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Traditional Bone Broth in Modern Health and Disease

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Introduction

Broth, made from the bones of animals, has been consumed as a source of nourishment for humankind throughout the ages. It is a traditional remedy across cultures for the sick and weak. A classic folk treatment for colds and flu, it has also been used historically for ailments that affect connective tissues such as the gastrointestinal tract, the joints, the skin, the lungs, the muscles and the blood. Broth has fallen out of favor in most households today, probably due to the increased pace of life that has reduced home cooking in general. Far from being old-fashioned, broth (or stock) continues to be a staple in professional and gourmet cuisine, due to its unsurpassed flavor and body. It serves as the base for many recipes including soup, sauces and gravy. Broth is a valuable food and a valuable medicine, much too valuable to be forgotten or discounted in our modern times with our busy ways and jaded attitudes.

Definition

In general, broth is a liquid made by boiling meat, bones, or vegetables. There are many types of broths, based on what is being cooked. For example, Bieler Broth, a vegetable broth made with green beans, zucchini, and celery is a supportive remedy used in detoxification or cleansing protocols. Consommé, a rich broth made from meat, is another example. It is prepared by reducing, or prolonged simmering. Stock is another word used synonymously with broth, though some chefs denote stock as being made from bones whereas broth is made from meat. In this paper the two names are used interchangeably. Soup is a similar term referring to simmered vegetables, meat, and seasonings, and is defined by *Random House Webster's Dictionary* as a liquid food.¹ The difference is that soup contains solids such as meat, beans, grains or vegetables (sometimes disguised by a purée) while a broth is the liquid in which solids have been simmered and then discarded. Soup is what we think of as having for a meal. Broth is a starting ingredient for soup, and must be prepared separately beforehand.

Method

The ingredients are as follows: bones from an animal, with or without meat and skin, enough water to just cover the bones, a splash of vinegar, and optional assorted vegetables or their scraps. Making broth requires almost no work, just put the bones in a pot, add water and vinegar, bring it to a simmer and walk away. No chopping or tending is needed.

Why then, don't people make it? Stock needs to be prepared in advance to mealtime. It needs to boil for hours, and the longer it simmers, the better it gets. An easy solution is to routinely put meat scraps into a pot, instead of

the garbage can. Broth can just as easily be extracted from a single chicken breast bone as it can from a whole chicken, and it need not be raw. Broth can be allowed to simmer on lowest heat for a day or two. The greatest amount of work is at the end, when it must be strained, cooled, and put into containers, still not very troublesome. It can be kept in the refrigerator for about five days, or frozen for months.² With stock on hand, homemade soup can be ready for dinner within 20 minutes. ([See Appendix A for more recipe details.](#))

Nutritional Contents

Basically then, broth will contain the ingredients that are in bone. Covering and adhering to the ends of bones to form a joint, is cartilage. Therefore broth will also contain the ingredients that are in cartilage. Bone and cartilage are both classified as connective tissue. Connective tissue is one of the four basic tissue types that exist in animals. It functions to bind or hold together and to support and strengthen the body. Connective tissue consists of a matrix, and cells that secrete the matrix. The matrix is the material that fills the space between the cells and is therefore referred to as the extracellular matrix. It is composed of protein fibers, and ground substance, which can be a liquid, a gel or a solid. Since the cells are few, it is the valuable nutrients from the matrixes of bone and cartilage, which create the substance called broth. (Table I)

Table I: Connective Tissue

Extra Cellular Matrix		Cells	
Ground Substance	Protein Fibers		
<i>Bone:</i> calcium phosphorus magnesium sulfur fluoride sodium and potassium	<i>Bone:</i> collagen I (90%) collagen III	<i>Bone:</i>	osteocytes
<i>Cartilage:</i> chondroitin sulfate keratin sulfate hyaluronic acid	<i>Cartilage:</i> collagen II elastin	<i>Cartilage:</i>	chondrocytes

Bone

The primary functions of bone are to provide a support framework, protect organs, store and release minerals, produce blood cells and store energy. In the matrix of bone, the protein, collagen, forms the fibers. Collagen has the ability to resist a pulling or tearing force, called tensile strength. It is flexible and rubbery. The other matrix component, the ground substance, is made of mineral salts. Calcium and phosphorus, in a composite called hydroxyapatite, and some calcium carbonate, form 65% of the ground substance. Water contributes 25%. The remaining 10% is formed by magnesium, sodium, potassium, sulfate and fluoride.^{3,4} (Table I) The inorganic minerals form a solid ground substance and give bone its hardness. If bones were made only of collagen they would be rubbery, but if they were made only of minerals, they would be brittle. Together they make bone flexible and hard.

