What Do Deer Eat and Why

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Summary

Food selection by white-tailed deer is mainly a function of seasonal availability and relative abundance of plants and plant parts, palatability, appetite and nutritional factors. In addition to consuming food plants, deer meet their nutritional needs by synthesizing microbial symbionts in the stomach. Nutrients most frequently deficient in deer diets are crude protein, phosphorus and energy. The digestion and supply of these and other nutrients is markedly influenced by the physical and chemical character of consumed foods. Lack of adequate nutrition results in poor fetal development, neonatal mortality, fawn abandonment and the debilitation and death of mature deer. The relative abundance, condition and degree of key plant use by deer are useful indicators of habitat conditions and trends.

A short and oversimplified answer to the question posed in the title of this paper is, "Deer eat whatever food is available because they are hungry." However, when we attempt to analyze and evaluate the entire process of food selection, nutrition and animal response, it is obvious that the problem becomes quite involved with the interplay of many biological factors that frequently vary under different environmental circumstances. I will discuss the food problem under five headings: 1) factors affecting food selection; 2) the digestive process; 3) seasonal nutritional requirements of deer; 4) animal response to nutritional factors; and 5) plant characteristics and conditions that influence deer productivity.

Factors Affecting Food Selection

Being selective feeders, deer choose plants and plant parts with considerable discrimination, usually consuming items that are most apt to meet their nutritional needs. It is unlikely that deer possess nutritional wisdom; however, their survival under a variety of unfavorable circumstances suggests that their food choices are generally beneficial, regardless of the basis for these choices. In any case, survival is not dependent exclusively on successful acquisition of nutrients, but upon avoidance of toxins as well. Although purported to be browsers, there is no physiological reason why deer can not be considered true grazers (Nagy et al. 1967), turning to browse by need rather than choice. In some areas, deer reproduce and do well even though very little browse forage is available.

Palatability, the relative relish with which plants or plant parts are consumed, directly influences the rate and total intake of forage. It varies with species, location of animals and previous experience, and is influenced by the interrelationships of plant, animal and environmental factors.

The sense of taste may be different in deer than in humans. An association between essential oil composition and palatability of certain plants has been reported (Oh et al. 1968), and chlorogenic acid concentrations have been associated with the susceptibility of Douglas fir clones to browsing by black-tailed deer (Radwin, 1972). It is generally agreed that plants high in sugar content are eagerly sought by ruminants.

The sense of smell has not been studied separately from the sense of taste in deer.

The importance of sight has not been objectively studied in deer either, although fawns tend to mimic food choices of their mothers, a behavior that is dependent on sight.

Previous experience also seems to influence food selection. Young deer raised in captivity on formulated diets frequently prefer different food items than those consumed readily by wild deer. Preferences may be transmitted from one generation to the next through imitations of the doe's food selection by her fawns.

Digestion

Information on digestion is taken largely from Verme and Ullrey (1984). White-tailed deer are ruminants with a typical compound stomach (rumen, reticulum, omasum and abomasum). The nutritional needs of deer can be met by the consumption of food plants plus the synthesizing of nutrients by microbial symbionts in the reticulorumen. This latter process may be particularly important when only low quality food is available. Deer are by no means super ruminants and have difficulty in surviving on highly lignified foods.

Regardless of how and why food is consumed, it must go through the digestive process to benefit the deer. At birth, fawns have a relatively under-developed rumen, reticulum and omasum. During nursing, milk flows from the lower end of the esophagus into the omasum without entering the rumen. From the omasum, the milk immediately enters the abomasum and undergoes digestive processes there and in the intestine. The rumen, reticulum and omasum attain their adult proportions at about 3 to 4 months of age. The rumen is the largest compartment and it is here that food consumed in haste is stored until regurgitated, remasticated and reswallowed to promote microbial degradation. Digesta in the rumen and reticulum move rather freely from one compartment to another. Large volumes of saliva maintain the fluid volume and regulate pH and ionic composition. Some food may pass through the rumen in a few hours, while some remains for days. Even in starvation, the rumen is not found empty. Contractions of the reticulorumen mix the contents and ultimately result in movement of the smaller, denser particles of the digesta into the omasum and abomasum.

The microorganisms in the reticulorumen ferment carbohydrates and produce volatile fatty acids, which can be absorbed and used for energy. Of particular benefit is the breakdown of cellulose and hemicellulose, which are found in large quantities in herbaceous materials and which could not be used if it were not for the presence of these microorganisms. They also convert non-protein nitrogen compounds to amino acids that can be used by the host. These non-protein compounds may be present in food, but they are also recycled products of nitrogen metabolism which appear in the saliva and in secretions of the rumen wall. Given sufficient energy, deer can recycle nitrogen in the form of urea, thus allowing rumen microorganisms to synthesize amino acids and protein. As natural forage declines in protein content it also declines in energy value and the animal simply cannot or will not consume enough bulk to obtain the required supply of both.

