A Macronutrient and Mineral Comparison of Three Popular Homemade Raw Food Diet Plans with NRC and Ancestral Diet Nutrient Profiles; and Suggestions on How to Enhance Nutritional Compliance with Both

By Steven M. Brown

Abstract

Objective: To compare the protein, fat and mineral content of three popular homemade raw canine diet plans with standards recently updated by the National Research Council (NRC) standards, pet food nutrient profiles established by the Association of American Feed Control Officials (AAFCO), and nutrient profiles of the "ancestral" or "natural" diet; and to suggest changes in the homemade diet plans in order to comply with the latest NRC mineral recommendations for adult dogs.

Procedure: Using data from the USDA National Nutrient Database for Standard Reference,[1] from laboratory analyses of chicken necks, backs, and wings, and turkey necks, the author evaluates, on a caloric basis, the fat and mineral content of three popular homemade diets. The author compares these results with NRC nutrient profiles and what the author believes to be the nutrient composition of the "ancestral diet" of dogs—85% whole prey animals and 15% fruits, grasses and vegetables.

Results: All diets evaluated had a higher fat content than the ancestral diet. More than 60% of the calories in two of the diets are from fat. The ancestral diet provides about 45% of the calories from fat.

All the diets had some mineral shortages (zinc, copper or manganese) when compared with NRC adult recommendations and the ancestral diet. All the diets were below NRC puppy recommendations and the ancestral diet in zinc, manganese, and iron. One of the diets had too much copper; and one had a calcium phosphorus ratio exceeding both AAFCO maximums and the calcium phosphorus ratio of the ancestral diet. (The author does not suggest that lack of compliance with these nutrient profiles causes any health or temperament problems.)

Discussion: The author proposes changes in the homemade diet plans that help make the macronutrient and micronutrient content of these diets more similar to the ancestral diet, and bring the diets into compliance with the NRC adult recommendations.

The macronutrient content can become more similar to the ancestral diet by trimming the fat from necks and backs of chicken, and using leaner meats. The micronutrient shortages can be reduced by the inclusion, depending upon the diet plan, of sardines, oysters, rice bran, nuts and seeds. These foods help the diet plans reach the mineral levels recommended by the NRC for adult dogs, but not the recommendations for puppies and not the ancestral diet profiles.

Introduction

"The best way… is to feed a raw diet that mimics the evolutionary norms of canines."
Dr. Ian Billinghurst[2]

Many dog owners attempt to feed "natural" or "ancestral" diets to their dogs. Some studies report that up to 6% of dog owners feed their dogs homemade "raw" diets.[3] This author believes that most people feeding homemade raw diets are trying to mimic the ancestral diet of dogs.

In this article, I examine the protein, fat, and mineral content of a hypothetical ancestral canine diet, and three popular homemade raw canine diet plans. I then compare these diets with the 2004 NRC recommended allowances for puppies ("NRC Puppy") and adults ("NRC Adult"),[4] and AAFCO[5] nutrient profile maximums ("AAFCO Max"). In the discussion section of this article, I suggest changes in the diet plans to closer mimic the nutritional levels of the ancestral diet, and to ensure compliance with the NRC adult recommendations. In the last section, I examine the importance of adding calcium *and* phosphorus, not just calcium, to meat-based diets.

My purpose is to give you the best information possible so you can help your clients plan diets that are closer to their goals of feeding natural diets. I do not make any health claims, and I am not implying that lack of compliance with these nutrient profiles causes any health or temperament problems. I have great respect for the developers of these diet plans, and have seen many excellent dogs raised with these plans. My objective in this article is not to criticize these plans; it is simply to offer suggestions on how to help make these diet plans more nutritionally compliant with recognized standards.

I evaluate the protein, fat, and select mineral content only. I lack data on iodine, chloride, and selenium, the vitamin content of chicken wings, backs, and necks; turkey necks; and the fiber content of the ancestral diet. Therefore I have not evaluated these nutrients.

