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ORIGINAL PAPER

Nutritional evaluation of beef-bone broth products: focus on calcium, phosphorus, and magnesium content*

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Abstract

Beef-bone broth is a soup made by boiling beef bones for long periods, the eluate of which is then consumed; this broth is generally recognized as a healthy food and a source of calcium. Due to the time-consuming cooking process, the consumption of ready-to-heat beef-bone broth is increasing over that of homemade beef-bone broth. This study aimed to evaluate the calcium phosphorus, and magnesium contents of commercially available beef-bone broth products. In this study, 36 types of beef-bone broth sold in online and offline markets in South Korea from May to November 2022 were purchased. Energy and nutrient content information was collected from the nutrition label on the packaging, and the contents of calcium (Ca), phosphorus (P) and magnesium (Mg) were analyzed via inductively coupled plasma-mass spectrometry (ICP-MS). The price and nutritional content of the products were evaluated based on the reference serving size of 250 g of soup. The average calorie content was 42.6 kcal (1.64% EER of Korean men aged 19-29), with a minimum of 12.5 kcal and a maximum of 98 kcal. The average protein content was 4.6 g (7.04% RI of Korean men aged 19-29), and the average fat content was 2.4 g. The average Ca content was 7.6 mg (0.96% RI of Korean men aged 19-29), with a minimum of 2.2 mg and a maximum of 12.9 mg. The Mg content averaged 2.6 mg, and the P content was high at 299.0 mg. The results suggest that commercially available ready-to-heat beef-bone broth is low in energy but relatively high in protein. While beef-bone broth is low in Ca and Mg, its P content is high. Thus, the nutritional characteristics of beef-bone broth products should be taken into consideration, and product use should be guided by the purpose and context of consumption.

Keywords: beef-bone broth product, calcium, phosphorus, magnesium

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INTRODUCTION

Beef-bone broth is a soup made by boiling beef bones and miscellaneous bones for long periods, the eluate of which is then consumed; it has been recognized as a health food and a source of calcium (Ca), phosphorus (P), magnesium (Mg), and protein (Seol, Jang 1990, Kim et al. 2017). To make beef-bone broth, the mixture needs to be heated for long periods – more than 12 hours of heating are reportedly needed to fully elute nutrients from bones (Kim 2006). These long cooking times, along with changing social structures and the development of the food industry, have led to an increase in the consumption of ready-to-heat products over home-cooked broth. Furthermore, the COVID-19 pandemic has accelerated significant growth in the global convenience food sector in recent years (Sidor, Rzymski 2020, Wolfson, Leung 2020).

The average Korean diet has been consistently criticized for including insufficient amounts of Ca. The daily Ca intake of Korean adults falls below the recommended intake (RI) level, with only 64.7% of the RI consumed (KCDA 2023). The average Ca intake level was reported to be 521.9 mg/day (67.3% of the RI) for adult men aged over 19 years and 455.0 mg/day (62.4% of the RI) for adult women aged over 19 years (KCDA 2023). Given the importance of Ca in nutrition, previous studies have proposed strategies to increase the Ca content extracted from Ca-rich bones when making bone broth (Kim 2002, Kim et al. 2017). The addition of acetic acid, citric acid, or vinegar significantly increased the elution of Ca and P, but negative effects on sensory perception have been reported (Kim 2002, Kim et al. 2017). Furthermore, studies have investigated the addition of algal Ca to broth production (Kim et al. 2014). For Ca to be absorbed efficiently, the ratio of Ca to P should be considered. In general, a Ca to P ratio of 1 to 2:1 is considered ideal (Pastore et al. 2012). Moreover, Mg is an important component of the mineral phase of bone (Ciosek et al. 2021) and is also known as an important mineral for Ca nutrition (Dennehy, Tsourounis 2010). Mg is present in the human body at approximately 25 g, with 50-60% of it found in the skeletal structure. In plants, Mg is an integral component of chlorophyll, making green leafy vegetables a rich source of this mineral (Bohn et al. 2004). However, there has been relatively little research evaluating the magnesium content in broths made from bones.