Bone Marrow

In a central cavity, bone also houses marrow. There are two types of bone marrow, red and yellow. Red bone marrow is the location for the manufacture of the cells in blood. It produces the cells in their immature forms. The final conversion into mature blood cells occurs outside the bone marrow. The cells made in the red marrow are myeloid stem cells, the precursors to red blood cells, and lymphoid stem cells, the precursors to white blood cells and platelets. Red blood cells carry and deliver oxygen to other cells, white blood cells are part of the immune system, and platelets allow for clotting. Red bone marrow also contains collagen protein fibers, sometimes called reticulin fibers, classified as type III collagen.⁵ (Table I) In comparing why less chicken parts compared to beef parts are needed to produce a similarly strong tasting broth, the authors of *The Best Recipe* cookbook suggest that chicken bones have a higher concentration of red marrow, and that this considerably enhances flavor.⁶

Yellow bone marrow is a storage site for energy in the form of lipids or fats. It contains adipocytes within which fat is stored. It also contains a small amount of blood cells and type III collagen fiber.⁷ (Table I)

Cartilage

Cartilage is deposited in varying places in the body including the nose and ear. The joint cartilage is the primary type that gets incorporated in broth. It functions as a shock absorber and to reduce friction. In the matrix of cartilage, the fiber component is collagen protein and elastin protein. Like collagen, elastin provides strength, but it also provides stretch. It can stretch up to one and a half times its original length.⁸ The other matrix component, ground substance is made of the glycosaminoglycans (GAGs) chondroitin sulfate, keratin sulfate and hyaluronic acid. The GAGs form a gel ground substance that gives cartilage its resilience. (Table I)

Cartilage has enjoyed fame as a supplement for osteoarthritis in the form of shark cartilage. It has been studied for joint disease, and gastrointestinal disease. Prudden found that cartilage dramatically improved degenerative joint disease, including rheumatoid arthritis. He also found that it improved inflammatory bowel disease.⁹

Cartilage has a poor blood supply. It actually produces chemicals known as antiangiogenesis factors (AAFs) that inhibit the growth of blood vessels into it. This seemingly unfortunate quality can actually be used to advantage in the fight against cancer. Cancer cells grow very rapidly. They achieve rapid proliferation by stimulating the growth of new blood vessels to support themselves. AAFs are now being used as a treatment to inhibit the growth of blood vessels into cancer cells.¹⁰ As a medicine, AAFs are given in the form of cartilage.¹¹

Cartilage supplementation also stimulates B, T, and macrophage immune cells.¹² According to Murray and Pizzorno, malnutrition (protein deficiency) is the most common form of immune suppression in the world.¹³ That is because the immune system is composed primarily of protein, including antibodies, receptors and

chemical signalers. When it is further considered that 80% of the immune system lines the gastrointestinal tract, the role of cartilage gains importance, since it can nourish both the gut and the immune system.¹⁴

Pharmaceutically prepared cartilage is very expensive, often prohibitively so. Of course cartilage can be extracted at home, by making broth. Broth recipes stress the quality that can be obtained from using highly cartilaginous parts of animals. These parts will be joint areas, like chicken feet and beef knuckles, trachea and ribs, or anatomy with a concentration of glycosaminoglycans, like hooves and skin.

To summarize, cartilage (broth) can be considered for use in the following conditions: arthritis, inflammatory bowel disease (Crohn's disease and ulcerative colitis), cancer, decreased immune system states, and malnutrition.

Collagen and Gelatin

Collagen comes from the word kolla, which means glue. True to its verbal root, it has been used as glue in the past. It functions to hold the body together. One fourth of all the protein in the body is collagen.¹⁵ It is the framework for the extra cellular matrix of bone, cartilage and skin. Another word for collagen is gelatin. Collagen is a scientific term for a particular protein in the body, while gelatin is a food term referring to extracted collagen. It is usually encountered in powdered form, but gelatin also describes the collagen extracted into broth. Properly prepared broth will gel, just like Jell-O, when cooled, because collagen is rubbery and flexible. *Webster's Dictionary* defines gelatin as "the... substance extracted by boiling bones, hoofs, and animal tissues."¹⁶ Since collagen is present in both bone and cartilage, it can be extracted from either of the two connective tissues and be labeled as gelatin. Most commercial gelatin today is extracted from animal skin, another connective tissue which contains collagen.^{17,18} Gelatin, is what most people think of as the main ingredient in broth. Bone broth differs from gelatin in that it also contains minerals and GAGS. Traditionally made stock uses bone and cartilage and produces a higher quality result. It also produces a safer result considering that commercial gelatin contains small amounts of monosodium glutamate (MSG).¹⁹

Gelatin

Although it seems obscure today, gelatin has been studied and recommended, with great enthusiasm, by the medical community in the past. In 1937 Dr. Pottenger said, "Gelatin may be used in conjunction with almost any diet that the clinician feels is indicated."²⁰ From the late 1800s to the mid-1900s, gelatin was the subject of many studies, and these were summarized in the book, *Gelatin in Nutrition and Medicine*, by Dr. Gotthoffer.²¹ In her article, "Why Broth is Beautiful," nutritionist Kaayla Daniel speculates that one of the reasons gelatin is so infrequently studied today, is due to a lack of standardization. Without a consistent item, researchers in the past found it difficult to reproduce findings.²² In Gotthoffer's survey, one general area of health prescription clearly comes to the fore, and that is digestion. Most notably, he refers to over 30 years of research on gelatin's

ability to improve the digestion of milk. In the early 1900s gelatin was therefore recommended as an ingredient in infant formula, to decrease allergic reactions, colic and respiratory ailments. Gelatin was also reported to increase the digestibility of beans and meat (which gives credence to the practice of serving meat with gravy). It was also found that gelatin increased the utilization of the protein in wheat, oats and barley, all gluten containing grains.²³ Gluten is a notoriously difficult to digest protein for many people. Those that suffer from gluten allergy are diagnosed with Celiac disease, a debilitating condition.

