

Microbiological Quality and Safety of Meatball Sold in Payakumbuh City, West Sumatra, Indonesia

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Abstract—The aim of this study was to evaluate the microbiological quality and safety of meatball obtained from five different manufacturers around Payakumbuh City, West Sumatra, Indonesia. Microbiological analysis of meatball sample resulted in aerobic plate count range from 7 log CFU/gr to 8.623 log CFU/gr, respectively. Total coliform ranges from 1.041 log Most Probable Number (MPN)/gr to 3.380 log MPN/gr, respectively. Chemical analysis of meatball sample consisted of borax and formalin content. The result of qualitative detection of borax and formalin content on all meatball samples were not detected. Thus, it remains essential to include the significance of effective hygiene practices as an important safety measure in consumer education programmes.

Keywords—Borax, formalin, meatball, microbiological quality.

I. INTRODUCTION

IN the past, people used to prepare their own meal at home and to consume freshly. Today, however, especially in developing and developed countries, eating habits of the people have changed according to technological developments in food sectors. There have been many kinds of Ready to Eat Food (RTE) or semi-ready meat products at the supermarkets or traditional markets. Meatball, raw food products of animal origin, forms a significant portion of the diet of the Indonesian people. In Indonesia, people consumed meat products at the rate of around 8% of produced meat, and consumer demands increase for RTE and semi-ready meat products prepared from fresh ground beef such as meatball. The increase in demand for meat and semi-ready meat products without the infrastructure for proper sanitary handling may lead to transfer of pathogenic organisms from the animals to the consumer. For raw meat products such as meatball, potential safety and quality can be estimated with the use of indicator microorganisms. Meat is an important source of nutrition. The meat products consumers in urban areas are more than rural [1], [2]. Meat comprises of roughly 10-20% of energy intake in most meat-consuming countries [1], [3]. The availability of meat product is determined by needs and demands of the consumers [4]. Furthermore, [4], [5] noted that the growing complexity and hectic metropolitan life has developed demands for ready-to-eat prepared foods known as convenience foods. An addition of preservatives into dough balls was to prevent microbial activity, thereby inhibiting microbial activity in the meatballs. The longer the shelf life of

meatballs, will be better the quality.

Meatballs are a type of meat products restructured by processing and it is very familiar among some countries in the world, such as Asian and certain European regions. The Asian type meatballs are commonly produced by emulsifying fine ground meat with starch of some sort, salt, and certain herbs specific to the ethnic cuisine, and finally it is shaped into balls. It is then cooked in boiling water, steam or deep fried depending on the cuisine [6].

Indonesian traditional meatballs or known as *bakso* are produced from a mixture of finely ground meat with cooking salt, tapioca starch, and garlic. *Bakso* is one of the comminuted meat products, and its popularity in all classes of Indonesian society, especially in the youngsters, has attracted interest of the meat processors as a business opportunity. Therefore, the meat processors are integrating this product into their production line and they are making it fully industrial, hence the home industry type production is fully scaled to mass production of meatballs packed in vacuum packaging and sold frozen at supermarkets or grocery stores [7].

Meatball (*Bakso*) is a traditional meat product which is consumed particularly in Indonesia. Although meatball is produced widely, there are no standards established in terms of production methods and technology, food additives and their quantities, ingredients and microbiological quality. Methods that are used during production and ingredients vary depending on the location. Traditional meatball is made with naked hands. It requires to be mixed up all the ingredients and to be prepared like a batter by the movements of smashing until the required texture is obtained. The microbiological quality of the raw meat and other ingredients, personal hygiene, and any contamination during the process will determine the microbiological quality of end product. Ingredients used in the processing of food products are among the most important factors having great influence on the final quality [8]. Meatballs can be made from a variety of meats such as beef, chicken, fish meat, and rabbit meat. This meat difference will determine the type of meatballs.

Meatballs are representative of traditional food, and to conserve it availability in market, the producers should have a better method because they are using simple technology, and their marketing is oriented on local consumers [9]. The Indonesian National Standards [10] for *bakso* are moisture content approximately 70%, fat content maximum 2%, protein content minimum 6%, ash content maximum 3%, and no borax should be detected in the product [11]. Recently, there is an abuse of food additives on food processing and preservation because people think that these materials help to

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increase sensory quality and shelf-life of foods. However, these additives might cause public health hazard. Boric acid (borax) and formalin are some of these materials.

