AVITAMINOSES IN ANIMALS

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE AGRICULTURAL EXPERIMENT STATION AND EXTENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS
VITAMINS are nutrients indispensable to animal life and health. They are organic compounds, but evidently of varied chemical character. They occur in vegetable and animal food materials in extremely small concentrations, and the amounts needed daily by animals are so small as to require for their expression the smallest unit of weight, the microgram, which is equal to one one-thousandth of a milligram or one 65-thousandth of a grain.

The information given herein has been compiled from original sources for the purpose of helping the clinician in the diagnosis and treatment of diseases resulting from vitamin deficiencies.

Since investigations are continually modifying the information that has been acquired concerning these nutritional diseases, much of the subject matter given herein must be considered tentative and subject to further revision by future findings. Some of the basic principles are, however, sufficiently well-determined to be of definite value to the veterinarian in his efforts to help farmers and stockmen maintain the health of their flocks and herds.

Urbana, Illinois

Printed in furtherance of the Agricultural Extension Act approved by Congress May 8, 1914. H. W. MUMFORD, Director, Extension Service in Agriculture and Home Economics, University of Illinois.
THE ABSENCE of vitamins from, or a serious deficiency of vitamins in, the rations of animals produces—besides general signs of malnutrition such as failure of growth and emaciation—specific diseases.

Vitamin-deficiency diseases are generally pathognomonic of the dietary imbalance because the function of each vitamin seems to be related more or less specifically to some one tissue or organ in the body such as the epithelial tissue (vitamin A), the nervous system (vitamin B), the intercellular substance of blood vessels (vitamin C), the development of the bones (vitamin D), or the reproductive organs or their proper functioning (vitamin E).

The diseases resulting from deficiencies of vitamins in the diet are called avitaminoses, or hypovitaminoses, and in the literature are distinguished from each other by letters indicating the vitamin in which the diet is deficient, such as avitaminosis A, when the disease results from a vitamin A deficiency.

Low vitamin levels in the ration may affect the health of animals in a nonspecific manner as well as in a specific manner. The nonspecific effects may be of greater economic significance than typical avitaminoses, because of a much greater prevalence. Impaired resistance to infection has been demonstrated, in animal experiments, to result from the continued feeding of diets deficient in either vitamin A or vitamin C (when the animal needs this vitamin) and, less generally, in vitamin B.

In suggesting treatment it is not intended to convey the idea that avitaminoses in animals can always be dramatically cured by supplying the essential vitamins. The addition of any one or all of the vitamins to a ration already containing adequate amounts of them cannot be expected to increase resistance to infection or to combat infection already incurred. Furthermore avitaminoses accompanied by secondary bacterial infections, as well as advanced stages of uncomplicated vitamin deficiency, may respond only slowly or not at all to the indicated nutritional treatment. It is important for the clinician to realize also that symptoms of some infectious diseases frequently simulate avitaminotic symptoms, so that the latter can be diagnosed as such only when the ration upon which the animal is subsisting is obviously or probably deficient in one or more of the vitamins, or when for some reason the ability of the animal to utilize vitamins in its food is seriously impaired.
AVITAMINOSIS A

Typical appearance of advanced eye lesions caused by vitamin A deficiency

(From Hart and Guilbert)
VITAMIN A is called the antiphthalmia vitamin, or “anti-infective” vitamin. It is formed by the animal body from the plant pigment carotene. It is destroyed by prolonged heating and oxidation, and is fat soluble.

**Recognized diseases** resulting from vitamin A deficiency are keratomalacia (cattle), nutritional roup (chickens), and avitaminosis A (swine).

**Symptoms.** In cattle: Early functional disturbance, hemeralopia, or night blindness. Extensive keratitis, profuse lachrymation, opacity of lens, corneal ulceration. (If the condition indicated by these symptoms is not corrected in time, it may terminate in blindness.)

In chickens: Naso-pharyngeal catarrh, atrophy and degeneration of epithelium of mucous membrane of upper respiratory and upper alimentary tracts marked by whitish exudates in sinuses and eyes with secondary bacterial infections.