The products of microbial fermentation, the microorganisms themselves and the dietary components which escape fermentation undergo further digestion in the abomasum and small intestine.

The omasum absorbs water, certain minerals and some products of fermentation. The abomasum secretes hydrochloric acid, pepsin and rennin. In fawns, the breakdown of proteins to amino acids and the splitting of milk fat begins in the abomasum.

Material entering the small intestine is digested by enzymes from the pancreas and the small intestine itself. Items which escape digestion in the small intestine may undergo limited microbial fermentation in the cecum and colon. Some absorption of volatile fatty acids and certain minerals and vitamins occurs in the lower bowel. The indigestible residue is formed into fecal pellets and excreted from the rectum via the anus.

The chemical and physical character of natural foods markedly influences digestion and the supply of nutrients which deer obtain from those foods. Of particular significance are the concentrations of cell wall constituents—cellulose, hemicellulose, lignin, cutin, pectin, tannin and silica. The cell solubles of deer browse are 98 percent digestible, while lignin-cutin complexes are low in digestibility. Thus, the proportions of easily digested cell solubles to more difficultly digested consumed fractions directly influence potential nutritive value. As forages mature, cell wall constituents increase and digestibility diminishes.

Deer at the northern limits of their range and in overpopulated areas frequently succumb to starvation. Lost rumen function may be involved. Some winter foods may be so low in available nitrogen and energy that the nutrient needs of the reticulorumen microorganisms, and thus, of the host, are not met (Ullrey et al. 1971). Deer in relatively good physical condition can fast for several weeks without harmful effects.

If potentially useful supplements are introduced into the deer diet, it must be gradual. Rumenitis, probably as a consequence of lactic acidosis, was diagnosed in nearly 30 percent of white-tailed deer found dead during a severe winter in Saskatchewan (Wobeser and Runge 1975). Several of the deer were found in or near cattle feedlots and in a provincial park where grain screenings had been distributed as deer food. The reticulorumens of some were filled with large volumes of fluid plus wheat or barley. Apparently, these readily fermented foods had been consumed in large quantities, without adequate microbial adaptation. Emergency winter feeding often begins too late and fails to prevent death despite the presence of food in the digestive tract (Nagy et al. 1967).

Nutrient Requirements

The term "requirement" should be used with caution because it implies an exactness which does not exist. Strictly speaking, a requirement is the minimum amount of a nutrient that will promote a given body function to the optimum in a perfectly balanced ration. The minimum varies with age, class, reproduction cycle and weather.

Dry Weight

The dry weight of food consumed by an animal normally is closely related to body size. For big game, daily consumption is roughly 2 to 4 percent of live weight.

Consumption is influenced by many factors other than body weight. Older animals eat less per unit of body weight than younger animals. Consumption also varies with food quality. Diets low in protein cause lowered food consumption (Madsen 1939). In extremely cold weather, wild animals may consume very little food.

In the South, Short et al. (1969) found food consumption generally decreased during the hot, humid summer, but increased slightly in August for bucks, and gradually increased from July to October for does.

Consumption then fell rapidly to lows in late autumn and early winter. In a northern Michigan winter study (Ozoga and Verme 1970), activity and browse consumption by fawns and adult does was high from December to January and in late March. Activity and food consumption were reduced in the interim. Peaks of activity were noted at 4- to 6-hour intervals—sunrise, mid-day, sunset and twice during the night. As winter progressed, nocturnal and early morning movements were reduced and food consumption was concentrated during the warmer part of the day.

The amount of food consumed per unit of time is also a function of appetite. Food intake is physiologically regulated over both the long and short term, otherwise starvation or obesity would be more common.

Physical limitations of the digestive tract very likely limit the intake of coarse foods. Foods difficult to digest are retained longer in the reticulorumen than are easily digested foods, restricting the amount of food consumed per unit of time.

In the lower ranges of dietary nutritive value, physical factors may be most important in limiting dry matter intake, and digestible energy intakes may never reach the deer's needs. In the upper ranges, chemostatic and thermostatic mechanisms may regulate intake such that energy consumption corresponds to need, while dry matter intake declines with increasing value.