Boric acid is commonly used as a pesticide in agriculture. However, there are still food manufacturers using these harmful substances as a food preservative. Boric acid (H_3BO_3) is a boron compound which is soluble and it is circulated in plasma [12]. Boric acid is a compound with the chemical name sodium tetraborate. Boric acid is a dangerous chemical compound for foods which can be found in solid form, and when dissolved in water, it will be a sodium hydroxide. Boric acid can be made by adding sulfuric or hydrochloric acid in borax. But, boric acid was forbidden to be drunk or used on scars because they are poisonous if absorbed by the body. Many manufacturers reported using boric acid as food preservatives in various food products. Boric acid is used for preserving dairy and meat products such as meatballs and sausage [13]. This is because boric acid is able to inhibit the growth of a microorganism, therefore, the preserved food can stay fresh for a longer period of time [14].

37% of formaldehyde soluble, known as formalin, is characterized as an inexpensive and effective preservative that rapidly penetrates the tissue. It is frequently used as one of the most common preservatives for meat products. Besides, it is widely used as a disinfectant in many human medicines and cosmetics and as an antiseptic in veterinary drugs and biological and in fungicides, textiles and embalming fluids [15]. This formalin is very harmful to human health. Formaldehyde, if ingested about 30 ml of a solution, can cause death. Continuous addition of formaldehyde through meat product in human body may cause uncontrolled cell growth or cancer in any part of body like stomach, lung, and respiratory system. Also, inhalation of formaldehyde causes respiratory system cancer such as sulfuric acid mists, mineral acid, metal dust and heat [16]. In many countries, adding formaldehyde to foods is banned, nevertheless, some manufacturers still add it if the food stays unrefrigerated for a while. Consumers of foods must know if the formaldehyde was excessive and harmful amounts. Inspectors of food need to control if formaldehyde was added illegally as a food preservative.

II. METHODOLOGY

A. Sample Preparation

20 meatball samples (200 g each) were obtained from five of different manufacturers, in Payakumbuh City, West Sumatra. The sample consisted of Istiqomah Meatball (A), Trisno Meatball (B), Cak Karno Meatball (C), Ateng Meatball (D) and Iga Hockey Meatball (E). The samples were collected and transferred immediately to the laboratory for further analysis. All samples were brought to the laboratory and were packed in polythene bags.

B. Microbial Analysis

Total Plate Count (TPC): Bacterial counts were analyzed by spread plate method using Plate Count Agar (PCA, Oxoid CM 0325) [17], [18]. 25 g of macerated meatballs sample put onto

225 ml of peptone water as the first serial dilution (10^{-1}) and 1 ml of the supernatant was mixed with 9 ml of peptone water (10^{-2}), and it was serially diluted as 10^{-3} and 10^{-4} . After serial dilutions, inoculate 1 ml of each of the dilutions was spread on agar plates in duplicates. Using a sterile bent glass rod spreads the inoculums uniformly on the surface of the plates. The plates are incubated at 37 °C for 24 hours. After incubation, all white spots or spread were counted and recorded as total viable counts using the colony counter. The counts for each plate were observed as colony forming unit of the suspension (CFU/g).

Total Coliform: The numeration of total coliform was carried out by employing of standard methods [19] using Crystal Violet Neutral red bile lactose (VRBL) agar (Oxoid CM 0107), 1 ml of appropriate dilutions on poured-plated; plates were incubated at 37 °C for 48 h. The counts for each plate were expressed as colony forming unit of the suspension (CFU/g).

C. Chemical Analysis

Borax Content: Qualitative detection of borax was conducted in accordance with standard AOAC methods of [20]. Grinding 10 gram of samples, adding 5 ml HCl 4N and 20 ml distilled water. The Borax test sheet was dipped into the samples solution. The test sheets were kept dry at 40 °C. The result is read following the color changes.

