



## THE DAILY VALUE OF MICRONUTRIENTS IN NEWLY PRODUCED BEEF AND HORSE CONCENTRATED BONE BROTHS

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### ABSTRACT

*Beef and horse marrow bones were used to produce the concentrated bone broth and the possibility to make a bone broth only with salt was assessed. Protein and mineral contents in horse broth were higher ( $p < 0.02$ ; 1.92 and 2.3%, respectively) than in beef broth. Concentrations of calcium, magnesium and iron in beef bone broth (85.3, 46.7 and 23.3 mg/100g) were higher ( $p < 0.05$ ) than in horse broth (66.6, 10.0, and 12.3 respectively). Beef bone broth had more ( $p \leq 0.05$ ) essential amino acids than in horse broth. The daily value of total essential amino acids of 100g concentrated beef and horse bone broths were 38 and 27.4% respectively. While daily value of calcium 6.7-8.5%, magnesium 4.5-21.2% and iron was 6.8-12.9% respectively. Results showed that bone broth possess many health beneficial properties, such as being a good source of minerals and essential amino acids.*

**KEY WORDS:** Amino acid, mineral, calcium, magnesium, iron

### INTRODUCTION

In the past 20 years, micronutrients of the world have assumed great public health importance. As a consequence, considerable research has been carried out to better understand their physiological role and the health consequences of micronutrient-deficient diets, to establish criteria for defining the degree of public health severity of micronutrient malnutrition, and to develop prevention and control strategies [1,2]. Since 2000, Mongolian food scientists studied the biologically active components, which are potential human health benefits include: calcium, iron, magnesium, essential amino acids and connective tissue proteins and/or peptides from bones or other edible parts of the slaughtered animals which are often used in further processing [3]. The Demberelnyam [3] extracted calcium ion by crystal form from horse marrow bones, studied biological value and then he has intended a technology of producing calcium supplement for calcium deficiency symptoms. Mongolian medicine uses animal bone broths for boosting the immune system, supporting digestive systems. Especially the

process of simmering marrow bones for longer time causes the bones to release healing compounds such as essential amino acids that have the power to transform the human health. Furthermore, the minerals including calcium, magnesium and potassium etc. and the marrow helps build blood cells, which play an important role in the healing mechanism of the body [4, 3]. Therefore, the world major markets for bone broth appear to be in beef or chicken bone stock with various flavor enhancers, preservatives or vegetables. Besides being used as the traditional dishes, the bone broth have been as healing tonics for the prevention and remedy of many ills for centuries, however, science-based studies on the nutritional value are lacking. Thus, purpose of this work was to study of biological valuable related to essential amino acids and minerals on newly produced concentrated beef and horse broth and to compare daily value of micronutrients in concentrated bone broths to recommended allowances based on WHO/FAO data.

## MATERIALS AND METHODS

Concentrated bone broth was produced in “HASU” factory of “Khatan suikh” LLC. The fresh marrow bones including, knuckle, patelle and femur from pasture-raised cattle and horses were used. No additives, flavor enhancers, preservatives or vegetables except salt added in bone broths. Totally 60 products /beef's n=30 and horse's n=30 respectively/ were used for following chemical analyses.

**The total protein:** The total protein was determined by “Foss Kjeltac™ 8100” auto distillation unit, based on a Kjeldahl method [5].

**Mineral content:** Calcium, magnesium and iron content was analysed by spectrophotometer (Thermo Scientific, Gallery, Finland). The absorbance was measured; calcium at 660 nm, magnesium 520 nm, iron 600 nm respectively [6].

**Amino acid concentration:** Broth samples were hydrolyzed by 6N HCl at 110°C during 24 h. Samples cooled and dissolved in 2 ml buffer after evaporation residual hydrochloric acid at 150°C.