In swine: Posterior paralysis, unthriftiness, muscular incoordination, degeneration of nervous system, spasms.

**Other Symptoms and Lesions Ascribed to Avitaminosis A**

1. Keratinization, degeneration, and atrophy of epithelia of respiratory, gastro-intestinal, and genito-urinary tracts.

2. General lowering of resistance to infection because of keratinization of epithelial defenses, observable in sinuses, middle ear, salivary glands, lungs, stomach, cecum, and kidneys.

3. Urolithiasis (calculi in kidney, ureter, or bladder) due to keratinization of secreting epithelium and consequent interference with formation and elimination of urine.

4. Sterility in female due to failure of fertilization. Sterility in male due to injury to epithelial structures.

5. Anorexia and digestive disturbances due to derangement and inflammation of secreting epithelia.

6. Marked dental changes, especially in enamel formation.

7. Cessation of growth.

8. Edema, in fore quarters; excessive mucous secretion from nose; scouring (observed in calves). Abortion, simulating contagious abortion (observed in cows).

**Prevention and Treatment.** Feed carotene or foods rich in vitamin A or in carotene.

<table>
<thead>
<tr>
<th>Vitamin A Concentrates</th>
<th>Animal Feeds</th>
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<tbody>
<tr>
<td>Halibut liver oil</td>
<td>Green forage</td>
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<tr>
<td>Cod-liver oil</td>
<td>Carefully cured hays, particularly alfalfa hay and clover hay</td>
</tr>
<tr>
<td>Sardine oil</td>
<td>Yellow corn</td>
</tr>
<tr>
<td>Salmon oil</td>
<td>Milk</td>
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<tr>
<td>Egg yolk</td>
<td>Carrots</td>
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AVITAMINOSIS B
A typical case of polyneuritis
VITAMIN B₃ is called the antineuritic vitamin. It is probably a quaternary base. Moist heat and alkalinity promote its destruction. It is water-soluble.

Recognized diseases resulting from vitamin B deficiency are polyneuritis of pigeons, chickens, rats, and dogs and beri-beri of man.

Symptoms. In pigeons and chickens: Elevation and retraction of head (opisthotonos); convulsions; cart-wheel turning.
In rats and dogs: Posterior paralysis; muscular incoordination; gastric ulcers; bradycardia; hypertrophy of adrenals, heart, and kidney; atrophy of spleen.
In man: Loss of appetite; multiple peripheral neuritis, involving especially nerves of the limbs, pneumogastric and phrenic nerves; gastro-intestinal disturbances; subnormal temperature; slow pulse; cardiac hypertrophy followed by edema.

Other Symptoms and Lesions Ascribed to Avitaminosis B
1. Loss of appetite—first distinctive symptom.
2. Impaired growth and later, emaciation.
3. Palpitation and breathlessness due to accumulation of lactic acid in tissues.
4. Subnormal temperature.
5. Stomatitis, inflammation of tongue, gastro-intestinal stasis, lowered gastric acidity, constipation, ulceration, colitis.
7. Sterility in male due to atrophy of testes and failure of spermatogenesis.
8. Sterility in female due to failure of ovulation and cessation of estrus.
10. Impaired resistance to certain types of infection probable.

Prevention and Treatment. Feed materials rich in vitamin B.

<table>
<thead>
<tr>
<th>Vitamin B Concentrates</th>
<th>Animal Feeds</th>
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<tbody>
<tr>
<td>Dried brewers' yeast</td>
<td>Wheat germ</td>
</tr>
<tr>
<td>Rice bran extract (tikitiki extract)</td>
<td>Wheat bran</td>
</tr>
<tr>
<td>Wheat germ extract</td>
<td>Whole cereals</td>
</tr>
<tr>
<td></td>
<td>Green forage</td>
</tr>
<tr>
<td></td>
<td>Carefully cured hays</td>
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</table>

*Also referred to as vitamin B₃.
AVITAMINOSIS C
A typical case of scurvy
(From M. S. Rose)
VITAMIN C is called the antiscorbutic vitamin, or ascorbic acid. Cevitamic acid is the name for this vitamin adopted by the Council on Pharmacy and Chemistry of the American Medical Association. Vitamin C is chemically related to the hexose sugars, is destroyed by oxidation, is more stable in acid than in alkaline medium, and is water-soluble.