The results and suggestions should be used as general guidelines only, since there is a large variance in nutritional content of natural foods. The nutrient content of plants differs by variety, soil, time of year, fertilizers used, and other factors. The fat and mineral content of prey animals varies by what the prey animal ate, time of year, geographic locations, soil qualities, and many other factors.

The Ancestral Diet of Dogs

There is no one "ancestral diet" of dogs. Dogs, in their evolution from wolves, ate a variety of foods—generally whatever was available. Many scientists have studied and written about the natural diet of dogs and wolves. There seems to be little agreement on what the diet consisted of—except that meat was a major part of that diet. Here are three viewpoints.

"The staple diet of carnivores living in a natural setting include other animals, carrion, and occasionally fruits and grasses." [6]

Scraps of meat, bones, pieces of carcass, rotten greens and fruit, fish guts, discarded seed and grains, animal guts and heads....[7]

"Their (wolves) preference is freshly killed meat, but when that's not available, they'll eat anything that could remotely be considered edible.[8]

Combining these viewpoints, I assume the "ancestral diet" consists of 85% whole small prey and occasional eggs, and 15% scavenged grasses, berries, nuts, and other vegetation. The composition of this 15% of the diet cannot be exact, and is composed of a variety of easily available foods. The foods I analyzed are probably close enough in mineral content to be instructive.

85% whole small prey [9]
2.5% green leaf lettuce
2.5% broccoli stalks
2.5% apples w skin
2.5% asparagus
1.5% cereal grass
1% spinach
1% hazelnuts
1% whole egg, including shell
0.5% sunflower seeds

For whole small prey, I use data from Dierenfeld, et al. (1966).[10] The data include more than 1,000 analyses of mice, rats, chickens, rabbits, reptiles, and amphibians.

The analysis of this diet shows that the dog's ancestral diet was a high protein, moderate fat, low carbohydrate diet, with 47% of the energy coming from protein and 46% from fat. The mineral content of the ancestral diet exceeds NRC puppy and adult values for all evaluated minerals, with the exception of zinc (Table 1).

	NRC Puppy	NRC Adult	AAFCO Max	Ancestral
Ca, g	3	1	7.1	6.1
P, g	2.5	0.75	4.6	3.5
K, g	1.1	1.0		2.0
Na, g	0.55	0.2		0.9
Mg, g	0.1	0.15	0.86	0.4
Fe, mg	22	7.5	857	42
Cu, mg	2.7	1.5	71	5.9
Mn, mg	1.4	1.2		3.2
Zn, mg	25	15	286	24
Ca:P	1.2:1	1.3:1	2:1	1.8:1

Table 1. Ancestral Diet, Minerals per 1,000 kcals ME

The Homemade Diet Plans

The diet plans I chose to analyze were my interpretations of the recommendations of three of the most popular "bones and raw food (BARF)" writers. The first is B1, a Dr. Ian Billinghurst diet plan[11]; second, I analyzed Kymythy Schultze's diet plan in 2 variations (S1 and S2)[12]; and third is an "original" (O1) recipe plan used by a friend. This plan is, I believe, representative of the way many people choose to feed their dogs a "raw" diet. I analyzed diet plan B1 as recommended; diet plan S1 with 90% lean beef and S2 with 70% lean beef (to illustrate the significant difference the choice of meat can make in the macronutrient content of a diet); and O1 with 90% lean beef.

All the recipes are given for 10 pounds of food—enough to feed a 50 pound dog for 7 to 12 days, depending primarily upon the fat level of the food, and the activity level of the dog.

B1	Pounds	Grams	%
Chicken backs	2.0	889	20%
Chicken necks, no skin	2.0	889	20%
Chicken wings, skin intact	2.0	889	20%
Chicken liver, raw	0.7	333	7%
Broccoli, raw	0.7	333	7%
Egg, raw, large w shell, 58 g/egg	0.5	213	5%
Lettuce, romaine, raw	0.4	167	4%
Apples, raw, with skin	0.4	167	4%
Flaxseed	0.3	125	3%
Yogurt, plain, low fat	0.3	125	3%
Chicken heart, raw	0.3	115	3%
Carrots, raw	0.2	83	2%
Celery, raw	0.2	83	2%
Blackberries, raw	0.1	63	1%
Kelp meal, dried	0.1	42	1%
Garlic, raw	0.05	21	0.5%

Totals	10.0	4536	100%

Table 2. B1 (Billinghurst) diet plan analysis.