Protein

Protein is essential for growth, weight gain, appetite, milk secretion and regular oestrus. A liberal continuous supply is needed throughout life. When protein intake exceeds body needs of adult animals, nitrogen tends to be wasted since it can only be stored in very limited mounts. Therefore, protein is an expensive source of energy. During rapid growth, the body can utilize much more protein than the minimum requirement. The daily requirement increases with age and size. Young growing deer require crude protein levels of 16 to 20 percent of dry matter intake. Young males have a slightly higher requirement than females. About 11 percent crude protein is adequate for yearling deer (Holter et al. 1977). For adults the protein requirement is 6 to 8 percent for maintenance.

Minerals

Salt. Sodium and chlorine help maintain water metabolism, osmotic pressure, acid-base equilibrium and passage of nutrients into cells. Animals deprived of salt develop a craving and may resort to chewing wood, licking soft and similar manifestations. Deer can exist without supplemental salt, but they frequently use natural and artificial salt beds. A high turnover rate of water in the spring may lead to a temporary negative sodium balance. Thus, deer use natural salt licks andsalt blocks relatively frequently in the spring. Salt is used to bait deer into traps at this time of the year.

Calcium and Phosphorous. The principal function of these minerals is the formation of a skeleton. Adequate calcium and phosphorus nutrition depends upon a sufficient supply of each element, a suitable ratio between them and the presence of vitamin D. A desirable ratio is between 1 to 2 and 2 to 1. Adequate vitamin D decreases the importance of the ratio and increases the efficiency of utilization. Domestic herbivores need more calcium than phosphorus for early growth, but the ratio of the two requirements decreases as maturity is approached. Because male deer annually produce antlers, they need both abundant calcium and phosphorus for this development.

A depraved appetite with a specific craving for bones is evidence of a prolonged phosphorus deficiency in an animal. Symptoms of calcium deficiency are usually inconspicuous.

Young growing deer require phosphorus levels of 0.2 to 0.3 percent and calcium levels of 0.25 to 0.5 percent. Maintenance requirements of adults vary from 0.16 to .25 percent for phosphorus and 0.2 to 0.3 percent for calcium. Pregnant and lactating does have about the same requirements as do growing animals.

Energy

Energy provides a common expression of the nutritive value of foods. With the possible exception of protein and phosphorus, it is probably the most common nutritional deficiency of deer. Low energy intake causes reduced or halted growth, loss of weight, failure to conceive, increased mortality and lowered resistance to parasites and diseases.

Mature animals have a special need for high energy foods during the breeding season and in cold weather. In prolonged periods of extremely cold weather, many deer—especially fawns—die as a result of energy deficiencies. A diet that contains a digestible energy concentration of 2.75 kilocalories per gram is considered adequate for deer (Ullrey et al. 1971). If the available winter forage contains less than 2.2 kilocalories of digestible energy per gram (a digestion coefficient of 50 percent), the chances of fawn survival are slim. In Michigan, the winter maintenance requirements for pregnant does were 158 kilocalories of apparent digestible energy and 131 kilocalories of metabolizable energy per kilogram of body weight per day (Ullrey et al. 1970). On a full-feed diet in winter, deer are able to maintain a positive energy balance, but are unable to do so on a maintenance diet (Moen 1968). Even though nutrient deficiencies are apt to be critical during the winter period, winter feeding usually is not recommended. Short periods of feed deficiency are not necessarily harmful.

Water

Water is necessary for transportation of metabolic products, for secretion and excretion, in regulation of body temperature and in many other processes. Deer drink free water when it is available, but go for extended periods without it. Nursing females require it daily.

Vitamins

Vitamin A. Plants do not produce vitamin A, but they contain its precursor, carotene, which is converted into the vitamin in animals. Much of the carotene is lost during curing of roughage, and it is often deficient in late-winter food. Vitamin A can be stored in the liver and also as carotene in body fat. Animals on nutritious green forage store extensive reserves for the winter, when the diet may be deficient. The rate of vitamin A storage on a high-intake diet can greatly exceed the rate of depletion on a vitamin-deficient diet.

Vitamin D. Vitamin D is formed by the action of radiant energy on ergosterol and cholesterol in animals. The amount of vitamin D needed varies with the relative mineral concentrations in the diet and with the species. Vitamin D promotes retention of calcium and phosphorus in blood and tissue. The body can store some of this vitamin. Vitamin D is unlikely to be deficient in animals in the open during the summer. The most critical time is winter, when days are short and cloudy, and when the sun's rays are least concentrated.

