Qualitative Characteristics and Therapeutic Potential of Beef Bone Broth as a Functional Food: A Data-Driven Review

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Abstract: This paper analyzes the physicochemical, nutritional, microbiological, and therapeutic properties of beef bone broth using data from recent scientific studies. It evaluates the impact of animal age on protein and collagen yields, the presence of micro- and macronutrients, and the specific amino acid profile. Results confirm that beef broth from juvenile cattle (up to 24 months) exhibits the highest proportion of collagen (20.44%) and total protein (22.06%). The analysis demonstrates exceptional suitability for athletes and daily use, highlighting the clinical potential of collagen peptides in alleviating osteoarthritis pain, enhancing post-exercise recovery, and improving skin elasticity.

1. Introduction

The modern food industry is shifting towards the maximal utilization of animal by-products in accordance with the principles of the circular economy. Bones, particularly those sourced from local butchers, represent a significant portion of residual mass and are a rich source of type I collagen, calcium, phosphorus, and other bioactive substances [1]. Thermal extraction—the process of prolonged simmering under controlled conditions—transforms these bones into a functional beverage that perfectly aligns with modern nutritional demands.

2. Physicochemical Properties & Cattle Age Impact

The nutritional profile of beef broth depends primarily on the age of the cattle and the addition of other ingredients. A recent study by Anchidin et al. (2024) [1] analyzed four batches: juvenile animals (YBS1), juvenile animals with vegetables (YBVS2), adult animals (ABS3), and adult animals with vegetables (ABVS4).