S1	Pounds	Grams	%
Turkey necks	5.7	2574	57%
Beef, ground, 90% lean, 10% fat	1.9	858	19%
Egg, raw, large w shell, 58 g/egg	1.0	446	10%
Chicken liver, raw	0.9	429	9%
Broccoli, raw	0.1	54	1%
Carrots, raw	0.1	54	1%
Celery, raw	0.1	54	1%
Salmon oil, cold pressed	0.1	30	1%
Kelp meal, dried	0.05	23	0.5%
Cod liver oil	0.03	15	0.3%
Totals	10.0	4536	100%

Table 3. S1 (Schultze) diet plan analysis with 90% lean beef.

S2	Pounds	Grams	%
Turkey necks	5.7	2574	57%
Beef, ground, 70% lean, 30% fat	1.9	858	19%
Egg, raw, large w shell, 58 g/egg	1.0	446	10%
Chicken liver, raw	0.9	429	9%
Broccoli, raw	0.1	54	1%
Carrots, raw	0.1	54	1%
Celery, raw	0.1	54	1%
Salmon oil, cold pressed	0.1	30	1%
Kelp meal, dried	0.05	23	0.5%
Cod liver oil	0.03	15	0.3%
Totals	10.0	4536	100%

Table 4. S2 (Schultze) diet plan analysis with 70% lean beef.

O1	Pounds	Grams	%
Chicken necks no skin	5.0	2256	50%
Beef tripe raw	1.4	644	14%
Beef, ground, 90% lean, 10% fat	1.2	548	12%
Beef, liver, raw	0.9	419	9%
Chicken heart, raw	0.7	322	7%
Beef, heart, raw	0.7	322	7%
Salmon oil, cold pressed	0.05	25	0.5%
Totals	10.0	4536	100%

Table 5. O1 (Original) diet plan analysis.

The Analysis Program

I analyzed the diets using a nutrient analysis program that I developed and tested. The program includes over 400 ingredients, and analyzes recipes for macronutrients, vitamins, minerals, fatty acids, and amino acids. Most of the data comes from the USDA National Nutrient Database for Standard Reference. For the foods not listed in the USDA data base, primarily chicken wings, necks, backs and turkey necks, I used results of macronutrient and mineral tests I conducted for Natural Balance Pet Foods and Steve's Real Food; and published data from the BARFworld website.[13] I lack data on the vitamin content of these foods and therefore have not evaluated vitamins.

I've compared the program results to laboratory tests for raw foods produced by Natural Balance Pet Foods, and all nutrient data were within 15% of tested values.

I evaluated nutrient content of raw meat-based diets on a caloric basis—units of nutrients per 1,000 kcals ME, using Atwater factors (4 kcals ME per gram of protein, carbohydrate; and 9 kcals ME per gram of fat).[14] The *Official Publication* of AAFCO requires that diets with a caloric content exceeding 4,000 kcal ME per kg dry matter (DM) be evaluated on units of nutrient per 1,000 kcals ME basis. With energy-dense foods, the dog will require less of the food to meet its caloric requirement than with less energy-dense foods.

The vitamin and mineral content of natural foods varies up to 30% based on variety, soil conditions, growth enhancers used, and other factors. Therefore the analyses are general guidelines only; individual diet results vary. (I've also found that many nutrient testing laboratories make mistakes or suffer inaccuracies. One test report came back with 123% guaranteed analysis!)