Despite the studies on bone broth to date and the expectations of researchers, few studies have evaluated the extent to which bone broth contributes to the mineral supply in the diet, with a focus on Ca, P, and Mg. In particular, the nutritional value of ready-to-cook beef-bone broth, which is increasingly consumed in modern society, is important to evaluate. The mineral content of ready-to-heat bone broth can vary depending on the type of ingredients, water source, food additives, etc. Nutrition labeling of convenience food products has recently been mandated in South Korea, but sodium (Na) is the only mineral included in mandatory labeling for all food products except for mineral-fortified products (KFDA 2024). Therefore, analytical studies are needed to evaluate the nutritional value of minerals such as Ca, P, and Mg in ready-to-heat bone broth.

This study aimed to evaluate ready-to-heat beef-bone broth as a possible food source of Ca, P, and Mg. We first surveyed nutritional information and analyzed the Ca, P, and Mg contents of ready-to-heat beef-bone broth products sold in Korea. Next, the mineral content was compared according to the characteristics of the products, and the cost-effectiveness was evaluated against the purchase price. Finally, the mineral contribution rates of products relative to dietary reference intakes, DRIs (MOHW and the Korean Nutrition Society 2020) were evaluated.

MATERIALS AND METHODS

Sample collection

We purchased 36 types of ready-to-heat beef-bone broth products sold in online and offline markets in South Korea from May to November 2022.

Collection of general and nutritional information from beef-bone broth products

For each product, the selling price and amount (in grams) on the product label were recorded. The price of the broth was converted from Korean wons to US dollars using the current exchange rate. Energy value (in kilo calories), protein (in grams), fat (in grams), cholesterol (in milligrams), saturated fat (in grams), carbohydrate (in grams), sugar (in grams), and sodium (in milligrams) contents were collected from the nutrition label.

Mineral analysis of beef-bone broth products

Approximately 0.5 g of beef-bone broth (broth only), 5 mL of HNO_3, and 3 mL of H_2O_2 were mixed, and the mixture was digested using a wet decomposition method and a microwave digestion system (Multiwave 3000, Anton Paar GmbH, Graz, Austria). The concentrations of Ca, P, and Mg in the broth sample were analyzed using inductively coupled plasma-mass spectrometry (ICP-MS) with an Optima 5300 DV 9 instrument (PerkinElmer, Waltham, Massachusetts, USA). The operating conditions for ICP-MS were as follows: the analytical calibration curve was obtained by diluting a stock standard solution to 1, 5, 10, and 50 ppb (Kanto Chemical, Tokyo, Japan), with a correlation coefficient (r) greater than or equal to 0.999 for all minerals. The ICP-MS system was operated at 1600 W plasma power with a plasma gas flow of 20 L min^{-1}, a sample flush time of 60 s, an auxiliary gas flow rate of 2 L min^{-1}, and a nebulizer gas flow rate of 1.5 L min^{-1} with a perfluoroalkoxy nebulizer. The analytical masses used were ^{40}Ca, ^{31}P, and ^{24}Mg. The recovery rate from the wet digestion of the sample for mineral analysis was verified by conducting a parallel analysis of certified reference material (CRM No. 108-02-004, KRISS, Daejeon, Korea). The detection recovery rate was within ±5%. The relative standard deviation of the detected concentration was within 2-3% for each sample.

Nutritional evaluation of Ca, P, and Mg in beef-bone broth products

The contribution rates of Ca, P, and Mg from 250 g, the reference serving size of the broth, to the DRIs for Koreans were evaluated. The DRI was calculated from the daily RI values for male adults 19-29 years of age 800 mg Ca, 700 mg P, and 360 mg Mg (MOHW and the Korean Nutrition Society 2020). The Ca, P, and Mg contents of the beef-bone broth products were also compared with the contents of other broths and milk listed in the Korean Food Composition Database (RDA 2024).

Statistical analysis

Means and standard deviations were calculated for all the variables. Independent t tests were used to analyze the differences among the prices of products (above and below the median price). All the statistical analyses were performed using the program SAS Ver. 9.4 (SAS Institute, Cary, North Carolina, USA). The level of statistical significance was set to α=0.05.

RESULTS AND DISCUSSION

The price and nutritional content of the products were evaluated based on the reference serving size of 250 g for soup (Table 1). The average price was 1.42 US dollars per serving of beef-bone broth, with a minimum of 0.38 $ and a maximum of 3.86 $. The average calorie content was 42.65 kcal per serving of beef-bone broth, with a minimum of 12.50 kcal and a maximum of 98.00 kcal. The average carbohydrate content was very low, at 0. 8 g. The average protein content was 4.58 g, with a minimum of 1.30 g and a maximum of 18.33 g. The total fat content averaged 2.38 g, the saturated fat content averaged 0.92 g, and the cholesterol content averaged 5.45 mg. The average Na content was 299.66 mg, with a minimum of 25.00 mg and a maximum of 740.00 mg.