Formalin Content: Qualitative detection of formalin was conducted with the help of Formalin Test Kit[®] (Chemkit) according to the National Agency of Drugs and Foods Controls of Indonesia [21]. This kit contains two different reagents labeled as reagent 1 and 2. First, the samples were washed with small quantity of water, and a portion of washed out water was taken in a test-tube using a dropper incorporated in the kit. 3 or 5 drops of solution 1 were added in the test-tube containing washed out water. After well stirring, the solution was allowed reacting for 30 second. 1 mg of reagent 2 was added in the same test-tube. After waiting for 30 seconds, change in color pink or red indicated the presence of formalin, whereas unchanged color indicated the sample is free from formalin.

D. Statistical Analysis

Results are expressed as mean \pm SEM (Standard Error of Mean). Statistical tests included variance analysis (ANOVA) with a 5% significance level and mean comparisons according to Tukey's test [22].

III. RESULT AND DISCUSSION

A. Total Plate Count (TPC)

The results for the TPC and total Coliforms analysis of meatball samples from different manufacturers around Payakumbuh City are shown in Table I and II. Number of aerobic bacteria from all samples range from 7 log CFU/gr to 8.623 log CFU/gr, respectively. There were no significant differences ($P>0.05$) in TPC of the meatball among the five of different market places, in Payakumbuh City. The results in Table I also show that all samples were above the permitted

level (5 log CFU/gr) of Indonesian National Standard [10].

The higher values could be as a result of contamination from the slaughtering area and equipment used. The slaughter of meat animals under unhygienic conditions, the use of contaminated water, use of unsterilized equipment such as knives, rusted hooks, poor and unhygienic condition of abattoir located followed by production and processing of meat without adhering to good manufacturing practices can result in the increased level of total bacterial count in the fresh meat [23]. Also, from the studies, it can be seen that the highest level of TPC was recorded and this may be due to the way how it is prepared. The meat, during its preparation, remains in the ground for a long time, which creates an avenue for microbial pathogens to proliferate on it. From the results, it is evident that fresh meat from abattoir located recorded high total bacterial count [24].

TABLE I
TOTAL PLATE COUNT (LOG CFU/GR) OF MEATBALL IN FIVE OF DIFFERENT MANUFACTURERS AROUND PAYAKUMBUH CITY

| Samples | Manufacturers | | | | |
|---------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| | A | B | C | D | E |
| 1 | 8.477 | 8.380 | 8.398 | 8.255 | 7.778 |
| 2 | 8.505 | 8.477 | 8.556 | 8.623 | 8.415 |
| 3 | 8.041 | 8.176 | 8.322 | 7.204 | 7.431 |
| 4 | 7.869 | 7.000 | 7.079 | 7.380 | 7.591 |
| Average | 8.223 ±0.32 ^a | 8.008 ±0.68 ^a | 8.089 ±0.68 ^a | 7.866 ±0.68 ^a | 7.804 ±0.43 ^a |

According to the microbiological results, the hygienic quality of the raw meatball samples was quite poor (Table I). To provide enough microbial destruction using the boiling process, it is essential to distribute temperature uniformly in the meatball samples. In order to ensure microbiological quality of the meatballs subjected to conventional heating methods, heating time must be maintained for a longer period of time. It was also clearly shown from the results that the heating process is insufficient for destroying all pathogenic bacteria.

B. Coliform

Number of coliform bacterial from all samples range from 1.041 log Most Probable Number (MPN)/gr to 3.380 log MPN/gr, respectively. There were no significant differences ($P > 0.05$) in total coliform of the meatball among the five different manufacturers at traditional market, in Payakumbuh City. The results in Table II also show that all samples were above the permitted level (1 log MPN/gr) of Indonesian National Standard [10].

The presence of coliforms is an indication of contamination by humans, birds, or contaminated water used in washing both at the processing site and at the retail level [25]. The result from this study is in line with the report of [26] that the workers' hands and the equipment were the sources of meat and meat product contamination. The presence of high faecal coliforms in food depicts poor hygienic practices of handling of the meats during slaughtering and processing or due to possible contamination from the skin, mouth, or nose of the handlers which might be introduced directly into the meat and

meat product [27].