Results

Macronutrient Comparison

Figure 1 compares the caloric contribution of protein and fat in the ancestral diet, homemade diet plan B1, homemade diet plan S1 with 90% lean beef, S2 with 70% lean beef, and homemade diet plan O1

All of the homemade diets contain more fat than the ancestral diet. In the ancestral diet, protein provides 47% of the calories, and fat 46%. Fat provides 61% of the calories in B1, 55% in S1, 62% in S2, and 53% in O1.
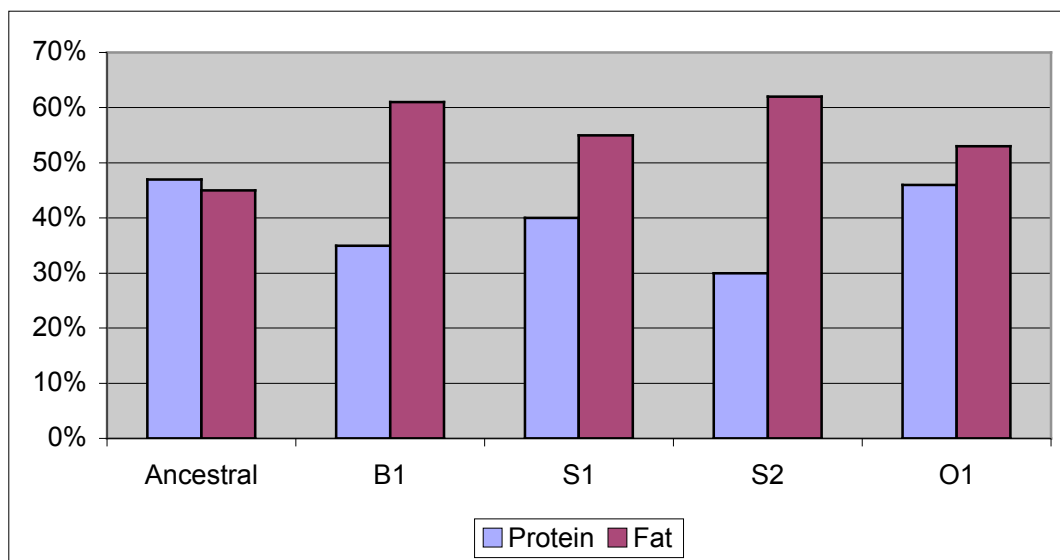

Figure 1. Caloric Contribution of Protein and Fat of the Analyzed Diets

One of the reasons for the excess fat in homemade diets is that most farm raised animals have a higher fat content than wild animals. Fat animals do not live long in the wild.

For comparison, the USDA recommends that humans get 20 to 30% of their calories from fat.

Micronutrient Comparison

All the homemade diet plans were short in trace minerals, when compared with NRC adult, puppy and the ancestral diet profiles. The reason for this, I believe, is that homemade diet makers are often not able to get many of the mineral-rich parts of the prey animal.

In the wild, the dog ate the entire prey animal—certainly if it was a small animal. This included mineral-rich parts such as blood (a major source of iron), heads (the natural source of DHA, phosphaditylserine and other nutrients), glands (pituitary, pancreas, spleen, thyroid and others) and organs. These parts are not often available to homemade diet makers. Blood is drained from slaughtered animals immediately, and used for other purposes (livestock feed, fertilizer, etc.). The juice present in packaged meats is not blood.

Results for Diet Plan B1

	NRC Puppy	NRC Adult	Ancestral	B1
Ca, g	3	1	6.1	5.3
P, g	2.5	0.75	3.5	2.8
K, g	1.1	1.0	2.0	1.6
Na, g	0.55	0.2	0.9	0.5
Mg, g	0.1	0.15	0.4	0.3
Fe, mg	22	7.5	42	12.5
Cu, mg	2.7	1.5	5.9	*1.0*
Mn, mg	1.4	1.2	3.2	1.5
Zn, mg	25	15	24	*13.6*
Ca:P	1.2:1	1.3:1	1.8:1	1.9:1

Table 6. Minerals per 1,000 kcals ME for diet B1 compared to standards.

Diet plan B1 does not meet NRC adult recommendations for zinc and copper. Compared with the ancestral diet, B1 has about a third of the iron, a sixth of the copper, and one-half of the manganese. The mineral content of this diet is also below the ancestral diet levels in calcium, phosphorus, potassium, zinc, sodium, and magnesium.

There is no source of long chain omega-3 fatty acids (EPA and DHA).