When the beef-bone broth products were compared, the products in the upper 50% price range had higher energy and protein contents than the products in the lower 50% price range (p<0.05). The products in the upper 50% of the price range had more cholesterol (p<0.01) but lower Na (p<0.05) than those in the lower 50% of the price range. We identified the Na content of the products on nutrition labels and found that the products in this study had a wide range of Na contents. The lower range was found in products

Table 1

Selling price, energy and nutrient contents per serving (250 g) of beef-bone broth products sold in Korea

Variables	Total (n=36)	Price		
		above median (*n*=18)	below median (*n*=18)	*t* value (*p*)
Price ($)	1.42±1.01 (0.38-3.86)	2.18±0.92 (1.16-3.86)	0.66±0.22 (0.38-1.03)	6.77 (<0.0001)
Energy (kcal)	42.65±22.95 (12.50-98.00)	51.56±24.98 (15.00-98.00)	33.74±17.10 (12.50-72.50)	2.50 (0.0175)
Carbohydrate (g)	0.79±1.30 (0.00-4.85)	0.78±1.11 (0.00-4.50)	0.80±1.50 (0.00-4.85)	-0.04 (0.9695)
Protein (g)	4.58±3.37 (1.30-18.33)	5.85±4.00 (1.50-18.33)	3.30±2.00 (1.30-9.75)	2.41 (0.0235)
Fat (g)	2.38±1.62 (0.40-7.00)	2.84±1.65 (0.50-7.00)	1.92±1.50 (0.40-6.00)	1.73 (0.0921)
Saturated fat (g)	0.92±0.72 (0.00-3.00)	1.06±0.79 (0.00-3.00)	0.78±0.64 (0.00-2.50)	1.18 (0.2475)
Cholesterol (mg)	5.45±6.03 (0.00-25.00)	8.50±6.55 (0.00-25.00)	2.41±3.50 (0.00-10.00)	3.48 (0.0018)
Na (mg)	299.66±224.30 (25.00-740.00)	209.17±198.91 (25.00-590.00)	390.14±216.04 (26.04-740.00)	-2.61 (0.0132)

The data are presented as the means ± standard deviations. The numbers in parentheses indicate the minimum and maximum values, *n* – number of samples.

that did not add salt to the bone broth, and some products were presalted such that they were ready to consume without additional salt. Considering the wide range of Na content per serving, it is important for consumers to check the Na content of ready-to-heat bone broth to ensure proper consumption. Na is one of the minerals that Koreans consume in excess, with an average intake of 3,000 mg reported by the National Health and Nutrition Examination Survey for adults aged 19 and over (KCDA 2023). Excess Na intake can negatively affect Ca absorption and promote urinary Ca excretion (Bedford, Barr 2011).

The Ca, P, and Mg contents of the products are shown in Table 2. The average Ca content per 250 g of beef-bone broth product was 7.65 mg, with a minimum of 2.23 mg and a maximum of 12.91 mg. The content of P, however, was high at 299.00 mg, with a minimum of 272.50 mg and a maximum of 344.18 mg. The average Mg content was 2.65 mg, with a minimum of 0.91 mg and a maximum of 6.87 mg. When the beef-bone broth products were compared, the upper 50% of the price range had a lower Ca content than the products in the lower 50% (p<0.05). These results show that the purchase of a lower-priced beef bone broth product may be more favorable for increasing the Ca content, whereas the purchase of a higher-priced product may be more favorable for increasing the protein content.

Table 2

Ca, P, and Mg contents per serving (250 g) of beef-bone broth products sold in Korea

Variables	Total (n=36)	Price		
		above median (n=18)	below median (n=18)	t value (p)
Ca (mg)	7.65±2.98 (2.23-12.91)	6.52±2.89 (2.37-11.02)	8.78±2.70 (2.23-12.91)	-2.42 (0.0209)
P (mg)	299.00±17.45 (272.50-344.18)	304.25±18.76 (278.50-344.18)	293.75±14.73 (272.50-318.83)	1.87 (0.0704)
Mg (mg)	2.65±1.38 (0.91-6.87)	2.73±1.73 (0.91-6.87)	2.57±0.95 (1.43-5.23)	0.34 (0.7349)

The data are presented as the means ± standard deviations. The numbers in parentheses indicate the minimum and maximum values, n – number of samples.