Gotthoffer also found gelatin to be prescribed for both hyper- and hypo-stomach acidity. He cites three physicians who report gelatin to "work better and more rapidly than bismuth and tannin" in clinical practice.²⁴ A more recent study by Wald, demonstrated that glycine (a main ingredient in gelatin) stimulates gastric acid secretion.²⁵

Another recent study found that "gelatin as feed supplement protected against ethanol-induced mucosal damages in rats."²⁶ This directly supports the traditional thought that broth is healing and coating to the gastrointestinal lining, and gives a scientific explanation for broth's ability to calm and soothe. Gelatin has also been found to improve body weight as well as bone mineral density in states of protein undernutrition.²⁷ Additionally, studies have shown that convalescing adults, who have lost weight because of cancer, fare better if gelatin is added to their diet. It is said to be tolerated when almost nothing else can be.²⁸

Some of the medical communities in other parts of the world value gelatin too. In Chinese herbal medicine, gelatin is an important herbal remedy, in use for thousands of years. Its Chinese name is e jiao. It is classified as a tonic herb. Tonics strengthen or supplement insufficiency and weakness. They are considered nourishing and enhance the body's resistance to disease. They are used for states of deficiency. Gelatin is used to tonify the blood, in particular. This correlates to Western medical knowledge since, as we will see, glycine, a key ingredient in gelatin, plays a vital role in the blood. (Table II) Also if gelatin is extracted from bone, then marrow, where blood cells are produced is also extracted. Chinese studies have shown gelatin to increase red blood cell and hemoglobin count, increase serum calcium level, increase the absorption and utilization of calcium, and prevent and treat myotonia atrophica (muscle wasting).²⁹

To summarize, gelatin (broth) can be considered for use in the following conditions: food allergies, dairy maldigestion, colic, bean maldigestion, meat maldigestion, grain maldigestion, hypochlorhydria, hyperacidity (gastroesophageal reflux, gastritis, ulcer, hiatal hernia) inflammatory bowel disease (Crohn's disease and ulcerative colitis), irritable bowel syndrome, leaky gut syndrome, malnutrition, weight loss, muscle wasting, cancer, osteoporosis, calcium deficiency and anemia.

Collagen

Over 15 types of collagen have now been identified, but histology classifies three main types.³⁰ Type I is in bone, skin, ligaments, tendons and the white of the eye. Type II is in cartilage. Type III is in bone marrow and lymph, and is also called reticulin fiber.³¹ (Table I)

Protein fibers are created by stringing together amino acids, the building blocks of protein. Collagen differs from the average protein in that it is composed of a high concentration of certain amino acids. Specifically, about one third of collagen is composed of glycine, the smallest amino acid. Another third of collagen is composed of proline (and hydroxyproline, the active form of proline).³² The small size of glycine along with the properties of proline, allows for the unique triple helix shape of collagen. A smaller portion of the amino acids lysine (and hydroxylysine) are also incorporated into collagen. The remaining structure is made from other amino acids that vary. (Table II)

Scurvy is a disease caused by a deficiency of vitamin C. It results in symptoms such as bleeding gums, bruising, and poor wound healing. These manifestations are actually due to a deficiency of collagen, because vitamin C is needed to synthesize collagen. It converts proline into hydroxy proline.³³ Collagen, along with minerals are needed for the creation and healing of bone. It is also integral to cartilage formation and repair, along with GAGs.

To summarize, collagen (broth) can be considered for use in the following conditions: poor wound healing, soft tissue injury (including surgery), cartilage and bone injury (including dental degeneration).

Table II:³⁴

Amino Acid Profile of Gelatin

Glycine	27.2 g/ 100 g
Proline	15.5 g/ 100 g
Hydroxyproline	13.3 g/ 100 g
Lysine	4.4 g/ 100 g
Hydroxylysine	0.8 g/ 100 g

Glycine

Glycine is the simplest amino acid. It contributes to the manufacture of other amino acids and is incorporated into important structures in the body. It is a primary ingredient in the synthesis of heme, the vital portion of our blood that carries oxygen. It is used in the synthesis of creatine, which buffers energy and shuttles energy across membranes in muscle tissue, especially the heart. It contributes to the synthesis of bile salts. It is incorporated into purines and pyrimidines, and nucleic acids, which form our DNA and RNA. It is used as a cofactor in phase I detoxification, during the final oxidation.³⁵ It is one of the three amino acids needed to form glutathione,

the key phase II detoxification enzyme. Glycine is used in gluconeogenesis, the synthesis of glucose from amino acids (protein) during times of fasting, and therefore affects the stabilization of blood glucose levels.³⁶

Glycine is classified as a nonessential amino acid because we can synthesize it within our body. Not all scientists believe it is unnecessary to consume it though. In fact, Yu and associates found that glycine metabolism is directly responsive to dietary glycine and that prolonged abstinence in the diet may limit the formation of heme, glutathione, purines and creatine.³⁷ Jackson has concluded that a marginal state of glycine is more common than previously thought.³⁸ Jackson also found that certain conditions increase our need for glycine, such as sickle cell anemia and pregnancy. In the case of sickle cell anemia, the high rate of heme destruction increases the requirement for glycine.³⁹ In pregnancy, the growing fetus creates a demand for glycine that is two to ten times greater than normal, and two to ten times greater than the need for other amino acids.⁴⁰