TABLE II
TOTAL COLIFORM COUNT (MPN/GR) OF MEATBALL IN FIVE OF DIFFERENT MANUFACTURERS AROUND PAYAKUMBUH CITY

| Samples | Manufacturers | | | | |
|---------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| | A | B | C | D | E |
| 1 | 1.041 | 1.041 | 3.041 | 3.041 | 1.556 |
| 2 | 3.380 | 1.462 | 3.380 | 3.380 | 1.724 |
| 3 | 3.041 | 1.968 | 2.663 | 1.322 | 1.041 |
| 4 | 1.544 | 1.633 | 2.322 | 1.322 | 1.041 |
| Average | 2.252 ±1.13 ^a | 1.526 ±0.39 ^a | 2.852 ±0.46 ^a | 2.266 ±1.10 ^a | 1.341 ±0.35 ^a |

Meatballs are considered to be spoiled when it is unfit for human consumption. It is subjected to changes by its own enzyme, by microbial action and its fat may be oxidized chemically. Microorganisms grow on meat product causing visual, textual, and organoleptic changes when they release metabolites [28]. Many factors that affect microbial growth in meat product are the intrinsic, extrinsic, and implicit factors [29]; however, the main factors having the large influence on the growth of bacteria are the storage temperatures, pH, moisture, oxygen availability, and bacterial characteristics such as endospores. Meat, the flesh of animals suitable for use as food, has a very high nutritional value and moisture content with pH value of 5.4 and could serve as an excellent medium for microbial contamination growth and spoilage [30].

TABLE III
TOTAL PLATE COUNT (LOG CFU/GR) OF MEATBALL IN FIVE OF DIFFERENT MANUFACTURERS AROUND PAYAKUMBUH CITY

| Manufacturers | Borax | Formalin |
|---------------|--------------|--------------|
| A | Not Detected | Not Detected |
| B | Not Detected | Not Detected |
| C | Not Detected | Not Detected |
| D | Not Detected | Not Detected |
| E | Not Detected | Not Detected |

C. Borax

The result of borax identification shows that all samples are not detected of borax content. This condition was indicated from each sample are did not appear a green flame (Table III). Boric acid is usually used as an anti-infective and ophthalmologic irrigation. Sodium borate is bacteriostatic and is generally added to the cold cream, eyewash, and mouthwash. According to [31], boric acid was added to increase the best organoleptic value of food such as color, texture and flavor. Therefore, FAO/WHO Expert Committee announced that boric acid is not allowed to use as food additives. The chronic symptoms caused by poisoning borax include decreased appetite, disturbance in digestion, confused and ignorant, as well as anemia, hair loss, and cancer [32]. Boric acid contains toxic substances that affect human health. Boric acid which has been consumed is hazardous substance that is absorbed by the intestine and accumulated in the liver, kidney, and testis. Finally, the levels of toxins accumulated in the body will be higher. Hence, its usage is not recommended [31].

Boric acid is not safe when consumed in large quantities

and will cause poisoning with symptoms of inflammation of the skin and peeling, irritability, tremors, convulsions, weakness, headaches, depression, diarrhea, vomiting, and other symptoms [33]. However, the toxicity mechanisms of boron compound residue are unclear [34]. According to [35], the accumulation of boric acid for a long time in the body causes damage to the central nervous system, liver tissue, and brain. Because of this, usage of borax to the mixture of food is an act that violates consumer protection laws.

D. Formalin

The result showed that all samples examined did not contain formalin, and there was no colour change on the test (Table III). International Agency for Research on Cancer has classified formaldehyde as a Group-I carcinogenic to humans. According to the United States Environmental Protection Agency (EPA), maximum daily dose reference (RfD) for formaldehyde is 0.2 µg g⁻¹ body weight per day [36]. Formaldehyde is a liquid that is colorless, pungent, and soluble in water and alcohol. Formalin is usually used as a disinfectant, embalming fluid, tissue preservatives, as insecticides and used also in textile industry. Consumed formaldehyde can cause symptoms such as hot throat, diarrhea, vomiting, and intoxication. In addition, formaldehyde may also cause disturbances of blood circulation and stimulate the growth of cancer and coma or death [37], [38]. The quantitative research to determine levels of formalin and borax content in meatball cannot be done because the qualitative research showed a negative value.

IV. CONCLUSION

According to our study, we observed that microbiological quality of meatball samples is poor. To minimize contamination, GHP or GMP and HACCP systems that are specific to the control of the pathogenic and spoilage bacteria at all stages of manufacture, storage, transport and retail could be applied.

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