Analysis of calcium levels in beef bones from kaledo waste

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Abstract. Kaledo is one of the special culinary from Central Sulawesi which containing beef bones. The large number of restaurants that provide kaledo in their menus resulted in the amount of beef bone waste that cannot be consumed. This waste can cause environmental problems. However, the bones have the number of minerals, one of them is calcium (Ca). Ca is a mineral that is needed by the body in maintaining body functions. This study aimed to determine the calcium levels in beef bones from kaledo waste which was taken randomly from the kaledo restaurant in Palu. Determination of calcium levels in beef bones from kaledo waste used atomic absorption spectrophotometer. The results of the analysis showed that the water content was 4.5950%, and the ash content was 61.7424%. The analysis of calcium levels measured at a wavelength of 422.7 nm was 19.6800 mg/L. The results of this study are expected to be a source of information about the levels of calcium contained in cow bones from kaledo waste, and it can be used further as a substance in the utilization of beef bones from kaledo waste as a food that can meet the body's need for calcium intake in preventing stunting.

1. Introduction

Central Sulawesi is an of the province in Indonesia that has a lot of culinary heritage. One of the famous culinary delights in Central Sulawesi is kaledo. Kaledo is a soup containing beef and beef bone as which is good to consume for human growth and development, especially for children. The large number of restaurants of kaledo raises beef bone waste which has no economic value. This waste is thrown into a landfill, of course, this can cause environmental problems. However, it should be noted that beef bones have many benefits, one of which is a good source of calcium for human growth and biological development. Therefore, it is necessary to study calcium in this waste and make it new alternatives that optimize the benefits of beef bones from kaledo waste, especially on the adequate intake of macro minerals (calcium) in humans.

Bone is the body's main support network whose structure consists of organic and inorganic elements. As much as 85% of all salts contained in bones are calcium phosphate, and 10% in the form of calcium carbonate. Approximately 97% of calcium and 46% of sodium in the body is found in bones. Bone in animals is one of the animal parts that have many benefits. Beef bone has quite a lot of mineral sources, especially calcium which can be used as a fulfillment of mineral intake in humans, especially children during the growth of bones and teeth [1]. Beef bones have a fairly high calcium content, which is around 85.84%. Organic bone filling materials contain 30.6% protein, mineral salts such as 58.3% calcium phosphate, 2.1% calcium carbonate 1% magnesium phosphate, and 1.9% calcium fluoride, bones also contain %. Bones also contain 50% water, 15% red and yellow marrow and 96% [2].
Calcium is useful for survival purposes because it is an important element in living organisms, especially in skin, bones, and teeth. Approximately 2% of the human body is composed of calcium. The role of calcium in the body can be divided into two, firstly to helping to form dental bones and secondly to regulate biological processes in the body [3]. The greatest need for calcium at the time of growth. However, the need for calcium is still continued even though it has reached adulthood. In bone formation, when new bone is formed, the old bone is destroyed simultaneously. The daily requirement of calcium is 800 mg for adults over 25 years and 1000 mg after the age of 50 years, this is because the calcium needs needed by the body increases with age and for the needs of the bone and tooth resistance processes. In addition, the need for calcium in older people is recommended by experts to consume more calcium intake to prevent bone loss. Pregnant and lactating women should consume 1200 mg of calcium per day [4].

Adequacy of calcium in humans affects the growing period of children, especially for the growth of height and teeth. The growth process experienced by a child is a cumulative result from the time the child is born. A good and healthy nutritional status in children under five years old is an important foundation for their health in the future. Conditions that have the potential to interfere with the fulfillment of nutrients, especially minerals (including calcium), energy, and protein in children, will cause disturbances during the child's growth [3].

According to [5], good physical growth cannot be separated from the intake of calcium the body receives. The lack of calcium intake in humans causes the human physical condition to be less good. Bodyweight is the first indicator that can be seen when a person is malnourished. In the long term, malnutrition will result in stunted growth, which causes humans, especially children, to experience low or short stature, which is known as stunting and ultimately has a negative impact on the mental development of individual children's intellectuals.

Stunting is a chronic nutritional problem in children characterized by a shorter height compared to their age. Children who suffer from stunting will be more susceptible to disease, and adults are at risk for degenerative diseases. Therefore, investing in calcium must be done as early as possible. If the nutritional intake in the form of calcium is not fulfilled every day, the body will take reserves in the bones which will later result in early bone loss, impaired height growth, and brittle teeth [5].

The purpose of this study was to determine the levels of calcium in beef bones from kaledo waste. The study result can be of benefit as a source of information about the levels of calcium contained in beef bones from kaledo waste and can be further utilized as a substance in bone utilization beef bones from the waste of kaledo.

2. Materials and methods

The materials used in this study were cow bones from kaledo waste, distilled water, tissue, filter paper, 1M HNO₃ solution, and calcium standard solution.

