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HAY AND PELLET RATIOS: CONSIDERATIONS IN FEEDING UNGULATES

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Formulating appropriate diets for zoo animals is a complex and challenging job, especially when formulating diets for the many types of herbivores. Herbivore feeding strategies include animals in a continuum from selectors of fruit and dicotyledon foliage (concentrate selectors) to unselective grazers of high fiber diets (grass and roughage eaters).[18] Body size and digestive tract morphology are adapted to these different feeding strategies, or, perhaps vice versa. The purpose of this document is to serve as a guide for the feeding of this diverse group, recognizing that there is not universal agreement on their classification. Suggested diets are based on limited research with wild animals, extrapolation from data on nutrient requirements of domestic animals, and anecdotal experience.

Body Size

It is important to note that energy requirements are not linearly proportional to body size. Energy requirements per unit body mass increase as body mass decreases. Small animals lose heat much more rapidly than large animals, thus have a higher energy requirement per unit body mass.[9] These concepts are illustrated by the Brody equation which states that the interspecific fasting metabolic rate (kcal/day) is equal to 70 x body mass (kg) to the 0.75 power (i.e., $BW^{0.75}$).[22] For simplicity, the authors have adopted body size categories: small <40 kg, medium 40 - 200 kg, and large > 200 kg.[17,18]

Digestive Tract Morphology

An ungulate is defined as a hoofed mammal.[3] Ungulates, in turn, may be classified by gastrointestinal tract morphology and function into ruminant and nonruminant herbivores. Ruminants are foregut fermenters with a large compartmentalized stomach which includes a reticulorumen containing microbes that aid in digestion.[5,31,38] Ruminants ruminate, or chew a cud (a regurgitated bolus of ingesta), facilitating the particle size reduction required for subsequent digestive processes. The total relative stomach capacity of the ruminant is much greater than that of the nonruminant,[5] and the fractional passage rate (portion of stomach contents passing per unit time) is reduced in ruminants compared to nonruminants due to the inability of large particles to pass through the small sieve-like structure (omasum) between the reticulorumen and the rest of the gastrointestinal tract.[19] Since the particle sizes must be so small for passage, food items consumed tend to remain in the reticulorumen until they have been digested or reduced by chewing to an appropriate size. This increased retention time allows for more extensive digestion of fiber. It also may be important in the detoxification of some secondary plant compounds, such as tannins.[24] End products of fermentation are absorbed at various sites, from the rumen throughout the intestine.

Nonruminant herbivores do not possess a rumen but have digestive tract modifications that provide for microbial fermentation. Nonruminant herbivores can be classified into foregut fermenters and hindgut fermenters. Foregut fermenters have a compartmentalized stomach where microbial fermentation occurs, but they do not ruminate.[4,33] Products of fermentation may be absorbed in the foregut and in the intestine. Hindgut fermenters generally have a large cecum and colon where fermentation occurs. Hindgut fermentation is commonly considered less efficient because release of some of the protein and carbohydrate in plant cell contents, surrounded by fibrous cell wall that can be degraded only by microbes, does not occur until these products are past the primary sites of protein and carbohydrate digestion and absorption.[5]

Influence of Body Size on Digestive Tract Morphology

Small animals require more energy per unit of body weight than larger animals.[38] Limitations in digestive tract capacity and in passage rate of large particles makes it difficult for a small ruminant to process sufficient fiber to meet its high energy needs.[15,38] Thus, in general, small ruminants do not do well on high fiber, less digestible diets. Very large herbivores, such as elephants, have a capacious cecum and colon where fermentation takes place, coupled with a feeding strategy involving consumption of large volumes of food per unit time, fast throughput, and relatively inefficient extraction of nutrients and energy. Zebras, hippopotamuses, and white rhinoceroses are smaller than elephants but use a somewhat similar strategy, although hippopotamuses do have some foregut fermentation. The majority of the remaining ungulates are ruminants.

Small ruminants, with relatively slow passage rates, tend to select high quality diets that are comparatively low in fiber and comparatively high in rapidly fermentable items, such as fruits, seeds, and new growth. Medium-size ruminants include adaptable intermediate feeders with a reticulorumen that can change in capacity and in absorptive surface to accommodate seasonal differences in the availability of suitable browse or grass.[3,17] Similar to small ruminants, some larger ruminants (e.g., certain

browsers) have evolved to select a high quality diet to compensate for the constraints imposed by reduced passage rate. Nonruminants dominate the large body size category, although the camelids are foregut fermenters.

