

Cross-contamination in Beef Meatballs: Pork, Bacteria, Cadmium (Cd), and Lead (Pb)

Amalia Ruhana

Department of Home Economics
Universitas Negeri Surabaya
Surabaya, Indonesia
E-mail: amaliaruhana@unesa.ac.id

¹Olivia Anggraeny, ¹Diah Noorariyani Mu'az, ¹Selvy Revitasari, ¹Wardatul Ashfia, ¹Luh Putu Wulan Cahyani,
²Dewi Erikawati
¹Nutrition Science Department
²Microbiology Department
Universitas Brawijaya
Malang, Indonesia

Abstract--Meatballs are one of the most popular foods in Indonesia. But some microbiological hazards, physical hazards, as well as pork contamination need to be particularly noticed for consumers of meatballs. The aim of this study was to identify the presence of pork, microbiological bacteria (*Listeria monocytogenes*, *Staphylococcus aureus*, and *Escherichia coli*) and physical contaminants (Cadmium/Cd and Lead/Pb) in beef meatballs. The study determined that, even though contamination of pork and *L. monocytogenes* were not found, the presence of *S. aureus*, *E. coli*, and Lead (Pb) exceeded the maximum amounts of bacterial contamination and lead in beef meatballs according to the Indonesian National Standard (SNI).

Keywords--meatball; *halal*; *listeria monocytogenes*; *staphylococcus aureus*; *escherichia coli*; lead

I. INTRODUCTION

Meatballs are one of the most popular foods in Indonesia, especially in Malang, which is well known in various circles of the archipelago as a distinctive producer of meatballs. Halal food has become very important issue in Indonesia, most of which are Muslim. Muslim dietary codes center around the concept of *halal*, which consumption of pork, or any food that contains pork, is forbidden. The meat, however, is generally processed into meatballs, and if the mixture has been blended with pork to increase profits for the sellers, buyers can inadvertently consume food that is not *halal*. This is especially true in times of globalization where buyers may be ignorant of the contents of processed food products. This is a vitally important subject throughout the nation, made problematic either by ignorance or the unavailability of technology. Testing the meatballs from the local market in Yogyakarta showed that nine of twenty meatball shops were detected to have pork contamination [1-2].

The contaminant pathogens typically identified in foods are *Salmonella*, *Listeria monocytogenes*, *Staphylococcus aureus*, *Clostridium perfringens*, *Escherichia coli*, and *Enterococci* [3]. The Indonesian National Standard has determined that food products made from animals in Indonesia should not contain *Listeria sp* [4].

Staphylococcus aureus bacteria produce toxins that can cause food poisoning. *Staphylococcus aureus* toxin is often found in meat products, poultry, eggs, milk and dairy products, salads, breads, pastry creams, sandwich fillers, and salty foods. [5-6]. *Escherichia coli*, if this bacterial count exceeds the normal limit, *E. coli* can produce human diarrhea-causing toxins. Globally, an estimated two million people die from diarrheal diseases in 2005[7].

In addition to pathogenic bacteria, heavy metals also pose a threat to food. Types of contamination of heavy metals in food include cadmium (Cd), mercury (Hg), and lead (Pb). Lead is a very toxic metal especially for children. It is naturally found on soil, odorless and tasteless. Lead sources include obsolete paint, dust, air, water, food, contaminated soil and lead-containing fuels. In infants and children, excessive lead exposure can cause brain damage, inhibit growth, cause damage to the kidneys, hearing loss, nausea, headaches, loss of appetite, and impairments in intelligence and behavior. In adults, lead can lead to increased blood pressure and indigestion, kidney damage, nerve damage, sleeplessness, brain and joint pain, mood swings and reproductive disorders[8-9]. Cadmium is a heavy metal used in industry such as metallic coating, metal melting, staining, batteries, lubricating oils, fuels and plastics[8,10]. Cadmium and its compounds are carcinogens and cumulative toxins. Cadmium is absorbed through the digestive tract and accumulates in the liver and kidneys [8]. In addition, cadmium may also have an impact on calcium metabolism which can cause osteoporosis in people living or working in high-cadmium contaminant environment. Cadmium is one of the heavy metals that is difficult to remove if already conjugated. It can occur in body organs and foods that have been contaminated with cadmium [11].

The purpose of this study was to identify the presence of three kinds of contaminants in beef meatballs in Malang: pork, microbiological bacteria (*Listeria monocytogenes*, *Staphylococcus aureus*, *Escherichia coli*), and heavy metal contaminants (Cadmium (Cd) and Lead (Pb)).

II. METHODS

This research use descriptive analytic research design with cross sectional approach that is researcher do measurement or observation at the same time (once time). The sample used in this research is meatball meatballs obtained from meatballs traders in Malang city. The sample used in this research is 20 samples of meatballs, determined by purposive random sampling. The area of Malang city is divided into 4 parts of the region. Each region, taken 5 samples of meatballs.

The identification of contamination of pork was done by using Polymerase Chain Reaction (PCR) method, contamination of lead and cadmium with spectrophotometry, while identification of *Listeria monocytogenes*, *Staphylococcus aureus*, *Escherichia coli* using microbiological culture method.