2.1 Sample preparation

Beef bones were taken from a number kaledo restaurants in Palu city, then washed to remove the remaining meat that is still attached. After that was dried under the sun for ± 3 days the cooled into a desiccator for ± 30 minutes. Dried bones were smoothed by using a mortar and pestle, then sieving using a 60-mesh sieve [3].

2.2 Determination of water content and ash content

Each sample of beef bone from kaledo waste was weighed as much as 2.0196 grams using an analytical balance and put into 3 vaporizer plates. Then heated in an oven at 105°C for ± 3 hours. Every 30 minutes of heating the beef bone sample from kaledo waste were cooled in a desiccator then weighing it until a constant weight is obtained then the water content is determined using the following formula [6].

\[
\% \text{ Water content} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100\% 
\] (1)
Each sample of beef bone from kaledo waste was weighed as much as 50.0137 gram using an analytical balance and put into 3 porcelain plates, then healed in a furnace at 700°C until it reached complete ashes. The beef bone sample from kaledo waste was cooled in a desiccator, then the ash obtained was weighed and the ash content was determined using the following formula [6].

\[
\% \text{ Ash content} = \frac{\text{Ash weight}}{\text{Initial weight}} \times 100\%
\]  

(2)

2.3 Determination calcium level by Atomic Absorption Spectrophotometry

The sample of beef bone ash from kaledo waste was weighed as much as 10 grams. Then the sample was dissolved with 10 mL of 1 M HNO\(_3\) solution into the sample and added with 50 mL of distilled water, then filtered until it separated between the filtrate and the residue. The filtrate obtained was diluted with distilled water in a 100 mL volumetric flask. The standard solution was prepared by adding 1000 ppm Ca\(^{2+}\) main solution into a 10 mL 100 mL volumetric flask using a volume pipette. Then, it is diluted by adding 100 mL distilled water or aquades.

The calibration curve was made by measuring the standard solution from the lowest concentration to the highest concentration. The first calibration curve was made by making a series of standard Ca\(^{2+}\) solutions with a concentration of 4; 8; 12; 16; and 20 ppm. The standard solution is put into a 100 mL volumetric flask with 4 volumes of fixed contents; 8; 12; 16; and 20 mL and diluted with distilled water to the mark. Making the next calibration curve was done by measuring the blank. The standard solution of Ca\(^{2+}\) was absorbed using an atomic absorption spectrophotometer at a wavelength of 422.7 nm.

The sample solution that had been taken was 1 mL and diluted with distilled water in a 50 mL volumetric flask until the limit mark. Calcium content in the sample solution is determined by measuring its absorption with an atomic absorption spectrophotometer, calcium metal was measured at a wavelength of 422.7 nm.

3. Results and discussion

The analysis results of water content and ash content obtained in beef bone samples from kaledo waste can be seen in Table 1.

| Table 1. Water content and ash content of beef bone waste |
|---------------------------------|----------------|----------------|
| Sample | Result (%) | Water content | Ash content |
| Beef bone waste | 1 | 3.7631 | 61.8257 |
| | 2 | 4.5999 | 61.7513 |
| | 3 | 5.4219 | 61.6501 |
| Average | 4.5950 | 61.7424 |

Based on Table 1, water content is a parameter that determines the character and shelf life of a food ingredient. In general, the higher the content of a food ingredient, the shorter the life of the food item [7]. The results of the analysis of the water content of beef bones from kaledo waste in the first plate were 3.7631%, the second plate was 4.5999%, and the third plate was 5.4219%. The average yield of the water content analysis was 4.5950%. This shows that the water content contained is quite low, due to the drying process before the beef bones from the kaledo waste are mashed/made into flour as well because the beef bone samples from kaledo waste do not have a high-water content [8]. Based on the results of this study, it was obtained a water content of 4.5950%, this indicates that the beef bones from kaledo waste have low air content, and meet the standards for air content. Water content standard is not more than 5% of a food ingredient. According to [9], the water content in the material can be expressed based on wet weight and dry weight. Water content is an important parameter of a food product because the water in food determines the acceptability, freshness, texture, and quality of foodstuffs as well as
material durability. Based on the water content obtained, it can be said that the beef bone samples from kaledo waste have good food resistance.

Analysis of the ash content in the beef bone sample from kaledo waste was also carried out 3 times with the same treatment and different plates. Furthermore, to determine a mineral in a food ingredient, an ashing method is first performed. Ashing methods are divided into dry ashing (dry ashing) and ashing base (wet digestion).