The amount of energy, protein, Ca, P, and Mg from one serving was evaluated as a percent contribution to the dietary reference intake (DRI) for Korean adult males aged 19-29 years (Table 3). The energy and protein contents of one serving of the beef-bone broth products averaged 1.64% and 7.04% of the DRIs, respectively. The contribution of protein to the DRI per serving of beef-bone broth was significantly greater for products in the upper 50% of the price range than for products in the lower 50% ($p<0.05$). The average Ca, P, and Mg contents from one serving of the beef-bone broth products were 0.96%, 42.7%, and 0.74% of the DRI, respectively. The contribution of Ca to the DRI per serving was greater for products in the lower 50% of the price range than for products in the upper 50% ($p<0.05$).

Table 3

The contribution rates of energy, protein, Na, Ca, P, and Mg to the reference intake of beef-bone broth products sold in Korea

Variables (%)	Total (n=36)	Price		
		above median (n=18)	below median (n=18)	t value (p)
Energy	1.64±0.88 (0.48-3.77)	1.98±0.96 (0.58-3.77)	1.30±0.66 (0.48-2.79)	2.50 (0.0175)
Protein	7.04±5.19 (2.00-28.19)	8.99±6.15 (2.31-28.19)	5.08±3.08 (2.00-15.00)	2.41 (0.0235)
Ca	0.96±0.37 (0.28-1.61)	0.81±0.36 (0.30-1.38)	1.10±0.33 (0.28-1.61)	0.34 (0.7349)
P	42.71±2.49 (38.93-49.17)	43.46±2.68 (38.93-49.17)	41.96±2.10 (38.93-45.55)	1.87 (0.0704)
Mg	0.74±0.38 (0.25-1.91)	0.76±0.48 (0.25-1.91)	0.71±0.26 (0.40-1.45)	0.34 (0.7349)

The data are presented as the means ± standard deviations. Numbers in parentheses indicate the minimum and maximum values, n – represents the number of samples. The reference intake values for male adults aged 19-29 years are: 2600 kcal for energy, 800 mg for Ca, 700 mg for P, and 360 mg for Mg.

Table 4 shows the Ca, P, and Mg contents of the beef-bone broth products compared with the contents of other broth and milk products in the Korean Food Composition Database (RDA.2024). The average Ca content per 250 g of other broth in the Korean Food Composition Database was 5.0 mg each, which was lower than the average for the beef-bone broth products in the present study. The average P contents per 250 g of beef-bone broth and

Table 4

Comparison of the energy, caloric nutrient, sodium, calcium, phosphorus and magnesium contents of beef-bone broth products with the contents of other broth and cow milk products in the Korean Food Composition Database

Specification	This study	Korean Food Composition Database		
		beef-bone broth*	beef-meat broth*	milk*
Per weight (250 g)				
Energy (kcal)	42.65±22.95	70	10	167.5
Carbohydrate (g)	0.79±1.30	0	0	12.15
Protein (g)	4.58±3.37	10.75	2.5	7.73
Fat (g)	2.38±1.62	2.5	0	9.63
Sodium (mg)	299.66±224.30	152.5	65	100
Calcium (mg)	7.65±2.98	5	5	295
Magnesium (mg)	2.65±1.38	-	-	25
Phosphorus (mg)	299.00±17.45	10	60	260
Per energy (100 kcal)				
Carbohydrate (g)	1.27±2.08	0	0	7.25
Protein (g)	7.32±5.39	15.36	25	4.61
Fat (g)	3.81±2.60	3.57	0	5.75
Sodium (mg)	479.45±358.88	217.86	650	59.70
Calcium (mg)	12.24±4.77	7.14	50	176.12
Magnesium (mg)	4.24±2.20	-	-	14.93
Phosphorus (mg)	478.40±27.92	14.29	600	155.22

* Data from the Korean Food Composition Database ver. 10.2. National Institute of Agricultural Sciences, Rural Development Administration, Korea

beef-meat broth in the Korean Food Composition Database were 10.0 mg and 60 mg, respectively, which were much lower than the average P content for the beef-bone broth products in the present study. The Mg contents of beef-bone broth and beef-meat broth were not listed in the Korean Food Composition Database; thus, the Mg contents were not compared with the results of this study. The Ca content of milk, a main source of Ca, was 295 mg 250 g^{-1}, and the P content was 260 mg 250 g^{-1}, which was similar to that of the bone broth products.