Additional studies have reported positive results with glycine for health conditions. Fogarty states that glycine is "associated with a strongly reduced risk of asthma."⁴¹ Wald demonstrated that glycine stimulates gastric acid secretion.⁴² In a study on wound healing, Minuskin theorized that glycine was particularly helpful due to its high concentration in connective tissue and also due to the increased need for creatine in wound healing.⁴³ It has also been found to be the rate limiting step in rapid growth, of which both wound healing and fetus growth are an example.⁴⁴ Lastly, Ottenberg stated that "the ability of the liver to perform protective synthesis is limited by the amount of glycine available," and further recommended gelatin as a glycine supplement for patients with jaundice and other liver problems.⁴⁵

Broths are often used in modified fasting and cleansing regimens. In the fasting state, glycine is used for gluconeogenesis. During periods of fasting when no food or energy source is being consumed, our body breaks down our own protein tissues, such as muscle, to create energy from. If broth is consumed, it supplies an outside source of glycine, which limits or prevents degeneration during the fast. Since glycine is also used for phase I and II detoxification, it puts broth into the category of a liver tonic (or liver supportive). Broth helps the body to detoxify during a cleanse, and in fact at any time it is eaten.

To summarize, glycine (broth) can be considered for use in the following conditions: anemia, fatigue, detoxification, blood sugar dysregulation, muscle wasting, wound healing, pregnancy, infant and childhood growth, asthma, hypochlorhydria, jaundice and liver support.

Proline

Proline is found in most of the proteins in the body. One of its main roles is in the structure of collagen. It is therefore incorporated into connective tissues such as bone, skin, ligaments and tendons, and cartilage. Proline is

also considered a nonessential amino acid, but as with glycine, it may be considered 'conditionally essential' in that it is important to consume proline dietarily. Research shows that proline levels drop significantly when it is absent from the diet.⁴⁶ Proline has also been shown to have beneficial effects for memory and the prevention of depression.⁴⁷

Glycosaminoglycans

There are other compounds in broth that gel besides collagen. The ground substance of cartilage is made of proteoglycans, huge sugar and protein molecules. Attached to a core protein are long strands of glycosaminoglycans (GAGs) also called mucopolysaccharides. These structures are naturally jellylike. As mentioned, the GAGs in cartilage are hyaluronic acid, chondroitin sulfate and to a lesser degree, keratin sulfate. Hyaluronic acid forms a central strand to which chondroitin and keratin sulfate bond.

Hyaluronic acid

Hyaluronic acid is strongly negatively charged, which allows it to attract and bond a large amount of water. This molecule is therefore aptly entitled hydrophilic, or water-loving. Dr. Francis Pottenger, who researched gelatin in the 1930's, believed that this hydrophilic nature was at the root of gelatin's digestive benefits by attracting digestive juices to the surface area of our food. He coined the term "hydrophilic colloids" to describe this process.^{48,49} Hyaluronic acid is viscous and slippery. It lubricates joints and helps in wound healing by assisting migration of phagocytes.

Chondroitin sulfate

Chondroitin Sulfate is a jellylike substance, now famous as a supplement for joint pain associated with osteoarthritis. It functions to support and provide adhesiveness. It lines blood vessels and plays a role in lowering atherosclerosis, cholesterol and heart attacks.⁵⁰

Minerals

Minerals have three major functions in the body. First, they provide a structural base for connective tissue like bone. Second, they create electrical potentials allowing for conduction of nerve signals and movement across cell membranes. Third, they act as catalysts for enzymes in physiologic processes, and as Paul Bergner says in *The Healing Power of Minerals*, "transform the food and air we breathe into energy, vibrant health, and consciousness."⁵¹

Minerals are essential to life but they are not easy to digest. In the stomach, the presence of hydrochloric acid is necessary to physically break down our food, but also to extract elemental minerals from the food that we've eaten. A similar reaction takes place in the making of broth. An acid is necessary to remove the minerals from the bone. This is the purpose of using vinegar (acetic acid) when making broth. As stated in *The Principles of Anatomy and Physiology*, "If inorganic minerals are removed by soaking bone in a weak acid such as vinegar, it

results in a rubbery, flexible structure."⁵² This rubbery flexible structure is the leftover collagen/gelatin. The chemical reaction that extracts the minerals is an acid base reaction, in which the vinegar is the acid, and the minerals are the base.⁵³

According to *The Best Recipe* cookbook, the US FDA and Department of Agriculture set no standards of definition for chicken broth or stock. The authors were wondering why commercially available broth was so flavorless, lacking in body and generally inferior to the homemade version. Their conclusions were that the ratio of water to chicken must be high, giving a dilute result, and that the high, long heating involved in canning destroys the flavor compounds. Canned broth that tasted good to them had high sodium and MSG. They did find that broth sold in aseptic packaging, which is subjected to a shorter duration of heat, called flash heating, tasted more flavorful than canned broth.⁵⁴

Since there are no standards for the preparation of, or ingredients in, commercial broth, it is possible that manufacturers are skipping the vinegar step, or perhaps not even using bones, both of which would leave the broth devoid of minerals. This may be why canned soup does not contain the same amount of minerals as home cooked. The milligrams of minerals in vegetable soup increase 2-8 fold when cooked at home.⁵⁵

Bone contains calcium and phosphorus, and to a lesser degree, magnesium, sodium, potassium, sulfate and fluoride. Bone is an excellent source of minerals. All of the minerals present in bone, except fluoride, are macrominerals, which are essential for proper nutrition and are required in greater amounts than 100mg/day.⁵⁶ The only macromineral not present in bone is chlorine. Minerals have numerous functions in the body beyond the composition of bone, which is why the body will rob the bones and tissues to maintain steady levels of minerals in the blood and other fluids.