Then supernatant was filtered by double filter. The 100 µl supernatant was added in 900 µl buffer and mixed by shaker. After sample preparation, separation and determination of the amino acids done by the analyzer Aracus /Clarity, Germany/ with the classic routine analysis of amino acids by post-column derivatization with ninhydrin. The maintenance-free LED photometers detect the separated amino acids at 570 nm and 440 nm and the signals are registered by the software Amino Peak. Individual amino acid values were expressed as mg/100g.

**Statistical analysis:** Statistical analysis was carried out by Generate orthogonal design procedure in SPSS 16.0 (SPSS Inc., IBM, USA) program package. Results were reported as mean±standard deviation and probability of obtained results defined by *p*-value. The estimates requirement for the indispensable amino acids was based on mean total protein requirement of 0.66 g/kg per day [7].

## RESULTS AND DISCUSSION

In the present study, protein and mineral contents in horse broth were higher ( $p < 0.02$ ; 1.92 and 2.3% respectively) than in beef broth (Table 1). These contents were falling within the scale published in relevant literature. Similar range were 28% for proteins of beef stock was established by Meat and livestock Australia (MLA) [8]. While 30% for proteins and 15% total minerals were in products from beef cattle breed of “Taranaki Bio Extracts” LLC, New Zealand [9]. According to USDA BFP

database [10] 100 ml beef stock (not concentrated) provides approximately 4.17g protein. These observations are in agreement with the results in the present study. In current study, the 100g concentrated beef and horse bone broths provides approximately 85.3 and 66.6 mg calcium (8.5 and 6.7% of the daily value), 46.7 and 10.0 mg magnesium (21.2 and 4.5% daily value) and iron 23.3 and 12.3 mg (12.9 and 6.8% of the daily value) respectively (Table 2).

Table 1

**Protein and total mineral content of bone broths compared with counterpart product of “Taranaki Bio Extracts” LLC from New Zealand**

Content	Concentrated bone broths		
	Beef broth /present study/	Horse broth /present study/	Beef broth, New Zealand
Protein, %	23.2±0.0001 <sup>b</sup>	25.1±0.0001 <sup>a</sup>	30.0
Total minerals (ash), %	10.7±0.001 <sup>b</sup>	13.0±0.001 <sup>a</sup>	15.0

These results are compared with the USDA database which provides some useful averages. For instance, 100 ml beef broth (not concentrated) provides approximately 8 mg calcium and 30 mg iron. While the mineral content will vary depending on the amount and types of bones and vegetables used as the base [10]. Furthermore according to USDA BFP

database [1], the mean apparent of calcium requirement for adults in developed countries is about 520mg (13mmol), but this is increased by insensible losses to some 840mg (21mmol). This reasoning forms the basis of the recommended intake for adults of 1000mg.

Table 2

**Comparison of the mineral contents and daily value of concentrated bone broths with recommended mineral allowances**

Minerals	Recommended intake (mg/day), FAO of the United Nations/WHO*	Mineral contents in current study, mg/100g		Daily value, %	
		Beef bone broth	Horse bone broth	Beef bone broth	Horse bone broth
Calcium	1000	85.3	66.6	8.5	6.7
Magnesium	220	46.7	10.0	21.2	4.5
Iron	18	23.3	12.3	12.9	6.8

\*Food and agriculture organization of the United Nations/ World Health Organization

Many other investigators have documented that among the nutrients of greatest concern are calcium iron and magnesium. Calcium is an essential nutrient that plays a vital role in neuromuscular function, many enzyme-mediated processes, as well as providing rigidity to the skeleton by virtue of its phosphate salts. Its non-structural roles require the strict maintenance of ionized calcium concentration in tissue fluids at the expense of the skeleton if necessary and it is therefore the skeleton which is at risk if the supply of calcium falls short of the requirement [1]. Particularly, beef and horse bone are good sources of iron. Iron intake is important to combat anaemia, which is still widespread amongst children and pregnant women. Iron in meat or bone has a higher bio-availability, better resorption and metabolism than iron in plant products [11]. Soft