III. RESULTS AND DISCUSSION

Meatballs are one of the processed foods of meat that are easy to be contaminated with pork, bacteria, and heavy metals. From the results of the study, there was no contamination of pork in all samples of meatballs studied. Likewise with *Listeria monocytogenes* bacteria, no *Listeria monocytogenes* bacteria were found in all studied samples (Table 1). Although there was not found *Listeria monocytogenes* bacteria, but there found *Listeria* other , namely *Listeria grayi* and *Listeria ivanovii* in small amounts. *Listeria ivanovii* was originally thought to only infect ruminants, but some researchers reported that *L. ivanovii* may be associated with gastroenteritis and bacteremia in humans [12]

Listeria grayi, an example of different *Listeria* species line with *Listeria monocytogenes* and *Listeria ivanovii*, were found to be more numerous (13.6%) than other *Listeria* species, including *Listeria ivanovii* (5.8%) and *Listeria monocytogenes* (2.9%) Food samples used in the study were obtained from processed meats (pork, beef and chicken), fish (salmon, hake, and sole), vegetables (lettuce and spinach), and potato omelets obtained from several restaurants during the period of September 1999 to March 2000. *Listeria grayi* is naturally resistant to trimethoprim and co-trimoxazole whereas *Listeria ivanovii* is naturally resistant to most classes of quinolones and phosphomycin. Even the *Listeria grayi* strain resistance was found against all anti-folate[13-14].

TABLE I. THE RESULT

| Contaminant | Amount |
|-------------------------------|--------------------------------|
| Pork | - |
| <i>Listeria monocytogenes</i> | - |
| <i>Staphylococcus aureus</i> | 9.5x10 ² CFU/gram |
| <i>Escherichia coli</i> | 3.7 x 10 ³ CFU/gram |
| Cadmium (Cd) | 0.1099 mg/kg |

Indonesian National Standard (SNI) 7388: 2009 recommends the maximum limit of *Escherichia coli*

microbial contamination on meat and its preparations is 5 x 10¹ CFU / gram [9]. Based on Table 1, the E Coli content of the meatballs sample exceeds the established standard. E Coli content in the average meatball sample is 3.7 x 10³ CFU/g, this value is higher than the Indonesian national standard. A study conducted in Turkey on ground beef and beef, 48.2% of ground beef samples and 25% of beef samples contained E. coli with an average of 1.4 x 10³ CFU/g on ground beef, and 6.4 x 10² CFU/g in beef samples [15]. Meanwhile, study that was conducted in Arabia on meat products, 10% of the total sample beef burger contains E. coli [16].

The maximum requirement amount of *Staphylococcus aureus* on beef meatballs based on Indonesian National Standard (SNI) is 1 x 10² CFU/g [9], based on the study, the average number of *S aureus* is 9.5x10² CFU/g, so that the *S aureus* content of meatballs exceeds the established standard. A study conducted in the summer of Agri, Turkey, 6 of 17 samples (35.3%) of frozen raw beef were contaminated with *S. aureus* [17]. Meanwhile, research conducted by Gundogan and Devren on ready to eat meatballs found as many as 51.1% of 90 samples containing *S.aureus* [18]. About 50% of humans are carriers of *S. aureus*. Food handlers are often involved in *S.aureus* contamination into food, other than that organisms can survive well in the factory environment. These organisms can become flora in the production equipment and also become a source of contamination or recontamination [19].

Handling food properly from stable to the table should be applied. Consumers should understand, that when cooking raw meat should be cooked adequately before consumption.

Referring to SNI 7387: 2009 for the maximum limit of cadmium metal contamination in beef meatballs is 0.3 mg / kg so that the cadmium content in the sample is still within normal limits. In the present study, the obtained results revealed that the mean Cadmium concentrations in pork products (bacon, ham, sausage and salami) samples were 0.11,0.13, 0.16 and 0.21 mg/kg. The highest concentration of Cadmium was found in salami and sausage, followed by bacon and ham. The explanation for these results is that sausages and salami were highly spiced; they were found highly contaminated with Cadmium [20].

Maximum lead pollution in food products is 0.25 mg/kg, so that Lead content in meatball sample (1.719 mg/kg) exceeds the standard set by SNI .The study conducted in Romania, the highest concentration of lead was found in salami (0.96 mg/kg), followed by the concentration in sauce (0.82 mg/kg), concentration in ham (0.65 mg / kg), and concentration in bacon (0.58 mg/kg) [20].Meanwhile, research conducted in Bangladesh, The highest concentration of Pb was found in animal meat of local cow that is 24.9 mg/kg, whereas the highest concentration of Pb was found in animal meat of Indian cow that is 43.37 mg/kg [21].

IV. CONCLUSION

Of the meatballs we analyzed, no pork contamination and *Listeria monocytogenes* contamination were found; other *Listeria* strains (*L. grayi* and *L. ivanovii*), however, were evident within normal limits. Cadmium contamination was also within normal limits. The presence of *Staphylococcus aureus*, *Escherichia coli*, and lead, however, exceeded the maximum amount of bacterial and lead metal contamination in beef meatballs based on Indonesian National Standard (SNI). The immediate concern is not only for food that is *halal*, but whether dangerous contaminants are present in these products in general.

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