Results for Diet Plan S1

	NRC Puppy	NRC Adult	Ancestral	S1
Ca, g	3	1	6.1	*7.6*
P, g	2.5	0.75	3.5	3.0
K, g	1.1	1.0	2.0	1.5
Na, g	0.55	0.2	0.9	0.6
Mg, g	0.1	0.15	0.4	0.2
Fe, mg	22	7.5	42	13
Cu, mg	2.7	1.5	5.9	*0.8*
Mn, mg	1.4	1.2	3.2	*0.6*
Zn, mg	25	15	24	22

Ca:P	1.2:1	1.3:1	1.8:1	***2.6:1***

Table 7. Minerals per 1,000 kcals ME for diet S1 compared to standards.

Diet plan S1 contains too much calcium. The Ca:P ratio exceeds the AAFCO maximum (2:1).

S1 does not meet NRC adult recommendations for copper and manganese. Compared with the ancestral profiles, this diet plan is short in magnesium, iron, copper, manganese and zinc.

Because S1 90% lean meat diet was already higher in fat than the ancestral diet, I did not perform further analyses or recommend changes for the higher fat S2 diet.

Results for Diet Plan O1

	NRC Puppy	NRC Adult	Ancestral	O1
Ca, g	3	1	6.1	5.4
P, g	2.5	0.75	3.5	3.6
K, g	1.1	1.0	2.0	1.5
Na, g	0.55	0.2	0.9	0.6
Mg, g	0.1	0.15	0.4	0.2
Fe, mg	22	7.5	42	14.1
Cu, mg	2.7	1.5	5.9	***7.2***
Mn, mg	1.4	1.2	3.2	***0.7***
Zn, mg	25	15	24	23
Ca:P	1.2:1	1.3:1	1.8:1	1.5:1

Table 8. Minerals per 1,000 kcals ME for diet S2 compared to standards.

Diet plan O1 contains too much copper (from the beef liver). With reference to NRC adult recommendations, it is low in manganese. Compared with ancestral profiles, this diet plan is short in magnesium, iron, manganese, potassium and sodium.

This diet contains no source of fiber.

Discussion

In this section, I suggest changes in the B1, S1, and O1 diet plans in order to reach NRC adult dog recommendations. However, these revised recipes will not meet the NRC standards for puppies, or the ancestral diet profiles. Making food for puppies that meet NRC recommendations and the ancestral diet profiles requires the use of parts of prey animals that are generally not available; additional whole food supplements; careful supplementation with specific trace minerals; or the use of mineral mixes generally available only to commercial dog food manufacturers.

These suggestions should be used only as general guidelines or illustrations. I am reporting gross mineral content only—without considering the bioavailability or cost of the ingredients. A variety of foods, of course, is essential. There are other foods besides those foods listed that provide these nutrients.

Summary of suggestions for homemade diet plans:

Reduce fat and increase protein:
- Use leaner meats;
- Remove the skin and visible fat.
- If the meat is cooked, drain the fat before serving.

Add trace mineral-rich foods

- Sardines and other fish replace salmon or fish oil. Sardines provide a range of vitamins and minerals, including vitamin D and iodine, and the long-chain omega 3 fatty acids. Don't add sardines if excess calcium is in the diet (diet plan H2).
- Oysters add zinc, fatty acids, and other trace minerals.
- Nuts and seeds add trace minerals and quality fats. Some reports suggest that nuts and seeds need to be soaked to enhance mineral bioavailability.
- In recipes without beef liver, copper may be short; add cashews and sesame seeds.
- Rice bran and hazelnuts add manganese.