Deficiencies of minerals can be acquired, similar to vitamin deficiencies. Generally there are two ways this can happen, lack of intake in the diet, or lack of absorption in the intestines. Broth can be an excellent remedy for both of these causes of mineral deficiency because it provides easily absorbed extracted minerals, plus promotes healing of the intestinal tract. Unlike vitamins, minerals do not have defining deficiency diseases, but rather a collection of associated deficiency signs, symptoms and diseases. Interestingly, many of the deficiency symptoms of minerals are mood and behavior disturbances. This offers a scientific explanation for broth's ability to soothe and stabilize. It is reasonable to assume that previous to the development of pharmaceutical mineral supplements, bone broth was an important supply of minerals, especially in the winter when fresh fruit and vegetables are less available, and warm food is preferred. Even just one generation ago broth was a part of most household and restaurant repertoires. Yet today, neither nutrition nor science textbooks list bone as a dietary source of minerals.

Calcium

Calcium is the most abundant mineral in bone, present both as hydroxyapatite (bonded to phosphorus) and calcium carbonate. It is also the most abundant mineral in the body. Calcium is necessary for the normal functioning of nerve conduction and muscle contraction (including the regulation of the heartbeat). It facilitates neurotransmitter release, and hormone action via its relay role as a second messenger, thus playing an important role in mood and endocrine balance. Proper blood clotting and tissue repair is also dependent on calcium. It is necessary for the passage of fluids between cell walls. It is a cofactor for the activity of hundreds of enzymes. It is involved in the production of the body's primary energy source, adenosine triphosphate (ATP), due to its role as a citric acid cycle intermediate. Calcium is involved in immune function by helping to stabilize mast cells. It regulates cell reproduction and it also regulates the manufacture of proteins. As we can see, calcium is a vitally important mineral, so important, that it is maintained at a constant amount in the bloodstream at all times, to be readily available for the body's needs.

Intake of calcium is reported to be low in the American diet.⁵⁷ Calcium (broth) can be considered for use in the following deficiency signs, symptoms and conditions: pain and inflammation, cramps, muscle spasms, delusions, depression, insomnia, irritability, hyperactivity, anxiety, palpitations, hypertension, high cholesterol, allergies, brittle nails, periodontal and dental disease, pica, rickets, osteomalacia, osteoporosis and any situation that creates bone loss such as aging, immobilization, postmenopause, and caffeine, tobacco, and alcohol use.

Phosphorus

Phosphorus is an ingredient of ATP, the body's source of energy. It is therefore a regulator of all enzymes via activation reactions. It is a component of nucleic acids, which make up our DNA, phospholipids which make up our cell membranes, and cyclic adenosine monophosphate (cAMP) which as a second messenger, relays information into the cells. It buffers acids, and regulates osmotic pressure intracellularly.

Phosphorus (broth) can be considered for use in the following phosphorus deficiency signs, symptoms and conditions: decreased attention span, fatigue, weakness, muscle weakness, celiac or sprue disease, rickets, osteomalacia, primary hyperparathyroidism and seizures.

Magnesium

Magnesium is present in enzymes that generate and stabilize ATP. It is involved in over 300 enzyme reactions and acts as a cofactor for vitamins B1 and B6. It is involved in the synthesis of cAMP, fatty acids, proteins, nucleic acids and prostaglandins via delta 6 desaturase. It contributes to muscle excitability, nerve transmission and allows the parathyroid gland to function normally. Magnesium deficiency is the most common dietary deficiency in the U.S. Magnesium levels in the diets of 10 different, non-industrialized groups, still eating their traditional diets, were 130–2,850% higher than are consumed in the modern diet.⁵⁸ Magnesium deficiency

causes a reduction in all antibodies (except IgE) and antibody forming cells due to its involvement in protein synthesis.⁵⁹

Magnesium (broth) can be considered for use in the following magnesium deficiency signs, symptoms and conditions: loss of appetite, nausea, vomiting, diarrhea, fatigue, nervousness, anxiety, restlessness, confusion, hyperactivity, insomnia, muscular irritability and weakness, allergies, immunodepression, kidney stones and heart attack.

Sodium and Potassium

The electrolytes sodium and potassium have a major influence on osmotic balance between cells and the interstitial fluid (electrolyte balance), establishing ion gradients across cell membranes, and neutralizing positive and negative charges on proteins and other molecules. Their electrical conductivity is necessary for nerve signals, muscle contraction (including the heart) and hormone/ neurotransmitter release. Sodium, in particular, is important in nerve and muscle function and maintaining water balance. Potassium acts as a catalyst in carbohydrate and protein metabolism. Intake of potassium is low in the American diet.⁶⁰ Both minerals are involved in helping us adapt to stress, and during situations of prolonged stress such as cancer, the body's stores can be depleted.

