasteurized milk was obtained from 3 street vendors on Bandung, dodol milk was obtained from 3 home industries in Pangalengan, with 10 repetitions for each sample. This research was an explorative study preceded by survey methods to determine sampling of milk and dairy products from dairy cow farmers, street vendors, and dodol milk industry. The parameter observed were residues of Pb and Cd in fresh milk, pasteurized milk and dodol milk. Multi Stage Sampling data obtained were analyzed descriptively, compared to the maximum limit of Pb residue regulated in INS (1998), while Cd residue compared to MRLs recommended by EPA (1985). Measurement of residual content in milk was utilizing Atomic Absorption Spectrophotometry (AAS).

## **3. Results and Discussion**

The content of Pb residue in fresh milk, pasteurized milk and dodol milk was shown in Figure 1. It appeared that most of fresh milk samples were contaminated by Pb (83%), and as much as 53% of samples exceeded MRL standards. The average of Pb content in fresh milk sample  $0.5578 \pm 0.4308$  with coefficient of variation 77.23%, the average of Pb residual content in pasteurized milk sample  $0.0047 \pm 0.0027$  with coefficient of variation 57.45 % while the average residual content of Pb in dodol milk  $0.3173 \pm 0.2990$  with a coefficient of variation of 94.23%. This condition indicated that samples of fresh dairy milk, pasteurized milk and dodol milk varied greatly from each other. High in coefficient of variation showed the difference ways in handling milk by farmers, traders, and dodol milk industry. Standard deviation value indicated that there was no uniformity on dairy cattle farming management. Feed, water source, dairy cow housing hygiene, cleanliness, worker hygiene and type of milk containers were vary. In farmers who use plastic buckets as a milk container showed higher Pb content than in fresh milk on milkcan. The cleanliness of the equipment, the way of washing also affected the residual content of Pb in fresh dairy milk produced [3].

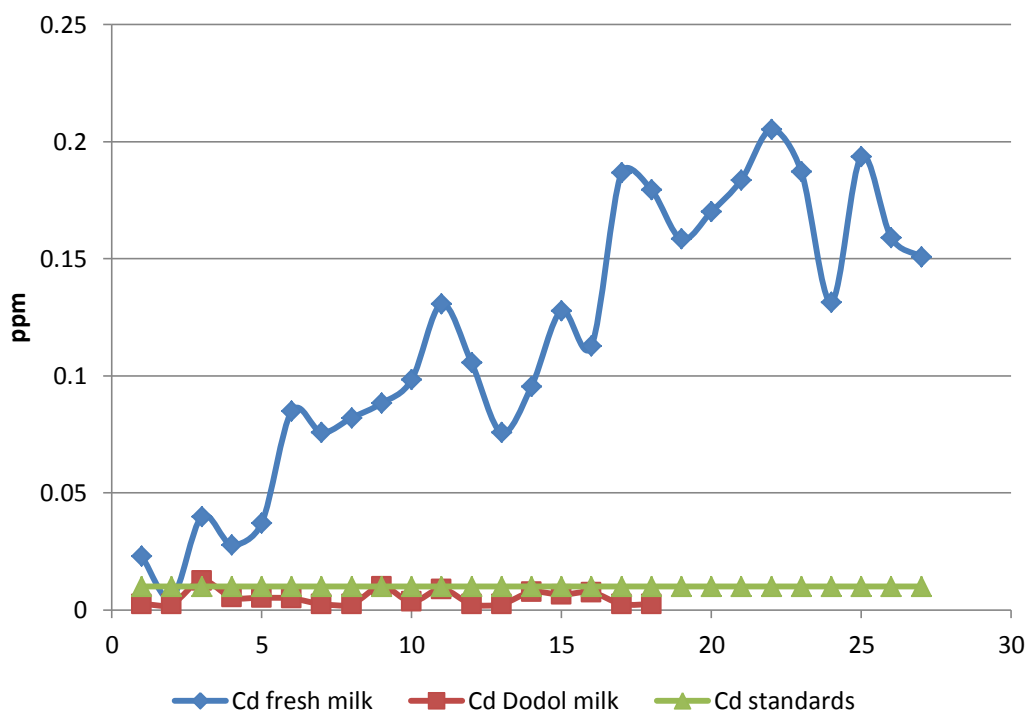


**Figure 1.** The content of Pb residue in milk and dairy products compared with Pb standards regulated by INS: (a) fresh milk and pasteurized milk; (b) dodol milk

Figure 1 showed showed most of fresh milk and dodol milk samples contained Pb above the MRLs. This condition was not meet food safety requirement. Accumulation of heavy metals residue on body gradually might harm human health in long term. Pb contamination on fresh milk and dodol milk were allegedly due to the presence of several sources of Pb residue from feed in the form of grass, straw, concentrate and water. In accordance with the opinion of [6], feed especially grass species grown on location near the road and industrial areas potentially contaminated Pb. Milk and dairy products became contaminated with heavy metals through materials and packaging processes [1, 2]. The source of dodol contamination derived from raw materials used which was milk. This was in

accordance with the opinion of [12], that milk was one type of food that is susceptible to contamination of Pb and Cd.