In order to get closer to the ancestral diet mineral profiles and NRC puppy recommendations, also occasionally add:
- Blood or spleen to increase iron.
- Mineral supplements that do not contain calcium. Do not add mineral supplements with copper if beef liver is in the recipe.
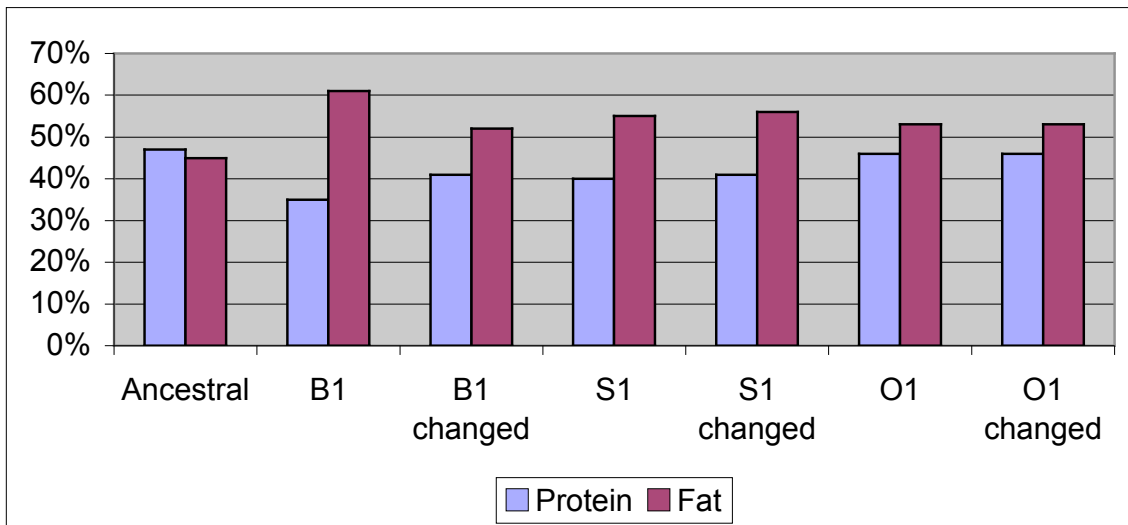- Small amounts of sea salt in order to reach ancestral diet profiles.

Figure 2. Caloric Contribution of Protein and Fat of Diets with Suggested Changes

Suggested Changes for Each Diet Plan

B1 Changed	Pounds	Grams	%
Chicken necks, no skin	1.9	850	18.7%
Chicken wings, skin intact	1.9	850	18.7%
Chicken, breast, meat only, no skin, raw	0.9	424	9.3%
Chicken backs, raw	0.9	424	9.3%
Broccoli, raw	0.7	319	7.0%
Beef, spleen, raw	0.4	159	3.5%
Mollusks, oysters, Pacific, raw	0.4	159	3.5%
Lettuce, romaine, raw	0.4	159	3.5%
Apples, raw, with skin	0.4	159	3.5%
Seeds, flaxseed	0.3	120	2.6%

Yogurt, plain, low fat	0.3	120	2.6%
Egg, raw, large w shell, 58 g/egg	0.3	122	2.7%
Chicken heart, raw	0.2	105	2.3%
Chicken liver, raw	0.2	105	2.3%
Beef, liver, raw	0.2	105	2.3%
Carrots, raw	0.2	80	1.8%
Celery, raw	0.2	80	1.8%
Sardines	0.2	74	1.6%
Blackberries, raw	0.1	60	1.3%
Kelp meal, dried	0.1	40	0.9%
Garlic, raw	0.04	20	0.4%
Totals	10.0	4536	100.0%

Table 9. Diet plan B1 with suggested ingredient changes.

With diet plan B1, I wanted to reduce the fat, increase the protein, and add zinc, copper and other trace minerals. Here are my changes:

- Reduced from 5 eggs to 3 to decrease fat content, and replaced the 2 eggs with a can of sardines (EPA, DHA, iodine, trace minerals).
- Reduced backs from 2.67 pounds to 1.33 pounds, and replaced with a 0.33 pound beef liver (for copper), and 1 pound chicken breast, no skin to increase protein.
- Reduced chicken liver from 1 pound to 0.33 pounds, and added _ pound of blood or spleen for iron and protein, and _ pound of oysters for zinc, other trace minerals, EPA and DHA.

These changes increased the percentage of calories from protein from 35% to 41% (Figure 2); and the mineral content of this diet plan now complies with NRC adult recommendations.