tissue magnesium functions as a cofactor of many enzymes involved in energy metabolism, protein synthesis, RNA and DNA synthesis, and maintenance of the electrical potential of nervous tissues and cell membranes. Moreover significant increases in bone mineral density of the femur have been associated positively with rises in erythrocyte magnesium when the diets of subjects with gluten-sensitive enteropathy were fortified with magnesium [1]. Estimates of the adult indispensable amino acid requirements of WHO/FAO/UNU [7] are shown in Table 3, as mg/kg per day. The amino acid content of the bone broth compared with the requirement pattern and showed the compared values expressed as a percentage of the daily values (how 100g broths provide the recommended daily intake of essential amino acids).

Table 3

**Essential amino acid content and daily value of concentrated bone broths compared with recommended amino acid allowances based on FAO data**

Essential amino acids	Recommended intake (mg/kg per day) FAO of the United Nations/WHO*	Essential amino acid content, mg/100 g		Daily value %	
		Beef bone broth	Horse bone broth	Beef bone broth	Horse bone broth
Threonine	15	10.99	7.37	7.3	4.9
Valine	26	8.76	6.15	3.3	2.3
Methionine	10	11.20 <sup>a</sup>	6.83 <sup>b</sup>	9.2	6.5
Isoleucine	20	6.92	4.68	3.4	2.3
Leucine	39	9.16	6.32	2.3	1.6
Phenylalanine	20	23.29 <sup>a</sup>	17.11 <sup>b</sup>	8.3	6.9
Lysine	30	12.82 <sup>a</sup>	8.89 <sup>b</sup>	4.2	2.9
Cysteine	4.1	-	-	-	-
Tryptophan	4	-	-	-	-
Total	168.1	83.15	57.34	38	27.4

\*Food and agriculture organization of the United Nations/ World Health Organization

The nutritional value of a protein reflects its essential amino acid composition. The estimate of the requirement for total essential amino acids were

168 mg/kg per day. Present results showed that the 100g concentrated beef and horse bone broths provides approximately 85.2 and 57.3 mg/100 g of

total essential amino acids (38 and 27.4% of the daily value) respectively. Percentage of the daily values of phenylalanine, methionine was greater than other essential amino acids. Although beef bone broth is more packed with essential amino acid; methionine, phenylalanine and lysine contents were greater ( $p < 0.02$ ) than in horse broth. Methionine plays a critical role in cardiovascular health, in the ability of body to detoxify potentially harmful substances, and in balanced availability of B-complex vitamins. Phenylalanine and tyrosine are best known for their role in the nervous system. Lysine and threonine are especially important for genetic processes that take place in the cell nucleus. Moreover, lysine eliminates virus infections in combination with vitamin C, A and Zn and lysine deficiency can cause poor appetite, weight loss and anaemia [1]. Bone broth has not only the health ..... as an added value, but also it has a cultural

aspect added to its features. As the food industry becomes more global, these products could become Mongolian brand with high quality, considering basic sources for foreign markets. In order to make bone broth healthier and palatable, a review of the process, further studies on fatty acid composition and quality control of lipids are recommended. Present results showed that concentrated bone broths could be the Mongolian brand products without any flavorings. There are no uses of artificial flavors like natural flavors, veggies, and spices flavor or yeast extract in this new products. Moreover, consumers are attracted by products that are safely packaged in a way that suggests easy to use and with user-friendly information (Fig.1). These 100% natural bone broths, suitable for a drinking straight daily and also for variety of recipes: add flavor and health-boosting benefits to soups, sauces, and meals.



Figure 1. Concentrated bone broths: A) beef broth and B) horse broth

## CONCLUSION

Both concentrated bone broth were rich in minerals, including calcium, magnesium and iron that support the immune system, and especially percentage of the daily values of phenylalanine, methionine was

greater than other essential amino acids. These results indicated that these products are biological valuable.

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