Potassium (broth) can be considered for use in the following potassium deficiency signs, symptoms and conditions: cramping, shallow breathing, fatigue, nausea, vomiting, confusion, increased urination, and heart attack.

Sodium (broth) can be considered for use in the following sodium deficiency signs, symptoms and conditions: muscle weakness, dizziness, headaches, hypotension, increased heart rate, shock, mental confusion, stupor and coma.

Sulfur

Sulfur is a component of connective tissues (cartilage and skin, as chondroitin and keratin sulfate), proteins (enzymes and antibodies), hormones, and B vitamins (thiamin and biotin). It is involved in energy production, blood clotting, phase II detoxification and bile secretion from the liver.

Sulfur (broth) can be considered for use in degenerative arthritis, and detoxification.

Fluoride

Fluoride is not considered an essential mineral for humans. Its function is to stimulate and strengthen bone as it is being formed.

Food or Medicine?

Is broth a food or a medicine? It has traditional use as both. As a food it is generally incorporated into other dishes, serving as a base structure to make soup, stew, sauce or gravy, or to cook grains and beans in, instead of water. Broth is not a complete protein, since it only contains three amino acids. A complete protein needs to contain all 8 essential amino acids. Therefore it is not a meat replacement, but it can be used as a meat extender. Since glycine is used to make other amino acids, it is considered protein sparing. In addition, because glycine is used to make energy in gluconeogenesis, consuming glycine spares your own body protein from being broken down to make energy. Broth is not a meal replacement, which is why it is used as a starting point for soup, or as the first course of a meal.

As a medicine, it is often used alone, sipped at intervals or drunk much like a tea. The word tea, besides referring to the popular beverage, also refers to a form of herbal medicine. "Tea" can be used to describe an infusion or a decoction. To make an infusion, pour boiling water onto herbs, let soak for 5–10 minutes, discard the herbs, and drink the tea. This is how black tea, is made. A decoction differs in that it is made by directly boiling the herbs in water, for 20–40 minutes. This method is used on substances that are tougher, like roots, or bones. Broth is a bone and cartilage decoction, or tea. What this process is doing, with herbs or bones, is removing the active chemical ingredients into the water by means of heat, time, and acid, making the nutrients immediately available to absorb. (Vinegar is also used to remove the minerals from plants when making extractions.)⁶⁰ Using the standard of herbal formulation, broth qualifies as a medicine.

Being both a food and a medicine, broth has some distinct benefits. In general, food is a form of medicine that has few side effects and is difficult to overdose on. There is less likelihood of forgetting to take the medicine, since eating is a part of a normal daily routine. This is especially true if the medicinal food can be incorporated into established eating patterns, such as using broth to cook grain for a patient who eats grain on a regular basis. Using leftover meat and vegetable scraps to make medicine is a pretty smart form of recycling. It is an example of using the entirety of what Nature provides. Most importantly, broth tastes good, it's a delicious food that people enjoy eating, and that makes the best medicine.

Conclusion

Broth can be thought of as a protein supplement, and a calcium supplement. The chemical ingredients extracted from broth are glycine and proline (collagen/ gelatin), calcium and phosphorus (minerals), hyaluronic acid and chondroitin sulfate (GAGs), and other minerals, amino acids and GAGs in smaller amounts.

It's time we reclaim broth making from the past. The *All New Joy of Cooking* describes broth as inherently calming, consoling, and restorative to our spirit and vigor.⁶¹ Brewing broth fills a home with an aroma of indefinable goodness. That, in itself, is medicine. Because it's easy to absorb, tastes good, and contains a rich

concentration of nutrients, broth makes a distinctively good medicine.

In conclusion, rather than revisiting the disorders broth may be applied to, ([see Appendix B for a complete listing](#)) a review of definitions associated with broth may illustrate its benefits more accurately:

To 'support and strengthen' the function of connective tissue. To 'support and protect' the function of bone. To 'store energy,' the function of yellow bone marrow. To act as a 'shock absorber and reduce friction,' the function of cartilage. To be 'flexible and strong,' the function of collagen. To 'hold it together' and 'keep it together,' also the function of collagen. To 'soup up,' to increase the power or speed of. To 'put stock in,' to trust.⁶²

Appendix A

Basic Broth Making and Usage

Ingredients

1. Bones—from poultry, fish, shellfish, beef, lamb*

- cooked remnants of a previous meal, with or without skin and meat
- raw bones, with or without skin and meat**
- use a whole carcass or just parts (good choices include feet, ribs, necks and knuckles)
- don't forget shellfish shells, whole fish carcasses (with heads) or small dried shrimp

2. Water—start with cold water

- enough to just cover the bones
- or 2 cups water per 1 pound bones

3. Vinegar—apple cider, red or white wine, rice, balsamic

- a splash
- 2 tablespoons per 1 quart water or 2 pounds bones
- lemon juice may be substituted for vinegar (citric acid instead of acetic acid)

4. Vegetables (optional)—peelings and scraps like ends, tops and skins or entire vegetable

- celery, carrots, onions, garlic and parsley are the most traditionally used, but any will do
- if added towards the end of cooking, mineral content will be higher

Recipe

Combine bones, water and vinegar in a pot, let stand for 30 minutes to 1 hour, bring to a simmer, remove any scum that has risen to the top, reduce heat and simmer (6–48 hrs for chicken, 12–72 hrs for beef). To reduce cooking time, you may smash or cut bones into small pieces first. If desired, add vegetables in last ½ hour of cooking (or at any point as convenience dictates). Strain through a colander or sieve, lined with cheesecloth for

a clearer broth. Discard the bones. If uncooked meat was used to start with, reserve the meat for soup or salads.