	NRC puppy	NRC adult	Ancestral	B1	B1 changed
Ca, g	3	1	6.1	5.3	4.5
P, g	2.5	0.75	3.5	2.8	2.7
K, g	1.1	1.0	2.0	1.6	1.8
Na, g	0.55	0.2	0.9	0.5	0.6
Mg, g	0.1	0.15	0.4	0.3	0.3
Fe, mg	22	7.5	42	12.5	24
Cu, mg	2.7	1.5	5.9	*1.0*	3.0
Mn, mg	1.4	1.2	3.2	1.5	1.6
Zn, mg	25	15	24	*13.6*	18
Ca:P	1.2:1	1.3:1	1.8:1	1.9:1	1.6:1

Table 10. Diet plan B1 changed, Minerals per 1,000 kcals ME

S1 changed	Pounds	Grams	%
Turkey necks	5.6	2551	56%
Beef, ground 95% lean, 5% fat, raw	2.1	944	21%
Chicken liver, raw	0.9	425	9%
Egg, raw, large no shell 50 g	0.4	187	4%
Sesame seeds, whole dried	0.3	150	3.3%

Broccoli, raw	0.1	53	1.2%
Carrots, raw	0.1	53	1.2%
Celery, raw	0.1	53	1.2%
Rice bran, crude	0.1	45	1.0%
Cold pressed salmon oil	0.1	30	0.7%
Kelp meal, dried	0.05	22	0.5%
Cod liver oil	0.03	15	0.3%
Totals	10.0	4536	100.0%

Table 11. Diet plan S1 with suggested ingredient changes

Diet plan H2 was short on copper and manganese, and had too much calcium. The Ca:P ratio exceeded AAFCO maximums.

I eliminated the egg shells, thereby reducing the calcium content and bringing the Ca:P ratio into compliance with the NRC and ancestral diet profiles.

I added 1.5 oz ground sesame seeds and 0.5 oz rice bran for copper and manganese. Some reports indicate that if the sesame seeds are soaked for 24 hours, the manganese is more available. Both ingredients have high fat content. I therefore changed the meat to 95% lean.

There was no significant change in the protein and fat caloric contributions. If I had used 90% lean meat rather than changing to 95% lean meat, 59% of the calories would come from fat, rather than 56%.

	NRC Puppy	NRC Adult	Ancestral	S1	S1 Changed
Ca, g	3	1	6.1	*7.6*	4.4
P, g	2.5	0.75	3.5	3.0	3.1
K, g	1.1	1.0	2.0	1.5	1.6
Na, g	0.55	0.2	0.9	0.6	0.5
Mg, g	0.1	0.15	0.4	0.2	0.3
Fe, mg	22	7.5	42	13	17
Cu, mg	2.7	1.5	5.9	*0.8*	1.7
Mn, mg	1.4	1.2	3.2	*0.6*	2.0
Zn, mg	25	15	24	22	24
Ca:P	1.2:1	1.3:1	1.8:1	*2.6:1*	1.4:1

Table 12. S2 changed, Minerals per 1,000 kcals ME

O1 changed	Pounds	Grams	%
chicken necks, no skin	5.0	2257	50%
beef, ground, 95% lean, 5% fat	1.6	725	16%
beef tripe raw	1.4	645	14%
chicken heart, raw	0.7	322	7%
beef, heart, raw	0.7	322	7%
beef, liver, raw	0.4	161	3.6%
hazelnuts or filberts	0.17	77	1.7%
cold pressed salmon oil	0.06	26	0.6%
Totals	10	4536	100.0%

Table 13. Diet plan O1 with suggested ingredient changes

Diet plan O1 had too much copper, not enough manganese, and, in my opinion, not enough fiber. The natural diet of dogs includes some plant material in the digestive tract of the prey as well as grasses and other plants consumed separately.

I decreased the beef liver to decrease the copper, and added hazelnuts to increase manganese and provide some fiber.

I changed the meat from 90% lean to 95% lean, since I substituted high-fat hazelnuts for some of the low-fat beef liver; 46% of the calories come from protein, 54% from fat.