Foraging Ecology

Herbivores have different foraging strategies as well as different digestive strategies. Foraging strategies generally correspond to digestive tract morphology and animal size.[33,37] Although the distinction between herbivores is not discrete (nor universally agreed upon), and they are more properly a continuum (with overlap), in this document they will be termed concentrate selectors, browsers, intermediate feeders, and grass and roughage eaters.[3,17,18]

Concentrate selectors are predominantly highly selective, small ruminants that tend to choose a diet consisting of dicotyledon foliage and fruit, although this fruit is very different in composition from the commercial fruit consumed by humans.[18,21,35] They tend to select forage that maximizes the intake of nutrient-rich, low fiber, easily digestible plant matter.[17,37] In zoos, they consume little hay and when they do, may select mostly leaves. Examples of concentrate selectors are suni, dikdik, duikers, klipspringer, and bongo.[3]

Browsers are predominantly medium to large ruminants and nonruminants that are less selective than the concentrate selectors. They select a diet of mostly leaves of shrubs and trees.[8,3,35] In zoos, browsers are offered alfalfa hay or a combination of alfalfa and grass hay. Ruminant browsers include giraffe, kudu, reindeer, okapi, and gerenuk.[4,35] Nonruminant browsers include pygmy hippopotamuses and black rhinoceroses.[3,35]

Intermediate feeders are typically ruminants of medium size. They are intermediate in selectivity, variously preferring browse or grasses.[18,21,35] Young shoots of fresh grass are preferred over dried hays, but most zoos only have dried hay consistently available. Alfalfa hay or a combination of both alfalfa and grass hay are usually offered. Those species that prefer browse include Dama gazelle, goats, and eland.[35] Those species preferring grass include addax, sheep, and Pere David's deer.[3,17]

Grass and roughage eaters, often referred to as grazers, tend to consume a diet high in fiber.[3,17,18,35] They can be large grazing nonruminants that choose (without much selectivity) a fresh grass diet, such as a Nile hippopotamus, or small ruminants that select the most nutritious parts of grasses, such as the oribi.[3,17] Because zoos have limited access to forages beyond dried alfalfa and grass hays, small grazing ruminants are commonly offered a diet similar to those fed concentrate selectors or browsers. The large size of most grazers allows them to be less selective and consume the higher fiber diets.[17] Ruminant grass and roughage eaters include waterbuck, topi, bison, and camels. Nonruminant grass and roughage eaters include zebra and white rhinoceroses.[6]

Diet Ingredients

The primary foods selected by herbivorous ungulates (ruminant and nonruminant herbivores) are called forages. However, forages fall within a range of very high fiber, poorly digested material to very low fiber, highly digestible material. In general, mature grasses are considered very high fiber forages, whereas new leaves and shoots are considered low fiber forages. The nutrients in the forages are made available mainly by microbial fermentation in the gut.

It is important to consider gastrointestinal morphology, foraging strategy, and plant digestibility when providing a diet for captive wild ungulates. With this in mind, supplying a combination of hays and a nutritionally complete pellet at appropriate ratios can be used to provide balanced diets. Although the nutrient content of forages may vary, the pellet will offer a consistent supply of nutrients. Adjusting the types of hay and the ratio of hay to nutritionally complete pellets will tailor the diet more specifically to the animal's needs (e.g., needs for lactation as compared to maintenance).

Hay

The plants used for dried forage consist principally of fibrous cell walls surrounding cell contents. The major components of cell wall are cellulose, lignin, hemicellulose, and silica.[4,38] Cellulose and lignin provide the cell with its rigid structure. Cellulose (made of glucose molecules) and hemicellulose can be digested by microbes and thus becomes available to ruminants.[38] Lignin is an indigestible portion of the plant. The matrix of the cell wall is made up of water, hemicellulose, and pectins. Hemicelluloses are complex carbohydrates containing a variety of sugars.[5,37,38] As cell growth stops and the plant matures, the matrix is filled with lignin.[4,38] The cell contents include protein, free sugars, starches, organic acids, minerals, and secondary compounds (e.g., tannins, phenols). The nutritional value of forage depends in part on the ratio of cell contents to cell wall constituents and the degree of lignification of the cell walls.[4,5,37]