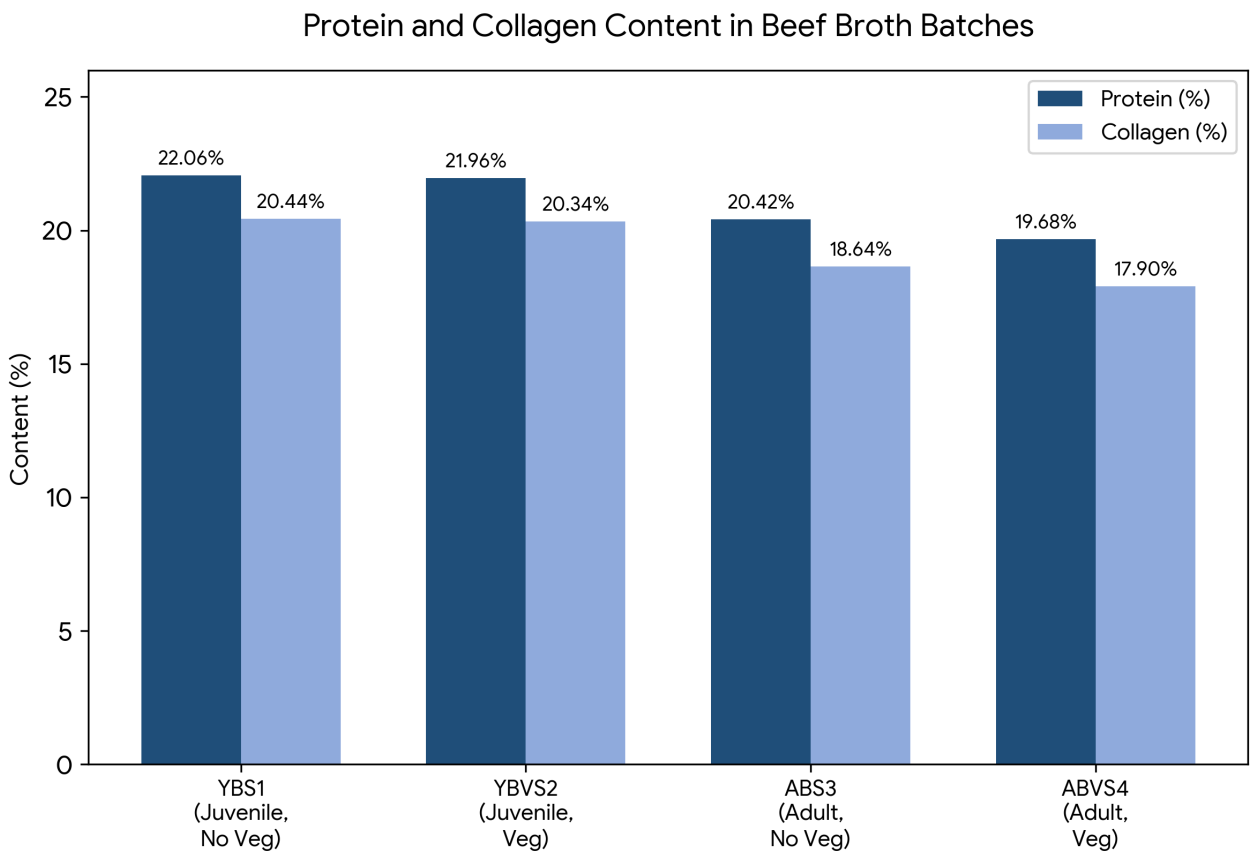

Figure 1: Comparison of protein and total collagen content across different beef broth batches [1].

Broths prepared from juvenile cattle bones (under 24 months) show a higher degree of collagen hydrolysis into liquid form, resulting in a higher protein content (up to 22.06%) and specifically collagen (20.44%) compared to older animals [1]. Conversely, broths from adult cattle had a significantly higher lipid content (8.36% to 11.52%, compared to 1.26% in juvenile animals).

3. Nutritional Profile: Amino Acids & Minerals

3.1 Amino Acid Profile

Proteins in beef broth consist primarily of denatured collagen, which provides bioactive peptides upon consumption [4]. Beef femur broth is exceptionally rich in Glutamic acid, Histidine, Arginine, and Glycine [2]. This unique profile differs from other animal proteins by providing the critical conditionally essential amino acids required for endogenous collagen synthesis [5].