Beef-bone broth is one of the most popular hot soups traditionally consumed in Korea, and it is made by boiling beef bones in water for long periods to leach out nutrients and remove fat after cooling (Kim et al. 2014, Yoon et al. 2015).

It is also used as a flavor-enhancing broth to make other foods, such as soups, stews and sauces (Chimegee, Dashmaa 2018, Ozturk, Kerimoğlu 2022). Considering the inconvenience of cooking for long periods at home, the cost of ingredients, and the fuel required for cooking, beef-bone broth may not be a cost-effective food in the modern world; however, owing to the development of science and technology and the food industry, various broth products have been sold on the market in the form of pouches that are distributed at room temperature or refrigerated (Lee 2017). When beef-bone broth is consumed as hot soup by itself, it is seasoned with salt and pepper and served with cooked rice, a staple food, and kimchi, a traditional Korean preserved vegetable. The mild flavor of beef-bone soup pairs well with any dish, and its easy digestibility makes it preferable among children and elderly individuals. In particular, since it is made from beef bones, it is often consumed by elderly people, who are concerned about their bone health, with the expectation that it is good for their bones.

Ca and Mg play crucial roles in the skeletal function in the body, and a deficiency in these minerals has been reported to be commonly associated with noncommunicable diseases, such as osteoporosis, sarcopenia, and cardiovascular disease, which are having an increasing global impact on health status (Swaminathan 2003, Pickering 2021, Shlisky et al. 2022, van Dronkelaar et al. 2023). Our mineral content analysis of the ready-to-heat beef-bone broth showed that the average Ca content was very low at 7.65 mg per serving (250 g), with a maximum of 12.91 mg. The Ca content of the same amount of milk (295 mg 250 g^{-1}), a well-known source of Ca, was about forty times greater. The average Mg content of the ready-to-heat beef-bone broth in our study was also low at 2.65 mg per serving (250 g), with a maximum of 6.87 mg. These results suggest that ready-to-heat beef-bone broth products are not good sources of Ca and Mg. In a study that analyzed the mineral content of Korean beef-bone broth prepared by heating bones in only water for 12 h using a conventional home cooking method, the Ca content of the beef-bone broth was 6.31 mg kg^{-1}, and the Mg content was 2.03 mg kg^{-1} (Yoon et al. 2015). Converting these values to the same serving size of 250 g in this study yields 1.5 mg of Ca and 0.51 mg of Mg, which demonstrates that beef-bone broth still has low levels of Ca and Mg. Contrary to the common assumption that bone-based broths are rich in Ca, some plants, particularly dark green leafy vegetables have been demonstrated to contain considerable amounts of Ca and Mg. Wild vegetables, in particular, are noted for their exceptionally high mineral content, with Sedum species reported to contain 169 mg of Ca 100 g^{-1} (Bae et al. 2015). The mineral composition of plants is strongly influenced by soil properties and fertilization practices. Consequently, studies have been conducted to assess the effects of soil amendments on the mineral content of plants (Kepka et al. 2016).

A Taiwanese study that analyzed the mineral content of animal bone broths used in commercially available street food reported that beef bone broth contained an average of 21 mg of Ca and 17 mg of Mg per serving (Hsu et al. 2017). These levels are higher than those in this study but may be due to differences in the source of the ingredients or the concentration. Moreover, the Mg content may also be high as a result of the various spices in the broth. A Mongolian study reported that factory-produced beef-bone broth concentrate prepared with only salt and water contained 853 mg kg^{-1} Ca and 467 mg kg^{-1} Mg. Although the broth used in the Mongolian study was more concentrated than that used in this study and a simple comparison is not possible, the ratio of Ca to Mg is similar to that in our study, showing that concentrated beef-bone broth in the Taiwanese study can provide milk-level Ca content and a high level of Mg.