	NRC Puppy	NRC Adult	Ancestral	O1	O1 changed
Ca, g	3	1	6.1	5.4	5.0
P, g	2.5	0.75	3.5	3.6	3.3
K, g	1.1	1.0	2.0	1.5	1.4
Na, g	0.55	0.2	0.9	0.6	0.6
Mg, g	0.1	0.15	0.4	0.2	0.2
Fe, mg	22	7.5	42	14.1	12.4
Cu, mg	2.7	1.5	5.9	*7.2*	3.3
Mn, mg	1.4	1.2	3.2	*0.7*	1.2
Zn, mg	25	15	24	23	22
Ca:P	1.2:1	1.3:1	1.8:1	1.5:1	1.5:1

Table 14. O1 changed, Minerals per 1,000 kcals ME

Balancing meat with Calcium and Phosphorus in Diets without Bone

Calcium and phosphorus need to be added to meat in order to comply with NRC, AAFCO and the ancestral diet calcium and phosphorus profiles.

Many recipes call for the addition of egg shell powder, plant-based calcium, or other calcium-only sources to meat in order to provide the proper amounts of Ca and P and to provide the proper Ca:P ratio. However, since about one-half of the phosphorus in prey animals is in the bone (calculated assuming 6.5% bone in a typical prey animal, with hydroxyapatite being 70% of the bone), these recipes often do not comply with NRC or ancestral profiles for P and the important Ca to P ratio. The mineral phase of bone is composed mostly of calcium hydroxyapatite ($Ca_{10}(PO_4)6(OH_2)$), which has a Ca:P ratio of 2.15:1 by weight (1.67:1 on a molar basis).[15]

My calculations in Table 15 below show that by adding just egg shell powder or plant-based calcium sources to meat, the absolute amount of P falls below NRC adult recommendations, and reaches only 25% of NRC puppy recommendations. The Ca:P ratios are above the AAFCO maximum, which is 2 parts calcium for 1 part phosphorus (1:1 to 2:1 is the recommended range).

When using calcium sources that are reported to be highly bioavailable, the effective ratios may increase even further, making the calcium phosphorus imbalance worse. In addition, there is a lack of data on the bioavailability of the P in cooked bonemeal.

If bone is not used, I recommend the use of bonemeal, whole bone extract (Microcrystalline Hydroxyapatite or MCHA), or other Ca and P sources to provide the correct Ca:P ratio.

	NRC Puppy	NRC Adult	Ancestral	Meat only	Meat + 2% egg shells	Meat + 2% plant calcium	Meat + 2.5% bonemeal
Ca, g	3.0	1.0	5.7	0.1	3.1	2.7	3.1
P, g	2.5	0.75	3.5	*0.6*	*0.6*	*0.7*	1.7
Ca/ P	1.2	1.3	1.6	*0.17*	*5.2*	*3.9*	1.8

Table 15. Using 80% lean beef. Grams of Ca and P per 1,000 kcals ME

Conclusion

I hope you find this information useful in helping your clients produce homemade dog foods that are similar to the canine ancestral diet and nutritionally compliant with recognized standards. My suggested changes are only a few of the many ways this can be accomplished. I look forward to your comments.

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Author Info

Steve Brown started working with dogs in the early 1980s trying to develop Charlee Bear® Dogs: 40 pound, non-shedding dogs bred for "teddy bear" traits. Working with several canine geneticists and behaviorists, he developed a long term breeding plan for the dogs. In 1992, understanding that positive reinforcement training techniques were required to enhance

teddy bear traits, he developed a best-selling low-calorie training treat (Charlee Bear Dog Treats). In the early 1990s Brown realized that he was not finding the hybrid vigor that he expected, and started focusing on diet. In 1998, he developed Steve's Real Food for Pets, one the first AAFCO-compliant raw meat-based diets. Since leaving Steve's, Brown co-authored a book on canine nutrition, *See Spot Live Longer*, and became a contributing editor to mercola.com. He is a frequent speaker to industry groups, breed clubs and the public about canine nutrition. His articles can be found at www.seespotlivelonger.com,.

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