Fiber may be described as either neutral or acid detergent fiber (NDF and ADF respectively). Neutral detergent fiber includes hemicellulose, cellulose, and lignin. Acid detergent fiber includes cellulose and lignin. The more lignified a plant, the less digestible it will be. Plant analyses [proximate fractions (defined as dry matter, crude protein, ether extract, ash, crude fiber, and nitrogen-free extract), NDF, ADF, and lignin] provide information as to the probable digestibility of the forage.[5,38] These and other analyses can be used to describe the nutrient composition, estimate potential digestibility, determine gross energy concentration, and identify the presence of inhibitors and toxins.[4]

Concerns. There are some concerns with hays in certain areas of the United States. In the Midwest, some soils are deficient in selenium. In some Western states, forages contain levels of molybdenum which can increase the requirement for copper. In Florida and the Coastal Plains, the soil is deficient in copper. These are a few examples of factors which affect the nutrient content of forage in the United States. Those managing diets should consult a local agricultural extension agent for specific data on area hays. Additionally, it is recommended that the hay fed to zoo animals be analyzed for dry matter, crude protein, NDF, ADF, lignin, calcium, and phosphorus. A paper that describes hay quality evaluation is Nutrition Advisory Group Fact Sheet 001. Please refer to it for further descriptions of hay and analyses.

Pellets

As stated above, hay provides a source of nutrients as well as appropriate physical characteristics (fiber) needed for normal gut function. Herbivore pellets complement the hay, and together they can provide all needed nutrients. Table 1 presents an example of a nutritionally complete low fiber herbivore pellet along with some commonly fed hays. The pellet serves as a consistent source of

nutrients and may be able to compensate for specific nutrient deficiencies (e.g., selenium, copper) or inappropriate nutrient ratios (calcium:phosphorus) in the hay. A variety of nutritionally complete pellets is available that may be offered to captive herbivores. For example, a low energy nutritionally complete pellet may be useful in maintaining adults or managing animals that have weight problems.

Table 1 also presents examples of hays available and used in United States Zoos (analyzed values from Brookfield Zoo, Fort Worth Zoological Park, North Carolina Zoological Park, and San Diego Zoological Park). This table serves as a basis for comparison with the hays available in your area. The major differences in the alfalfa categories listed are the protein and fiber values. Prime alfalfa (prebloom, 40-50% leaves, and green) may be too low in fiber to offer some animals and could cause digestive upsets (e.g., loose stools and colic) as compared to quality 1 alfalfa (early bloom, 35-45% leaves, and light green to green). Please note that these nutrient concentrations are expressed on a 90% dry matter basis, typical of air-dry hays and pellets as they are purchased.

Pellets and hay should be offered together in appropriate ratios dependent upon digestive tract morphology, foraging ecology, food items available, and animal condition and health. The ranges for pellet intake and hay proposed in Table 2 provide the nutrients necessary for growth, maintenance, pregnancy, and lactation.

Suggested Diets, Nutrient Profiles, and Nutrient Recommendations

The proposed diets presented in Table 2 are those that have successfully maintained herbivorous ungulates in captivity by meeting or exceeding the known or proposed nutrient requirements of domestic and exotic animals.[1,2,10,11,12,16,20,25,26,27,28,30,32,39] Elephant nutrition is discussed in Nutrition Advisory Group Fact Sheet 004.

The diets presented in Table 2 are composed of the indicated pellet to hay ratios, using the following designations: P = low fiber pellets, meeting specifications listed in Table 1; AHP = alfalfa hay, prime grade, meeting specifications listed in Table 1; AHQ1 = alfalfa hay, quality 1 grade, meeting specifications listed in Table 1; GH = grass hay, quality 3-4 grade, meeting specifications listed in Table 1.

To ensure that consistent diets are fed, it is suggested that the pellets offered be weighed. Quart measures, calibrated to hold specific weights of pellets, also can be used to provide consistent amounts. It also is recommended that hay offered be weighed. If bales or flakes are the standard measure, these should be quantified and checked with each new shipment of hay. Hanging scales work well to obtain total bale weights. A 36 liter (10 gallon) plastic bucket can be hung from the scale to weigh individual flakes of hay. To ensure that nutrient profiles are met, actual diet intakes should be recorded at least quarterly so adjustments can be made as recommended. Often what an animal consumes is quite different from what is offered.

Typically, salt blocks are offered to provide sodium when supplemental pellets do not contain salt. If a low fiber pellet is not tailored to the hay available (e.g., formulated by you), trace mineral blocks can be provided as additional sources of minerals. In general, trace mineral blocks contain sodium chloride, iron, manganese, copper, cobalt, zinc, and iodine. The better approach, of course, is to use a properly formulated pellet.