Moreover, air pollution, batteries, auto exhaust, containers for corrosives, fertilizers, pesticides, insecticides, foods grown in Pb-contaminated soil, lead-based paints, lead-glazed pottery, solder, tobacco smoke, water transported through lead pipes could be other sources of Pb contamination. Pb was a naturally-occurring neurotoxin. Even though many Pb-containing products (for example gasoline and house paints) were banned in the 1970s, contamination can be found in the present majorly from drinking lead-contaminated water, breathing leadpolluted air, and living in or near older painted buildings and certain toxic industrial areas. Pb toxicity mainly aimed kidneys, the nervous system, heart and blood, bones and poses greatest risk to infants, young children and pregnant women. It could affect fetal development, delay growth, and may also cause attention deficit disorder, learning disabilities, behavioral defects, and other developmental problems [8].



**Figure 2.** The content of Cd residue in milk and dairy products

Figure 2 illustrated the content of Cd in fresh milk and dodol milk. Fresh milk samples were mostly contained Cd above Cd standards by EPA, while dodol milk samples in contrary contained Cd below MRLs. Most of Cd contamination were derived from air pollution, batteries, ceramic glazes/enamels, cigarette smoke, tap and well water, food (grown in cadmium-contaminated soil), fungicides, mines, paints, power and smelting plants and seafood. Exposure to cadmium can occur through inhalation or ingestion in places or situations where cadmium products are used, manufactured, or ingested. Cigarette smoke is the biggest source of cadmium toxicity, which seems to mainly affect the lungs, kidneys, bones, and immune system. It may lead to lung cancer, prostate cancer and heart disease, and also causes yellow teeth and anemia. Cadmium also seems to contribute to autoimmune thyroid disease [8].

#### 4. Conclusion

The heavy metal content of Pb in milk and dodol milk mostly exceeded MRLs, while pasteurized milk had met the MRLs requirement. The content of heavy metals Cd in milk largely exceeded MRLs, while dodol milk had met eligible MRLs. Fresh milk was not meet food safety standards however processed it into products can be decrease heavy metals residue.

## 5. References

- [1] Anastasio, A., Caggiano, R., Macciato M., Paolo, C., Ragosta, M., Paino, S. and Cortesi, M. L. 2006. Heavy metal concentrations in dairy products from sheep milk collected in two regions of southern Italy, *Acta Veterinaria Scandinavica* **47**: 69-74.
- [2] Ayar, A., Sert, D. and Akin, N. 2009. The trace metal levels in milk and dairy products consumed in middle Anatolia Turkey, *Environmental Monitoring Assessment* **152**: 1-12.
- [3] Birghila, S., S. Dohrinas, G. Stanciu, and A. Spceanu. 2008. Detemination of Major and Minor Elements in Milk through ICP-AES. *Environmental Engineering and Management Journal. November/Desember 2008, Vol. 7, No.6*, pp 805-808.
- [4] Brown, G. E., and G. A. Parks. 2001. Sorption of trace elements on mineral surfaces: Modern perspectives from spectroscopic studies, and comments on sorption in the marine environment. *Int. Geol. Rev.* **43**:963–1073.
- [5] Buzby, J.C. 2003 International Trade and Food Safety: Economic Theory and Case Studies. United States Department of Agriculture. *Agricultural Economic Report* Number **828**.
- [6] Onder.,S. Dursun.,S. Gezgin.,A. Demirbas. 2007. Determination of Heavy Metal Pollution in Gras and Soil of City Centre Green Areas (Konya, Turkey). *Polish J.of. Environ. Stud.* Vol **16** No.1. P.145-154.
- [7] Qin, L. Q., Wang, X. P., Li, W., Tong, X. and Tong, W. J. 2009. The minerals and heavy metals in cow's milk from China and Japan. *Journal Health Science* **55(2)**: 300-305.
- [8] Tibebu Kocharea, BerhanTamirb. 2015. Assessment of Dairy Feeds for Heavy Metals. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)* Volume **11**, No 1, pp 20-31
- [9] Valérie Page and Urs Feller. 2015. Review Heavy Metals in Crop Plants: Transport and Redistribution Processes on the Whole Plant Leve. *Agronomy*, 5, 447-463; doi:10.3390/agronomy5030447 agronomy ISSN 2073-4395
- [10] Wiczorek, J. Z. Wiczorek, T. Bieniaszewski. 2005.Cadmium and Lead Content in Cereal Grains and Soil from Cropland Adjacent to Roadways. *Polish Journal of Environmental Studies* Vol. **14**, No 4,P 535-540
- [11] Yintao Lu, Hong Yao, Dan Shan, Yichen Jiang, Shichao Zhang, and Jun Yang. 2015. Heavy Metal Residues in Soil and Accumulation in Maize at Long-Term Wastewater Irrigation Area in Tongliao, China. Research Article..*Journal of Chemistry*.Volume, Article ID 628280, 9 pages <http://dx.doi.org/10.1155/2015/628280>
- [12] Simsek, O., R. Gultekin, O. Oksuz, and S. Kurultay. 2000. The effect of environmental pollution on the heavy metal content of raw milk. *Molecular Nutrition Food Research* Vol. **44** Issue 5, October 2000, page 360–363.