Recognized diseases resulting from vitamin C deficiency are scurvy of monkeys, guinea pigs, rabbits, and man.

Symptoms. Gingivitis; loosening of the teeth followed by ulceration; hemorrhagic and painful swellings near the joints, especially the knee joints; petechial ecchymotic hemorrhages of the skin; and anemia.

Predeficiency state—debility, slight pains in lower limbs; bleeding from gums; intestinal disturbances. General capillary fragility also occurs and is of diagnostic value.

Other Symptoms and Lesions Ascribed to Avitaminosis C

1. Loss of appetite and emaciation.
2. Lowered resistance to bacterial infection.
3. Degeneration of skeletal muscles, hyperplasia of connective tissue.
4. Reproductive failure in female.
5. Decalcification and decay of teeth, fragility of bones.
6. Spontaneous hemorrhage in many tissues due to loss of intercellular cement substance of capillaries.
7. Delayed clotting time of blood.
8. Peptic ulcers (guinea pigs).

Prevention and Treatment. Feed ascorbic acid or materials rich in vitamin C, such as oranges, lemons, grapefruit, strawberries, raw peppers, and tomatoes. Fresh green forage and germinated seeds also contain significant amounts of vitamin C.
AVITAMINOSIS D

A typical case of rickets resulting from vitamin D deficiency

(From Rupel, Bohstedt, and Hart)
VITAMIN D is called the antirachitic vitamin. It is probably a sterol and multiple in nature. It is stable to heat, light, oxidation, and hydrogenation and is fat soluble.

Recognized diseases resulting from vitamin D deficiency are rickets in very young animals; tetany; and osteomalacia, mainly in adults.

Symptoms. Rickets: Faulty calcification of bones, especially noticeable at the epiphyses of the long bones; enlargement of epiphyses; beading of ribs; low concentration of inorganic phosphorus in the blood, and less commonly of calcium; delayed and defective dentition; flabby musculature (pot belly); intestinal atony; constipation; alkalinity of feces.

Tetany: General convulsions (spasmophilia), or convulsions in specific groups of muscles, as laryngospasm, carpopedal spasm; hypocalcemia.

Osteomalacia: Softening of bones due to the absorption of calcium salts, especially in pregnancy and lactation, leading eventually to gross deformities of bones.

Other Symptoms and Lesions Ascribed to Avitaminosis D
1. Retardation of growth.
2. Impaired utilization of calcium and phosphorus.
3. Defective dental development, predisposing to caries.

Prevention and Treatment. Exposure to direct sunlight is most important in the prevention and treatment of vitamin D deficiencies in farm animals. In special cases, particularly when severe rickets has developed, it may be expedient to use more intense sources of ultraviolet light, such as the mercury vapor or the carbon arc lamp.

Vitamin D does not occur in appreciable amounts in any of the common farm feeds or fresh forages. Hays cured in the sun acquire a moderate degree of antirachitic potency. Vitamin D is found in considerable amounts in egg yolk and fish but it occurs in greatest concentration in fish-liver oils and fish-body oils, such as halibut-liver oil, cod-liver oil, sardine oil, and salmon oil. These oils are the most practicable sources of vitamin D in the rations of young animals. Other less practicable sources of vitamin D in animal feeding are irradiated feeds (milk, cereals, yeast) and viosterol (irradiated ergosterol in oil).
AVITAMINOSIS E

Uterus of rat rendered incapable of normal reproduction because of lack of the dietary factor essential for fertility; 20th day of gestation

(From Evans and Burr)
VITAMIN E is called the antisterility vitamin. It is stable to heat, light, and some types of mild oxidation and is fat soluble. Readily destroyed by contact with ferric salts or by mixing with autoxidizable fats. Chemically vitamin E is probably a high molecular alcohol.