Deer Response to Nutritional Factors

There is a close relationship between maternal nutrition and neonatal mortality (Verme 1962, 1953). When pregnant does were well fed, fawning loss averaged 7 percent and birth weight 3.5 kilograms. At a low plane of nutrition the mortality was 93 percent and birth weight averaged 1.9 kilograms. Small but fully-formed stillbirths were commonly borne by underfed mothers. Most fawns were born alive, but died because they were too weak to stand, too small to reach the teats, lactation was delayed or absent or the mother abandoned and refused to nurse them.

Langenau and Lerg (1976) investigated the phenomenon of fawn abandonment by malnourished mothers. Death of fawns was attributed to the does' failure to groom the young at birth, fear or aggression toward them, failure to eat the afterbirth and refusal to nurse the fawns. The lack of an immediate doe-fawn bond was a critical factor. Both twins usually were abandoned. Maternal rejection was probably caused by an insufficient pituitary secretion of prolactin, which is believed to promote maternal instinct.

Murphy and Coates (1966) reported a 42 percent loss of fawns from does receiving a 7 percent diet, a 27 percent loss from mothers on 10 percent protein intake, but a 100 percent fawn survival when does were fed a 13 percent protein diet. The surviving fawns generally averaged heavier birth weights than fawns from mothers on lower protein levels.

The healthy newborn fawn nurses almost immediately. Intake of colostrum milk during the first 24 to 36 hours provides antibodies that impart a passive resistance against disease until the fawn's own immunization begins to function.

As rapidly growing fawns demand more milk, the mother may lose appreciable body weight, especially if she is underfed. Fortunately, fawns begin grazing when just a few weeks old. They become functional ruminants at roughly 2 months of age, hence high quality forage must be available thereafter if fawns are to reach their full growth. On most summer ranges, available forage adequately supplements the doe's milk, but instances of poor growth and starvation of young fawns have been noted (Teer et al. 1965, Cook et al. 1971). On overstocked areas where summer drought prematurely cures the forage, serious nutritional problems are apt to arise.

Fawns are almost always malnourished in winter, and serious body weight loss may occur. Weight recovery and growth resumes in spring. When restored to adequate rations, fawns underfed in winter gain weight faster than those which were on a high nutrition level (Verme 1962, Ullrey et al. 1969). This probably means that half-starved deer assimilate their food more efficiently than do well-fed deer, which tend to be wasteful.

Some nutrients are shunted into fat production. The obligatory tendency to store fat represents a wise strategy for winter survival, when these reserves must be utilized for emergency energy. A deer which is healthy, but small, will not require as much energy to withstand climatic adversity as one that is healthy and large (Ullrey et al. 1967).

The nutritional plane of fawns may change drastically with the advent of cold weather, when they are forced to switch from preferred succulent forage to a low quality diet of woody browse. Factors which contribute to high protein reserves and which are important to winter survival include selective foraging, delayed nursing and recycling of non-protein nitrogen.

Ullrey et al. (1969, 1970) concluded that the maintenance requirements of pregnant does was greater than could be met by the consumption of the most nutritious winter browse in northern Michigan. In this event, the doe catabolizes her fat deposits to supply the energy deficit. On a completely inadequate diet she sacrifices her bones and body tissue to nourish the fetus. After a prolonged siege of harsh weather, the physical reserves of a famished mother may be small or non-existent. At this point fetal growth slows appreciably.

To conserve energy in extremely cold and prolonged winters, deer seek optimum shelter in dense cover and slow their metabolism to a relatively torpid, almost semi-hibernating state. Although these adaptations protect them against harsh weather and famine, a prolonged winter spells trouble. The increased energy demands rapidly sap the scant internal reserves to the point that the animal's defense system may suddenly collapse. Grave debilitation and death most commonly result during the winter-spring transition period. Hence, it is vital that deer get proper nourishment at this time. A severe winter can definitely be detrimental to fetal development. The difference of a few ounces in natal weight could be crucial to a fawn's survival, thus ample nutrition during the final third of gestation is a significant factor in herd productivity.

Plant Characteristics and Conditions

It isn't always obvious why some plants or plant parts are more appealing to deer than others. Nevertheless, there is selectivity, and the more the deer manager knows about some of these factors, whether they are chemical, physical or otherwise, the better job he can do in the management of the deer and their habitat.

It is axiomatic that a plant or plant part must be within reach of deer to be of any use to it. Yet the seasonal and yearly availability, or scarcity, of a food item can be one of the most difficult problems in deer management. The acorn is a good example. If available, the acorn is consistently a high choice item in the deer's diet. When eaten by deer in the fall, this high energy food has a tremendously positive effect on reproduction rate and the winter survival of deer, especially fawns. However, the consistency of acorn production is erratic and in many years acorns are absent or scarce and the results to deer may be disastrous, especially on heavily stocked winter ranges where browse forage is scarce.