Produce is not included in the pellet to hay ratio. Many zoos offer produce in the diet for training and behavioral enrichment. Animals in the wild do consume fruits and vegetable material.

However, the fruits and vegetables cultivated for human tastes are very different in composition from those items consumed in the wild. The commercial produce available to zoos is relatively low in plant fiber, and most fruits and some vegetables are high in fermentable sugars.[29] Offering readily fermentable substances to foregut or hindgut fermenters can lead to digestive upset.[29] If produce is necessary for training or behavioral enrichment, it is recommended that it be offered at no more than 2-5% of the diet on a 90% dry matter basis. If produce is included as a greater portion of the diet, the diet may not meet nutrient requirements. It is recommended that the amount of the nutritionally complete pellet offered not be reduced when produce is fed because this would distort further the nutritive value of the diet.

The proposed nutrient concentrations in Table 3 include quantitative data on the nutrient requirements of domestic animals and wild/zoo animals (white-tailed deer, aoudads, llamas, and buffalo) plus extrapolations.[1,2,10,11,12,16,20,25,26,27,28,30,32,39] Suggested diets and nutrient profiles in Table 2 include nutrient ranges that have maintained animals in captivity and either meet or exceed the proposed nutrient concentrations listed in Table 3. Riboflavin and thiamin are not listed in Table 2 or 3 for ruminants since rumen microbes can supply these nutrients to the animal. These nutrient concentrations are not minimum recommendations, rather they are rational working nutrient profiles designed as guidelines based on hay to pellet ratios. Since most animals are fed in groups, it is difficult to formulate to meet the needs of individuals. Meeting the needs of the animal with the highest probable nutrient requirements will necessitate feeding above the needs of other animals in the group. The ranges suggested are designed to meet the needs of growth, reproduction, lactation, and maintenance. The lower values are generally for maintenance and the higher values are generally for growth and lactation. To attain the higher range of nutrient values, increase the pellets to the maximum amount listed (thus reducing the hay to the lowest). In pregnancy, begin increasing the amount of pellets offered either half way through pregnancy or as soon as pregnancy is confirmed.

Concerns. In zoos, research suggested that vitamin E requirements may be greater for exotic animals as compared to domestics, although higher vitamin E concentrations are now being used in domestic animal diets, also.[10,11,12] Mineral requirements may be different among exotic species (considering different breeds of cattle have different requirements).[39] Sheep and llamas are extremely sensitive to copper toxicity, and pellet formulation should consider the special sensitivity of these animals.[20,27] These examples indicate the necessity to consider research in exotic animals and continually update recommendations.

Intake as a percentage of body mass (Table 2) is based on 3-4% for smaller animals and 1-2% for larger animals.[35] The values listed in Table 2 are a base from which to work. These values may be used to estimate the total amount of food to offer an animal. The total amount can then be split into the suggested hay and pellet ratios. Again, this is a base from which to work. More or less food may need to be offered based on the animal's condition, physiological status (maintenance, growth, lactation, reproduction), or environment.

Recommendations

Recommending a diet for herbivores can be challenging. The classifications of ungulate herbivores and the categories listed in Tables 2 and 3 are on a continuum and are intended as a guide. The guidelines in Table 2 may provide some general parameters from which diets can be developed. The guidelines

were established by attempting to meet or exceed probable nutrient requirements using domestic animal data[25,26,27,28] and research with exotic animals (white-tailed deer, aoudads, llamas, and buffalo).[1,2,16,20,30,32,39] Diets may need to be modified based on the nutrient composition of products available. To achieve the proportions in the suggested diets, it is recommended that both the pellets and hay be weighed. To achieve nutrient profiles, analyze hays for dry matter, crude protein, NDF, ADF, lignin, calcium, and phosphorus, and obtain information on special local problems, such as potential trace mineral deficiencies, from an agricultural extension agent. Specify the nutrient content of the pellets you have manufactured and compare by analysis or analyze a commercially available product to establish its suitability. Continually monitor animals for body condition and make adjustments as necessary. With careful attention to changing needs of the ungulates being fed, a combination of nutritionally complete pellets and hay can meet their needs.

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Table 1. Nutrient analyses of alfalfa hays, grass hays, and an herbivore pellet on a 90% dry matter basis.