Sterility in rats, mice, and poultry results from vitamin E deficiency. Sterility in cattle and other domestic animals as well as in man may possibly result from the same cause.

Symptoms. In the female mammal, failure of placental function with death and resorption of fetuses. In poultry, death of embryo during incubation of egg, generally within three or four days. Female sterility produced by deficiency of vitamin E is always curable.

In the male, failure of spermatogenesis, preceded by excessive liquefaction of the chromatin material, first in the spermatozoa and spermatids, and later in the less mature cells, followed by extensive fusion especially of injured spermatids and spermatocytes, into a typical giant cell of variable size. These degenerative changes are irreversible and hence incurable.

Other Symptoms and Lesions Ascribed to Avitaminosis E

Nervous impairment and paralysis of young born to mothers receiving barely enough vitamin E to complete gestation.

Prevention and Treatment. Feed materials rich in vitamin E.

Vitamin E Concentrates

- Wheat germ oil
- Cottonseed oil

Animal Feeds

- All cereal grains
- Green forage
- Wheat bran
- Wheat shorts
- Linseed oil meal
- Cottonseed oil meal
- Hominy feed
- Kafir
AVITAMINOSIS G
A typical case of black tongue
(From H. C. Rea)
VITAMIN G\(^a\) is called the antipellagra or antidermatitis vitamin. It probably consists of two components, one of which is a flavine pigment (lactoflavine, hepatoflavine, ovoiflavine). It is heat stable, more stable in acid than in alkaline media, and is water soluble.

Recognized diseases are black tongue in the dog, avitaminosis G in the rat, and pellagra in man.

Symptoms. In dog: Stomatitis; glossitis, salivation, followed by necrosis; intestinal congestion; diarrhea; anorexia; anemia; granular degeneration of heart muscle. Some doubt concerning etiology.

In rat: Scaliness of skin of hind paws and later of fore paws; thick inflamed crusts, with serous and bloody exudate on tip of muzzle, eyes, ears, chest, and flanks; alopecia; stomatitis; glossitis; intestinal inflammation; hematuria; priapism.

In man: Stomatitis; glossitis; achlorhydria; enteritis, diarrhea, symmetrical dermatitis accentuated by exposure to light; anemia; spinal cord degeneration; ataxic paraplegia; spasms; mental disturbances. Possibly other factors than vitamin G involved in etiology.

Other Symptoms and Lesions Ascribed to Avitaminosis G
1. Anorexia, failure of growth, cachexia.
2. Keratitis and cataract (in rat).
3. Excessive intestinal putrefaction.

Prevention and Treatment. Feed materials rich in vitamin G.

**Vitamin G Concentrates**
- Dried brewers’ yeast
- Dried milk whey
- Dried skim milk
- Liver
- Kidney

**Animal Feeds**
- Fresh green forage
- Leafy hays
- Milk

**Sources of Illustrations**

The authors are indebted to the following authors and publishers for the illustrations indicated.


Page 8. ROSE, M. S. The foundations of nutrition. Fig. 70, page 305. Macmillan Co. 1933.


\(^a\)Also referred to as vitamin B\(_2\).
VITAMINS are widespread in whole grains, properly cured hays, and well-nourished forage crops and vegetables. Animals receiving a varied diet therefore usually have adequate amounts of the vitamins that are necessary for the maintenance of their health and the promotion of normal growth and reproduction.

Vitamin deficiencies in farm animals are, however, causing important clinical problems to both veterinarians and stockmen. Conditions particularly conducive to vitamin deficiency and the train of diseases that follow such deficiencies are the exclusive feeding of grains and grain products, subsistence on poorly cured hays, or upon stunted or "burned" pastures, and the rearing of young animals under shelter with no access to sunlight.

Veterinarians can render valuable service to stockmen by helping them to recognize symptoms of vitamin deficiency and to revise their practices in such a way as to prevent the difficulties, for, as in contagious bacterial and filterable virus diseases, avitaminoses, whether specific or nonspecific in character, are more effectively and economically prevented than they are cured.