Mushrooms present another example. Many of these fleshy fungi are readily eaten by deer, and because of their high protein and phosphorus content, may be a significant factor in the deer's ability to compensate for inadequacies of other forages. But because of their ephemeral existence, they cannot be relied upon as a consistent source of food.

One of the reasons why browse plants are often the mainstay of deer diets is that they present a high degree of permanency in the habitat. But on overstocked ranges where browse lines have developed, much of the potential source of food is above the reach of deer. Essentially the same situation exists for many of the browse plants in forest habitats where plants in the early stages of growth are within reach of deer, but within a few years most of the edible portion grows beyond the deer's reach. Thus, even though the browse plants are present on the area, they contribute little to deer sustenance.

Stage of growth markedly influences the consumption of some plants. As a general rule, young sprouts are more succulent and palatable than growth from older plants. Sprouts from species such as blackgum *(Nyssa sylvatica)* and sassafras *(Sasafras albidum)* are eagerly eaten by deer after a burn, whereas the mature growth from older plants is little used. Even the sprouts from unpalatable plants such as hickory *(Carya* sp.) may be readily consumed after a fire.

Whether or not a plant is evergreen may be of considerable importance in its selectivity during the winter. Yaupon *(Ilex vomitoria),* for example, is unlikely to contribute much to deer diets in the summer, but in the winter, when most woody plants have shed their leaves and herbaceous forage and fruits are usually scarce, the deer readily eat the leaves of yaupon as a source of much needed green food. On the other hand, just because a plant is evergreen doesn't mean that it will be sought after in the winter. For example, pine needles are seldom eaten by deer, even under dire circumstances.

The relative abundance of a plant species markedly affects its consumption. Again, acorns present a good illustration. If available in the fall, they constitute an almost exclusive diet for deer. Other food items, which may readily be eaten in the absence of acorns, are essentially ignored. Too, such plants as American beautyberry *(Callicarpa americana)* are ordinarily used little by deer during the spring and summer when such plants as Japanese honeysuckle *(Lonicera japonica)* are available. But in the absence of honeysuckle, American beauty and other prevalent species may be heavily used. During periods of scarcity, any kind of available food, palatable or not, may be consumed out of necessity. Relative abundance also explains, partially at least, why some plants are readily eaten in one section of the country but not in another.

Rate of stocking also influences plant consumption. On under-stocked ranges deer exhibit a great deal of selectivity in the plants and plant parts eaten, consuming only those of highest palatability. Conversely, on over-stocked ranges, many of the more palatable plants may be scarce or absent, and deer depend almost entirely on medium and low preference plants–whatever is available.

The relationship between chemical makeup and animal use is not always consistent. In some cases deer select plant parts of highest nutritional value. For example, twig tips and leaves, the more nutritious portions of browse plants, are also the most palatable. Too, the rapidly growing newly formed tissues of browse plants are more palatable and nutritious than older tissue. The partial explanation here may be in plant succulence. Plants higher in crude protein content often seem to be preferred by deer but this is not always consistent. For example, sweetgum has a low preference rating for deer, yet its crude protein is equal to or greater than plants readily consumed by deer.

In my opinion, a knowledge of the occurrence, use and condition of key forage plants is essential to wise management of deer and their habitat. The current usage of highly palatable forage plants by deer can be extremely useful information in assessing the range condition. The absence of highly palatable plants in a range where the plants were known to have previously existed is mute evidence of a long period of over-use. On the other hand, if palatable plants are plentiful but receiving heavy use, chances are good that the present over-use has not existed long. Certainly, the heavy use of medium or low preference plants is indicative of immediate and future trouble. And, usually, the light use of highly palatable plants indicates that deer have plenty to eat and the range is in good condition. The identification of these key forage plants and their conditions has to be defined for each habitat type. In the piney woods of East Texas, the area with which I am most familiar, the light use of Japanese honeysuckle or of yaupon in the winter indicates a well-stocked range. Conversely, any degree of use on loblolly pine *(Pinus taeda)* or wax-myrtle *(Myrica cerifera)* leaves is a sure sign of trouble.

The familiar browse line is, perhaps, the most obvious sign of range over-use by grazing animals. The insidious thing about a browse line is that it appears only after an extended period of heavy use. The real challenge to the deer manager is to recognize the early formative stage of the browse line and to make adjustments in operating procedures before extensive damage to habitat and deer takes place.

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