Nutrient	Quality Prime[a] Alfalfa	Quality 1[a] Alfalfa	Quality 3-4[a,b] Grass	Low Fiber Herbivore Pellet
Moisture, %	9.0-10.7	8.2-9.6	7.4-10.0	10.6
Crude protein, %	18.0-21.8	15.9-17.0	9.8-11.2	17.4
Neutral detergent fiber, %	29.1-36.5	37.2-42.8	51.0-67.4	29.3
Acid detergent fiber, %	24.6-27.3	25.3-33.5	31.2-36.3	17.3
Vitamin A, IU/g[c]	*	*	*	5
Vitamin D, IU/g[c]	*	*	*	1.2
Vitamin E, IU/kg[c]	*	*	*	400
Calcium, %	1.13-1.33	1.2-1.5	0.41-0.67	0.88
Phosphorus, %	0.26-0.27	0.26-0.27	0.19-0.38	0.64
Sodium, %	0.057-0.53	0.014-0.08	0.003-0.03	0.4
Magnesium, %	0.27-0.28	0.24-0.31	0.15-0.21	0.29
Potassium, %	2.1-2.2	1.4-1.7	1.9-2.4	1.5
Copper, mg/kg	7-12	5-9	5-11	23
Iron, mg/kg	166-240	106-138	69-85	394
Manganese, mg/kg	28-38	25-33	25-36	120
Zinc, mg/kg	25-29	17-20	15-31	136

[a] These are classifications of the Hay Market Task Force of the American Forage and Grassland Council (see NAG Fact Sheet 001).

[b] Grasses include timothy, coastal bermudagrass, and sudan.

[c] The vitamin levels in hays are variable; values in pellets were specified concentrations.

* Value not determined.

Table 2. Suggested diets and consequent nutrient profiles that have maintained ungulate herbivores in captivity (90% dry matter basis).

Body Size	Concentrate Selectors	Medium/ Large Browsers		Medium Intermediate Browsers	Medium Intermediate Grazers	Medium/Large Grazers		
Ruminant/Nonrum.	Ruminant	Ruminant	Nonrum.	Ruminant		Ruminant	Nonrum.	
Species	Bongo, Klipspringer	Giraffe, Kudu, Sitatunga, Gerenuk, Reindeer, Okapi	Tapir, Blk Rhino, Pigmy Hippo	Goats, Ibex, Eland, Springbok, Dama Gazelle	Sheep, Addax, Pere David's Deer	Waterbuck, Topi, Llama, Camel, Cape Buffalo, Banteng	Zebra, White Rhino	Nile Hippo
Suggested Diet, %[a]	50-75P 25-50AHP	30-40P 60-70AHP	30P 40-50AHQ1 20-30GH	30-40P 60-70AHQ1	30-40P 40-50AHQ1 20GH	30-40P 60-70GH	25-40P 60-75GH	25-30P 20AHQ1 50-55GH
Intake as %BM	3-4%	2%	1.5%	2-3.5%	2-3.5%	1.5-2.5%	1.5-3.0%	1.5%
Nutrient	Nutrient Profiles							
Protein, %	15-18	15-19	13-18	15-19	14-17	12-13	12-14	12-15
NDF, %	23-33	25-34	31-37	25-36	30-33	37-49	37-51	38-44
Vitamin A, IU/g	2.5-3.8	1.5-2.2	1.5	1.5-2.0	1.5-2.0	1.5-2.0	1.2-2.0	1.2-1.5
Vitamin D, IU/g	0.6-0.9	0.4-0.5	0.4	0.4-0.5	0.4-0.5	0.4-0.5	0.3-0.5	0.3-0.4
Vitamin E, IU/kg	200-300	120-178	120	120-160	120-160	120-160	100-160	100-120
Thiamin, mg/kg	-	-	2.4	-	-	-	2.0-3.2	2.0-2.4
Riboflavin, mg/kg	-	-	2.7	-	-	-	2.2-3.6	2.2-2.7
Calcium, %	0.65-0.87	0.70-0.97	0.80-0.90	0.90-1.10	0.80-1.00	0.56-0.63	0.55-0.63	0.68-0.72
Phosphorus, %	0.44-0.54	0.36-0.40	0.35-0.40	0.36-0.41	0.35-0.40	0.32-0.38	0.30-0.38	0.31-0.35
Magnesium, %	0.18-0.22	0.18-0.24	0.20-0.22	0.22-0.24	0.21-0.22	0.16-0.19	0.16-0.19	0.18-0.20
Potassium, %	1.3-1.5	1.6-1.8	1.5-1.7	1.2-1.8	1.3-1.7	1.4-1.8	1.4-1.8	1.6-1.7
Sodium, %	0.16-0.39	0.10-0.44	0.09-0.36	0.10-0.44	0.09-0.36	0.09-0.12	0.07-0.12	0.08-0.20
Iron, mg/kg	107-125	126-139	82-126	98-139	93-126	75-84	73-84	77-99
Zinc, mg/kg	77-106	54-68	52-58	51-67	51-68	50-84	44-71	45-60
Copper, mg/kg	13-16	10-12	10-12	11-13	11-12	9-14	8-14	9-12
Manganese, mg/kg	57-75	54-57	45-51	44-57	43-56	43-55	40-55	41-50
Selenium, mg/kg	0.20-0.30	0.12-0.18	0.12	0.12-0.16	0.12-0.16	0.12-0.16	0.10-0.16	0.10-0.12
Iodine, mg/kg	0.5-0.8	0.3-0.4	0.3	0.3-0.4	0.3-0.4	0.3-0.4	0.2-0.4	0.2-0.3