Beef-bone broth prepared using conventional methods, which primarily involve prolonged simmering of bones in water, contains only limited amounts of Ca. Thus, some studies have reported strategies to increase the elution of Ca from bone extracts (Kim 2002, Kim et al. 2017). In a study investigating the effects of organic acid treatment on the amount and content ratio of Ca and P in bone broth, the amount of Ca in the bone broth extract increased significantly with increasing acetic acid and citric acid contents, whereas the amount of P increased only when citric acid was added to the extraction medium (Kim 2002). The addition of vinegar and citric acid also increased Ca elution into the bone broth, but the sensory evaluation was not favorable (Kim et al. 2017). These findings have limitations in their application to the preparation of bone broth in Korea. In Western stews, bone broth is often flavored with various vegetables and other flavorful foods, but in Korea, beef-bone broth is usually consumed on its own. Therefore, the addition of organic acids can have a sensory deterrent effect, and consumers' preference for products without additives, even in processed foods, is high; therefore, bone broth products containing organic acids are rare. However, considering the recent increase in the production of broth products that flavor food in Korea, products need to be developed that can enhance the nutritional properties of bone broth, both when it is consumed on its own and when it is used as a liquid ingredient in strongly flavored foods.

In addition to Ca, P in the form of hydroxyapatite is one of the major building block minerals for the skeleton (Ciosek 2021). In this study, the average P content of the beef-bone broth products in this study was greater than the P content of the beef-bone broth in the Korean Food Composition Database. Importantly, the beef-bone broth in the Korean Food Composition Database is not processed food, as it is prepared in a homemade style with water in a pot without any additives. Additionally, in a study that analyzed the mineral content of Korean beef-bone broth prepared by a conventional home cooking method consisting of heating bones in only water for 12 hours, the P content was 10.11 mg kg^{-1} (Yoon et al. 2015). P can be found in foods in naturally occurring forms, such as cereals, seeds, nuts, legumes, meat, and dairy products as well as in inorganic phosphate additives (Vorland et al. 2017). When bone-broth is manufactured at the factory level, food additives can be used for various purposes during the manufacturing process. In this study, most, but not all, samples were labeled as containing food additives or ingredients other than water or salt. Food additives such as emulsifiers and stabilizers often contain P, and these factors may have contributed to the high P content of the bone-broth products. In addition, when manufacturing beef-bone broth in large quantities at the factory level, the pressure, temperature, time, amount of ingredients, etc., could be very different from those used in home cooking. These factors may have affected the P content of the products, and future research should be conducted to identify the underlying causes.

This study is not without limitations. The nutritional evaluation of minerals focused on Ca, Mg, and P contents in a limited number of samples, 36 in total, which is not sufficiently representative of the entire variety of beef-bone broth products. Increasing the number of samples of beef-bone broth products to be analyzed necessitates the evaluation of the mineral content using a more detailed classification. This study focused on the mineral content of beef-bone broth products, which is closely related to skeletal health, but it only presents information on the content of ready-to-heat beef bone-broth products sold in Korea. Therefore, comparative studies involving homemade and restaurant-made beef-bone broths are needed. Furthermore, clinical studies evaluating the mineral availability of beef-bone broths need to be conducted. Despite these limitations, the consumption of ready-to-heat beef-bone broth products is increasing; therefore, the contents per serving and economic value of minerals such as Ca, which have high nutritional importance and consumers' expectations of intake, should be evaluated in products available on the market.

CONCLUSIONS

Taken together, the results of this study suggest that the ready-to-heat beef-bone broth currently sold in Korea does not contain high levels of Ca and Mg, which are needed to increase intake in Koreans. However, when the caloric, protein, and fat contents were evaluated based on the nutrition label, the products were found to be low in calories and fat and relatively high in protein. Because the consumption of ready-to-heat and ready-to-eat products continues to increase, companies should develop products that can fulfill the expectations that consumers have for food or provide consumption guidelines that reflect the nutritional characteristics of the products. The findings of this study suggest limitations in the Ca, Mg, and P contents of ready-to-heat bone broth as a food for bone health. However, its value as a low-calorie, high-protein food should be emphasized.

Author contributions

M.H.C – supervision, methodology, writing, review; M.H.K. – conceptualization, investigation, methodology, project administration, formal analysis, original draft preparation, review, editing, funding acquisition. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors of this study declare that there are no conflicts of interest.

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