Mineral Nutrition: Are animals nutritionally wise?

Early studies on nutritional wisdom focused on the innate ability of livestock to balance minerals in their diet. From these studies, nutritionists concluded that livestock are unable to consume minerals in correct quantities to prevent or correct mineral deficiencies and they are not nutritionally wise. However, many of the assumptions nutritionists held about diet selection are questionable if one considers animals must learn about foods and the consequences of eating those foods before they can make correct choices.

Listed below are assumptions implied by nutritional wisdom studies and alternative explanations about how animals learn about foods and nutrients, including minerals.

1. Animals are "genetically programmed" to instinctively recognize needed nutrients similar to the way animals regulate intake of sodium. Animals don't instinctively recognize nutrients. When an animal eats a food that contains needed nutrients, once digested the effects of those nutrients on cells and organs in the body feedback to the brain and the animal comes to prefer the food. Thus, experiences with foods shape food preferences.

2. Animals ingest nutrients in exact amounts needed to meet their daily requirements - no under or over consumption. There is no scientific evidence animals eat to prevent nutritional deficiencies. Instead, they respond to excesses, deficits, and imbalances in their diet. While they may under- or over-consume needed nutrients within a meal, they generally do a good job of meeting daily nutritional needs. When animals suffer from deficits or imbalances, they seek out different and sometimes unusual foods. If eating a food rectifies the deficiency or imbalance, they form a preference for that food.

3. All individuals select nutrients in amounts that match NRC requirements. Many researchers have little appreciation for individual variation. Variation is often viewed as the enemy of statistics. In reality, individuals within a species vary in their need for nutrients. Every animal has its own unique morphology and physiology causing animals to need different amounts of nutrients, including minerals. An animal's experience with foods also shapes food preferences and influences diet selection.

4. Social learning and culture are not considered in nutritional wisdom. Social learning and culture are critical for animals to acquire nutritional wisdom. Animals that learn about foods from mom or herd mates are more productive than animals that learn about foods by trial and error. Wild animals are often considered better than livestock at balancing their diet. However, wildlife have an advantage over livestock because they tend to stay with their mothers until they are much older facilitating the transfer of information about their environment and foods over a longer period of time. In addition, wildlife tend to live in the same place for generations enabling one generation to pass on information about surviving in their environment to the next.

If animals can learn to prefer foods that contain needed nutrients, then why didn't they learn to consume minerals in the correct amounts when fed in cafeteria

trials? Given the design of most mineral cafeteria trials, animals may have been more confused than educated about the value of minerals. Listed below are some possible problems with past studies that may have made it difficult for animals to consume minerals in expected amounts.

1. Sodium was often mixed with every mineral. Many minerals are required in minute amounts so researchers mixed minerals with salt to limit intake. Unfortunately, animals only required a limited amount of sodium each day and it may have either encouraged or limited the intake of other minerals. Also, given the flavor of sodium, the minerals probably tasted similar. Animals discriminate among foods by flavor. If the minerals tasted similar, animals couldn't associate feedback from the mineral with its flavor.

2. Flavor not color. Researchers colored the minerals so livestock could discriminate among them. As stated above, animals discriminate among foods by flavor not color. If foods taste the same, they are the same to the animal regardless of how they look. We select foods the same way. If a bowl of jelly beans are all lime-flavored and you don't like lime jelly beans, then you won't eat them even if they are in different colors. It's flavor that matters.

3. Prevent vs. rectify. Researchers expected animals to eat minerals to prevent deficiencies but animals eat to correct, not prevent, deficiencies. When animal diets are adequate in nutrients, animals usually continue to eat the same foods. If animals are deficient in nutrients, they seek new foods. Animals develop preferences for foods that correct deficiencies.

4. NRC recommendations. Researchers thought animals would eat minerals in the amounts recommended by NRC. However, NRC recommendations are often higher than an animal's needs. Some minerals can be stored in the body and don't need to be consumed each day. In addition, many minerals are only needed in small amounts, a few grams or milligrams per day. A single bite may be more than an animal needs for the day. Finally, whether or not an animal consumes a mineral depends on the mineral status of the animal and the mineral compound offered. For example, cows deficient in calcium tend to avoid phosphorus, thus salts of calcium and phosphorus are poor minerals to use when studying calcium-deficient animals.

Looking to the future. Considering the complexities of plants and landscapes, most researchers never imagined that animals were learning about the foods they eat. A better understanding of diet selection is leading to better experiments to determine if animals can learn to rectify mineral deficiencies. One important change in these studies is allowing animals the opportunity to pair the flavor of a mineral with recovery from a deficit of that mineral.

In a recent study, sheep on a phosphorus (P)-deficient diet increased intake of a P supplement when given a choice between a P, calcium (Ca) or sodium supplement. Conversely, sheep eating a Ca-deficient diet ate more of a Ca supplement than sheep eating a Ca-adequate diet. Calcium-deficient sheep also reduced intake of a P supplement typical of animals on low Ca diets. In another study, lambs avoided P during periods of P abundance, and increased their preference for P during periods of P need.

Mineral nutrition is extremely complex. The amount of a particular mineral an animal will ingest depends not only on the level of that mineral in the body but also on its interactions with other minerals in the diet and the body. The body's feedback mechanisms likely enable animals to make correct choices and maintain their mineral status. Recent studies indicate that animals can likely learn to balance minerals in their diets provided they are allowed to pair flavor with recovery from a mineral deficiency.

Fact sheet adapted by Beth Burritt from:
Provenza, F.D. and J.J. Villalba. 2006. Foraging in domestic herbivores: Linking the internal and external milieu. In: Bels, V.L (ed.) Feeding in Domestic Vertebrates: From Structure to Function. CABI Publ., Oxfordshire, UK. pp. 210-240.

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