[a]P = Low Fiber Pellets; AHP = alfalfa hay quality prime; AHQ1 = alfalfa hay quality grade 1; GH = grass hay.

Table 3. Proposed dietary nutrient concentrations for captive, ungulate herbivores based upon National Research Council requirements and research with deer, aoudads, elephants, nyala, rhinos, and buffalo (90% dry matter basis).

Body Size	Concentrate Selectors	Medium/Large Browsers		Medium Intermediate Browsers	Medium Intermediate Grazers	Medium/Large Grazers		
Ruminant/Nonrum.	Ruminant	Ruminant	Nonrum.	Ruminant		Ruminant	Nonrum.	
Species	Bongo, Klipspringer	Giraffe, Kudu, Sitatunga, Gerenuk, Reindeer, Okapi	Tapir, Blk Rhino, Pigmy Hippo	Goats, Ibex, Eland, Springbok, Dama Gazelle	Sheep, Addax, Pere David's Deer	Waterbuck, Topi, Llama, Camel, Cape Buffalo, Banteng	Zebra, White Rhino	Nile Hippo
Nutrient	Nutrient Recommendations							
Protein, %	16-20	16-20	14-18	16-18	15-18	10-13	9-14	9-14
Vitamin A, IU/g	1.0-3.5	1.0-3.5	1.0-3.5	1.0-3.5	1.0-3.5	1.0-3.5	1.0-3.5	1.0-3.5
Vitamin D, IU/g	0.5-1.0	0.5-1.0	0.2-0.5	0.5-1.0	0.5-1.0	0.5-1.0	0.2-0.5	0.2-0.5
Vitamin E, IU/kg	200-350	120-350	120-350	120-350	120-350	120-350	120-350	120-350
Thiamin, mg/kg	-	-	2.0-4.5	-	-	-	2.0-4.5	2.0-4.5
Riboflavin, mg/kg	-	-	2.0	-	-	-	2.0	2.0
Calcium, %	0.15-0.74	0.15-0.74	0.20-0.65	0.15-0.74	0.15-0.74	0.15-0.74	0.20-0.65	0.20-0.65
Phosphorus, %	0.10-0.44	0.10-0.44	0.15-0.34	0.10-0.44	0.10-0.44	0.10-0.44	0.15-0.34	0.15-0.34
Magnesium, %	0.09-0.18	0.09-0.18	0.07-0.10	0.09-0.18	0.09-0.18	0.09-0.18	0.07-0.10	0.07-0.10
Potassium, %	0.45-0.80	0.45-0.80	0.27-0.38	0.45-0.80	0.45-0.80	0.45-0.80	0.27-0.38	0.27-0.38
Sodium, %	0.05-0.16	0.05-0.16	0.09-0.27	0.05-0.16	0.05-0.16	0.05-0.16	0.09-0.27	0.09-0.27
Iron, mg/kg	27-45	27-45	36-45	27-45	27-45	27-45	36-45	36-45
Zinc, mg/kg	10-30	10-30	36	10-30	10-30	10-30	36	36
Copper, mg/kg	6-9	6-9	9	6-9	6-9	6-9	9	9
Manganese, mg/kg	18-36	18-36	36	18-36	18-36	18-36	36	36
Selenium, mg/kg	0.07-0.18	0.07-0.18	0.09	0.07-0.18	0.07-0.18	0.07-0.18	0.09	0.09
Iodine, mg/kg	0.09-0.72	0.09-0.72	0.09-0.54	0.09-0.72	0.09-0.72	0.09-0.72	0.09-0.54	0.09-0.54