An easy way to cook broth is to use a crockpot on low setting. After putting the ingredients into the pot and turning it on, you can just walk away. If you forget to skim the impurities off, it's ok, it just tastes better if you do. If you wish to remove the fat for use in gravy, use a gravy separator while the broth is warm, or skim the fat off the top once refrigerated. Cold broth will gel when sufficient gelatin is present. Broth may be frozen for months or kept in the refrigerator for about 5 days.

Usage

1. Soup—Make soup by adding vegetables, beans, grains or meat to broth. Briefly cook vegetables and meat with butter or oil in the bottom of a stockpot (5 minutes). Add broth, and grains or previously soaked beans if you wish. Simmer until everything is cooked through. Time will vary with the ingredients used, but count on a minimum of 20 minutes. Season at the end of cooking with salt and pepper and spices of your choice. Consult cookbooks for specific recipe ideas.
2. Cooking Liquid—Use broth in place of water to cook rice, beans or other grains. Bring broth to a boil, add grains or beans, reduce heat and cook for instructed time. Or you can simmer vegetables or meat in a little seasoned broth until cooked. Remove to a plate, thicken broth with cornstarch, arrowroot or flour, then pour over vegetables and meat.
3. Gravy—Make gravy to put on vegetables, meat or biscuits. Put fat (removed from the broth, or use butter) in a skillet. Add any type of flour, 1 tablespoon at a time, and stir constantly until browned. Whisk in broth and cook till thickened. Add salt and pepper to taste.
4. Tea—Don't forget you can just add salt and sip broth like tea. This is especially nice in the winter or if you're feeling sick. Since broth is simultaneously energizing and calming, it can take the place of morning coffee, afternoon tea, or evening nightcap. Try it in a thermos and sip throughout the day. Of course, the most traditional use for seasoned broth is as a first course, to enhance the digestion of any meal to come.

*Pork bones are not generally recommended for prepared ahead broth, but are cooked into stew and soup recipes, and boiled pig skin is traditionally consumed for many of the same purposes as broth.

**Raw bones and meat may be browned first in the oven, or in the bottom of the stockpot to enhance flavor and color.

Alphabetical Listing of Conditions that Broth Benefits

aging skin

allergies

anemia

anxiety

asthma

atherosclerosis

attention deficit

bean maldigestion

brittle nails

carbohydrate maldigestion

Celiac Disease

colic

confusion

constipation

dairy maldigestion

delusions

dental degeneration

depression

detoxification

Diabetes

diarrhea

fatigue

food sensitivities

fractures

Gastritis

grain maldigestion

heart attack

high cholesterol

hyperactivity

hyperchlorhydria (reflux, ulcer)

hyperparathyroidism (primary)

hypertension

hypochlorhydria

hypoglycemia

immunodepression

increased urination
infectious disease
inflammation
Inflammatory Bowel Disease (Crohn's Disease and Ulcerative Colitis)
insomnia
intestinal bacterial infections
irritability
Irritable Bowel Syndrome
Jaundice
joint injury
Kidney stones
leaky gut
loss of appetite
meat maldigestion
memory
muscle cramps
muscle spasms
muscle wasting
muscle weakness
Muscular Dystrophy
nausea
nervousness
Osteoarthritis
Osteomalacia
Osteoporosis
pain
palpitations
Periodontal Disease
pregnancy
rapid growth
restlessness
Rheumatoid Arthritis
Rickets
seizure
shallow breathing
stupor