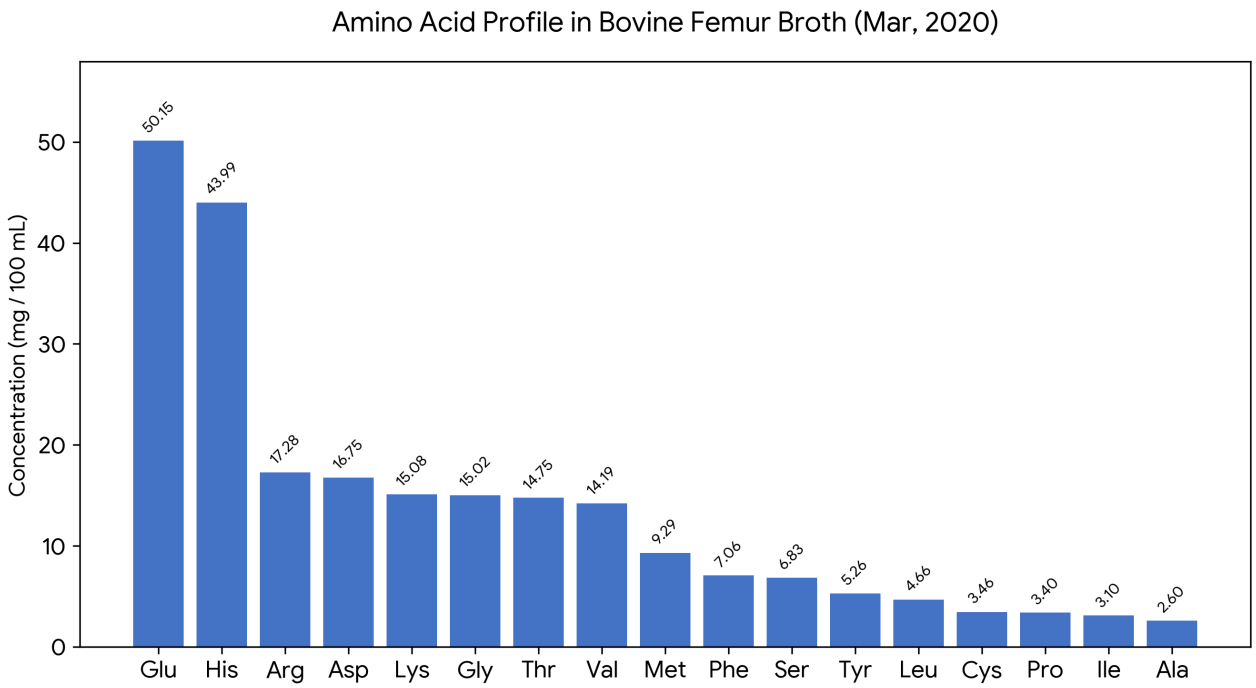

Figure 2: Key amino acid concentrations in bovine femur broth (mg / 100 mL) [2].

3.2 Micronutrients (Minerals)

Concentrated beef broth provides a significant portion of the daily requirement for essential minerals. It exhibits a statistically significant higher content of calcium, magnesium, and iron compared to other bone broths [3].

Mineral	Content in Beef Broth (mg/100g)	% Daily Value (DV)
Calcium (Ca)	85.3	8.5 %
Magnesium (Mg)	46.7	21.2 %
Iron (Fe)	23.3	12.9 %

4. Therapeutic Efficacy and Clinical Benefits

Regular supplementation with beef bone broth, as a significant source of collagen peptides, has proven to be clinically relevant in several indications [4]:

- **Osteoarthritis and Joint Health:** Supplementation (5-10g daily) stimulates the synthesis of proteoglycans and type II collagen in cartilage, leading to a demonstrable reduction in pain (measured via VAS and WOMAC scores) in patients with degenerative joint diseases.
- **Dermatological Effects and Anti-Aging:** Peptides rich in proline and hydroxyproline pass into the dermis after absorption, where they protect the skin structure from degradation, increase its moisture, and reduce the formation of wrinkles.

- **Insulin Sensitivity and Wound Healing:** The high concentration of glycine in beef broth helps regulate insulin release, thereby protecting against postprandial glucose spikes, and directly supports fibroblasts in the production of new tissue during wound healing [2, 4].

5. Suitability for Athletes and Daily Use

Bone broth is highly recommended for daily consumption, particularly for individuals with an active lifestyle. For athletes, strenuous exercise can cause structural damage to the extracellular matrix of skeletal muscles, resulting in pain and reduced function. Supplementation with collagen peptides directly supports myofibrillar muscle protein synthesis, enhances recovery times, and improves overall body composition and grip strength [4]. The presence of glycosaminoglycans (GAGs) like chondroitin sulfate also protects articular cartilage from mechanical stress.

6. Recommended Dosage

Based on clinical efficacy studies regarding collagen hydrolysate (CH) and specific collagen peptides (SCPs), the optimal dosage varies by the desired outcome [4]:

- **Daily Wellness & Skin Health:** 5 to 10 g/day. This dosage is sufficient to improve skin hydration, reduce wrinkles, and maintain joint health.
- **Osteoarthritis & Joint Pain:** 5 to 10 g/day for long-term symptom relief and cartilage matrix stimulation.
- **Athletes & Post-Exercise Recovery:** 15 to 30 g/day. Higher doses are recommended to maximize muscle protein synthesis and accelerate recovery after intense physical activity.

7. Safety and Toxicology

High-quality beef broth is remarkably safe. Analyses have shown that heavy metal concentrations (e.g., Lead at 0.056 mg/kg, Arsenic at 0.011 mg/kg) are well below international safety limits (0.1 mg/kg) [2]. Cadmium and mercury were not detected. Furthermore, microbiological testing of pasteurized broths confirmed the absence of Salmonella and maintained safe levels of standard bacterial markers [1].

8. Conclusion

Beef bone broth, especially when sourced from juvenile cattle bones, is a highly potent and safe functional food. It delivers an ideal ratio of proteins, collagen, and bioactive amino acids with proven therapeutic overlap in sports nutrition, rheumatology, and dermatology. The meticulous formulation based on these scientific parameters ensures a premium product tailored for both daily consumers and professional athletes.

9. References

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