This study used the dry ashing method. Principled dry ashing oxidizes all organic substances at high temperatures, then weighing the remaining substances after the combustion process. The function of this ashing is to break the bonds between organic compounds and metals to be analyzed [10]. The ash content of a sample to be analyzed is placed in a porcelain cup, a porcelain cup is used because its weight is relatively constant after repeated heating. In the ashing process, the sample used is a dry sample which has a predetermined moisture content. Then the sample is treated by using a furnace with a temperature of 700˚C for ± 3 hours until the residual ashing is generally gray in color. This serves to oxidize all organic substances at high temperatures and to speed up and perfect the digestion process. The use of a furnace can also set the desired temperature. After the sample becomes ash, the sample is weighed [8].

The results obtained in the analysis of the ash content of beef bone samples from kaledo waste in the first plate were 61.8257%, the second plate was 61.7513% and the third plate was 61.6501%. The average result of the ash content analysis was 61.7424%. This result indicates the number of minerals contained in the foodstuff. Based on the results of the research conducted, it was obtained levels of 61.7424%, this indicated that beef bones from kaledo waste had a high mineral content.

The analysis of calcium absorption data from standard solutions by using Atomic Absorption Spectrophotometer can be seen Table 2.

| Concentration (ppm) | Absorbance |
|---------------------|------------|
| 4                   | 0.142      |
| 8                   | 0.245      |
| 12                  | 0.330      |
| 16                  | 0.437      |
| 20                  | 0.559      |

Based on Table 2, the calcium calibration curve is obtained from the absorbance measurement of the standard solution of calcium. From the measurement of the calibration curve, the regression line equation for calcium is \( Y = 0.025x + 0.034 \). The calibration curves for calcium and potassium standard solutions can be seen in Figure 1.

![Figure 1. Calibration curve of calcium](image-url)
Analysis of calcium levels in beef bone samples from kaledo waste using atomic absorption spectrophotometer (AAS) is presented in Table 3.

### Table 3. Water content and ash content of beef bone waste

| Sample       | Absorbance (A) | Concentration Ca (mg/100g) |
|--------------|----------------|---------------------------|
| Beef bone    | 0.157          | 1968                      |
| waste        | 0.158          | 1984                      |
| Average      | 0.157          | 1968                      |

The mineral content is generally in the form of calcium carbonate (CaCO$_3$) and a small portion is in the form of calcium phosphate (CaSO$_4$). Organic bone filling ingredients contain 30.6% protein, mineral salts such as 58.3% calcium phosphate, 1% calcium carbonate 2.1% magnesium phosphate, and 1.9% calcium fluoride, bones also contain 50% water, red marrow and yellow 15%, and fat 96%. The high level of calcium in beef bones from kaledo waste is because the bone is generally a connective tissue consisting of cells, fiber, and filler materials. The bone filling consists of protein and mineral salts [11]. Calcium is a mineral that is needed by our bodies at all ages, from infants to the elderly. The function of calcium in the human body is as a mineral in the growth and development of bones and teeth, a regulator of blood clotting, a catalyst for biological reactions, a regulator of muscle and mineral reactions that affect body growth [12]. The greatest need for calcium at the time of growth, but also the need for calcium are still continued even though it has reached adulthood. In bone formation, when new bone is formed, the old bone is destroyed simultaneously [13]. The need for calcium in children aged 1-3 years is 700 mg/day, at the age of 4-8 years, the need for calcium increases to 1000 mg/day, at the age of 9-18 years the need increases to 1300 mg/day, at the age of 19-50 year the need for calcium increases to 2500 mg/day, and at the age of 51-60 years it is reduced to 2000 mg/day [14]. Calcium levels found in beef bones from kaledo waste can be used as food to meet the body's calcium intake needs.

Lack of calcium intake in the human body causes abnormalities, especially at an early age, growth disorders such as less strong bones, easily bent, and brittle. Low calcium intake can result in low matrix mineralization of new bone deposits and osteoblast dysfunction, leading to stunting. Stunting or malnutrition based on height for age is an indicator of chronic malnutrition. It is estimated that around 26% of children under five worldwide are stunted [15]. Consumption of calcium should not exceed 2500 mg a day. The opposite condition of hypocalcemia is hypercalcemia. This hypercalcemia can cause hypercalciuria in a condition where the calcium level in the urine exceeds 300 mg/day. Excess calcium can lead to kidney stones or kidney problems. In addition, it can cause constipation (constipation).

Based on Table 3, it shows the average levels of calcium contained in beef bones from kaledo waste was 1968 mg/100g. Calcium level analysis aims to analyze the calcium levels of bovine bones from kaledo waste. In addition, this study is intended to provide further information regarding the substance in the utilization of beef bones from kaledo waste.

## 4. Conclusion

Based on the results of the research and the results of data analysis, the water content in beef bones from kaledo waste was 4.5950% and the ash content was 61.7424%. The average level of calcium (Ca) contained in beef bones from kaledo waste using the Atomic Absorption Spectrophotometer (AAS) method at a wavelength of 422.7 nm is 1968 mg/100g.

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