virility

vomiting

weakness

weight loss due to illness

wound healing

References

1. Braham, C, et al. *Random House Webster's Dictionary*, New York, NY, Random House Inc., 2001, pp.688 and 707.
2. Fallon, S, *Nourishing Traditions*, New Trends Publishing, Washington, DC, 1999, p.118.
3. Lian, J, et al. American Society for Bone and Mineral Research, www.depts.washington.edu/bone. (*Link not active as of Oct. 2005.*)
4. Tortora, G, et al. *Principles of Anatomy and Physiology*, New York, NY, Harper Collins Press, 1996, p.145.
5. Kaminski, M, Personal Communication, Professor of Histology, Portland, OR, National College of Naturopathic Medicine, May 2003 and October 1998.
6. The editors of *Cook's Illustrated, The Best Recipe*, Brookline, MA, Boston Common Press, 1999, p.18.
7. Kaminski.
8. Tortora, p.105.
9. Prudden, J, The Biological activity of bovine cartilage preparations, *Seminars in Arthritis and Rheumatology*, 1974, III, 4, 287–321.
10. Tortora, p.114.
11. Quillin, P, *Beating Cancer with Nutrition*, Carlsbad, CA, Nutrition Times Press, 2001.
12. Ibid.
13. Murray, M, Pizzorno, J, *Encyclopedia of Natural Medicine*, Rocklin, CA, Prima Publishing, 1991.
14. Quillin.
15. Tortora, p.105.
16. Guralnik, D, *Webster's New World Dictionary*, New York, NY, The World Publishing Co., 1964, p.601.
17. Daniel, K, Why Broth is Beautiful, *Wise Traditions Quarterly*, spring 2003, 25–36.
18. Bensky, D, *Chinese Herbal Medicine Materia Medica*, Seattle, WA, Eastland Press Inc., 1993, p.332.
19. Fallon, p.118.
20. Daniel.
21. Ibid.
22. Ibid.
23. Ibid.
24. Fallon, p.121.
25. Wald, A, Stimulation of gastric acid secretion by glycine and related oligopeptides in humans, *American Journal of Physiology*, 1982, 5, 242, G86-G88.
26. Samonina, G, et al. Protection of gastric mucosal integrity by gelatin and simple proline containing peptides, *Pathophysiology*, April 2000, 7, 1, 69–73.
27. Koyama, et al. Ingestion of gelatin has differential effect on bone mineral density and bodyweight in protein undernutrition, *Journal of Nutrition and Science of Vitaminology*, 2000, 47, 1, 84–86.
28. Daniel.
29. Bensky.
30. Kaminski, April 2004.
31. Kaminski, October 1998 and May 2003.
32. Pischinger, A, *Matrix and Matrix Regulation*, Haug International, Brussels, Belgium, 1991, p.60.
33. Murray, et al. *Harper's Biochemistry*, Stamford, CT, Appleton & Lange, 2000.
34. Daniel.
35. Szabat, S, Personal Communication, Professor of Environmental Medicine, Portland, OR, National College of Naturopathic Medicine, September 2004.
36. Dangerfield, B, Personal Communication, Professor of Biochemistry, Portland, OR, National College of Naturopathic Medicine, June 2003.

37. Yu, YM, et al. Quantitative aspects of glycine and alanine nitrogen metabolism in postabsorptive young men,: effects of level of nitrogen and dispensable amino acid intake, *Journal of Nutrition*, 1985, 115, 399–410.
38. Jackson, A, et al. Urinary excretion of 5-oxoproline (pyroglutamate aciduria) as an index of glycine insufficiency in normal man, *British Journal of Nutrition*, 1987, 58, 207–214.
39. Ibid.
40. Jackson, A, et al. Optimizing amino acid and protein supply and utilization in the newborn, *Proceedings of the Nutrition Society*, 1989, 48, 293–301.
41. Fogarty, A, et al. Amino acids and asthma: a case controlled study, *European Respiratory Journal*, 2004, 4, 565–8.
42. Wald.
43. Minuskin, M, et al. Nitrogen retention, muscle creatine and orotic acid excretion in traumatized rats fed argenine and glycine enriched diets, *Journal of Nutrition*, 1981, III, 1265–1274.
44. Persaud, C, et al. Glycine: Limiting amino acid for rapid growth, *Proceedings of the Nutritional Society*, 1987, 46, 236A.
45. Ottenberg, R, Painless jaundice, *Journal of the American Medical Association*, 1935, 104, 9, 1681–1687.
46. Jaksic, et al. Plasma proline kinetics and concentrations in young men in response to dietary proline deprivation, *American Journal of Clinical Nutrition*, 1990, 52, 307–312.
47. Cherkin, A, et al. L-Proline and related compounds: correlation of structure, amnesiac potency, and anti-spreading depression potency, *Brain Research*, 1978, 156, 2, 265–273.
48. Daniel.
49. Fallon, p.116.
50. Lininger, S, et al. *The Natural Pharmacy*, Prima Publishing, Rocklin, CA, 1998.
51. Bergner, P, *The Healing Power of Minerals*, Prima Publishing, Rocklin, CA, 1997.
52. Tortora, p.145.
53. Zwickey, H, Personal Communication, Professor of Immunology and Research Director, Portland, OR, National College of Naturopathic Medicine, September 2003.
54. The editors of *Cook's Illustrated, The Best Recipe, American Classics*, Brookline, MA, Boston Common Press, 2002, p.13.
55. Bergner.
56. Williams, S, *Essentials of Nutrition and Diet Therapy*, St. Louis, MO, Mosby Inc., 1999, p.148.
57. Quillin.
58. Bergner, p.201.
59. Quillin.
60. Bergner.
61. Gladstar, R., *Herbal Healing For Women*, New York, NY, Simon and Schuster, 1993, pp.45–47 and 66.
62. Rombauer, I, et al. *The All New Joy of Cooking*, New York, NY, Simon and Schuster Inc., 1997, p.91.
63. Braham.

Selected Bibliography

In addition to the previously mentioned texts, the following sources were referenced.

- Campbell, N, *Biology*, Menlo Park, Ca, The Benjamin/ Cummings Publishing Co., 1996.
- Marks, D, *Basic Medical Biochemistry*, Lippencott Williams and Wilkins, Baltimore, MD, 1996.
- Peterson, H, Personal Communication, Biochemistry NPLEX Board Review, 2001.
- Robinson, W, et al. *General Chemistry with Qualitative Analysis*, Houghton Mifflin Co., Boston, MA, 1997.