Rabbit nutrition – how to prevent problems through correct feeding

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Glen Cousquer, BVM&S, BSc, CertZooMed, MRCVS examines a rabbit's natural diet and gives 10 top tips to ensure the basics are covered

IT is remarkable that in Britain, a nation reputed for its animal lovers and high standards of animal welfare, we appear to have forgotten how to feed rabbits. Indeed, it is probably fair to say that the majority of rabbits presenting to vets in the UK do so for problems that have a significant nutritional component. This problem is, in my experience, far less common on the continent, where the rabbit has traditionally been "put out to grass" and there has been little inclination to purchase commercial diets.

The following medical conditions are frequently seen in rabbits and can all be traced back to dietary inadequacies:

• gut stasis;

• dental malocclusion;

• fly strike;

• sticky bum (caecotroph accumulation, diarrhoea, etc);

• gastrointestinal foreign bodies;

• enteritis;

• obesity; and

• anorexia.

This feature will first review the anatomy and physiology of the rabbit’s digestive tract before addressing its nutritional needs.

Anatomy

The rabbit is a strict herbivore and, as such, its gastrointestinal system has evolved to ingest and digest large quantities of poorly digestible fibre. Indeed, every part of the rabbit’s digestive system is designed for this purpose.

The teeth of rabbits are all hypsodont, or open-rooted, and grow continuously. They possess a very long crown, rather than a true dental root, and are continuously worn down at the occlusal surface during chewing. Chewing is characterised by up to 120 jaw movements per minute and a pronounced lateral movement that ensures a rate of dental attrition capable of matching the rate of dental growth. Maxillary incisors grow at approximately 2mm per week, while the lower (mandibular) incisors grow at 2.4mm per week.

The abdominal cavity of rabbits is relatively large in order to accommodate the long gastrointestinal tract, the contents of which can make up to 20 per cent of the bodyweight. The rabbit possesses a monogastric stomach that typically contains 15 per cent of the alimentary tract ingesta. By contrast, the large, thin-walled caecum holds approximately 40 per cent of the ingesta and is the largest abdominal organ. The colon is separated into distal and proximal parts by the fusus coli; this thickened section of colon is heavily supplied with ganglionic cells and acts as a pacemaker, controlling colonic contractions.

Digestion

Rabbits are classified as hind-gut fermentors (Cheeke, 1987) and possess a population of symbiotic microorganisms that allow fermentation to occur within the caecum and colon. Rabbits do not completely ferment fibre; instead, they separate out indigestible fibre and expel it from the body as rapidly as possible. This sorting mechanism occurs as digesta enters the rabbit’s large intestine. Muscular contractions allow the digestible suspension of small particles to concentrate in the haustra of the proximal colon while the fibre remains within the lumen of the colon and is evacuated within four hours of consumption. The haustral contents are then passed to the caecum via a reverse peristaltic action.

Once in the caecum, this fluid is subject to an efficient fermentation process that allows the

concentration of proteins, amino acids and volatile fatty acids (VFAs). The particles of fibre entering the caecum are generally smaller than 0.3mm and this fibre is described as “fermentable” or digestible. After fermentation of the digestible fibre components in the caecum, a pellet (caecotroph) is formed that is expelled approximately eight hours after consumption.

Coprophagy is practised by rabbits as part of their circadian rhythm. Caecotrophs are produced at night, usually during the early hours of morning. A neural response, or the strong odour of volatile fatty acids, stimulates the consumption of caecotrophs directly from the anus. It is this practice that is termed coprophagy or caecotrophy. Once reingested, the caecotrophs remain intact in the stomach for up to six hours, until their protective mucus layer dissolves. Continued bacterial synthesis occurs during this time. The caecotrophs contain high levels of vitamins B and K, as well as twice the protein and half the fibre of hard faeces. This process of redigestion facilitates the absorption of previously undigested nutrients. Coprophagy enhances the rabbit’s strategy of high feed intake (65-80 g/kg bodyweight) and rapid feed transit time (19 hours) and allows rabbits to meet their nutritional requirements.

Gut microbes

The ileum forms the transitional zone between the upper small intestine that is sparsely populated with bacteria and the lower intestine where increasing numbers of bacteria are found. The caecum and colon are characterised by an anaerobic environment populated by large numbers of strict anaerobes and a few facultative anaerobes. By far the most significant of these organisms are the *Bacteroides species.* By comparison, *Lactobacillus* species are rarely found as part of the indigenous flora of the rabbit lower gut.

Microbes in the gut of rabbits produce VFAs much as they do in the rumen of a cow. Unlike cows, however, more VFAs are produced on a starch diet than on forage diets (Cheeke, 1994). These VFAs provide limited energy for overall maintenance requirements.

The gut microflora of rabbits are sensitive to antibiotic therapy and a dysbiosis frequently results. Therapy favours the overgrowth of Escherichia coli and clostridia, leading to the production of toxins, diarrhoea and enterotoxaemia.

The use of probiotics has been evaluated in rabbits. Linaje et al (2004) characterised the enterococcal species found in the gut of healthy rabbits, but recommended that potential probiotic strains required further evaluation in vivo. They identified *Enterococcus* faecalis and E faecium as the predominant enterococcal species, but found no lactobacilli. Tachikawa et al (1998) demonstrated the preventive effect of probiotics against enterohaemorrhagic *Escherichia coli* O157: H7 in rabbits. Only 15 per cent of treated rabbits developed diarrhoea whereas some 80 per cent of rabbits that did not receive prophylactic probiotic treatment developed diarrhoea.

Nutritional aspects

The need for fibre

When compared with other herbivores, the rabbit's ability to digest fibre is relatively low (14 per cent for alfalfa hay in rabbits, compared to 44 per cent in cattle and 41 per cent in horses [McNitt et al, 1996]). One might well ask, then, why fibre is so important to the health of the rabbit?

Dietary fibre plays a crucial role in maintaining gut health, and is achieved in a number of ways. In particular, the indigestible fibre is responsible for stimulating gut motility. The provision of indigestible fibre is essential to the prevention of gastrointestinal stasis and, in turn, reduces fur chewing and, in indoor rabbits, of carpet chewing. Fibre is also important in the prevention of enteritis. Rabbits need a minimum dietary fibre level of 20-25 per cent to maintain gut health. Diets less than 20-25 per cent fibre result in gut hypomotility, reduced caecotroph formation, prolonged retention time in the hind gut and often enteritis (Jenkins, 1999).

Fibre is also important in calorie control. Rabbits will consume five per cent of their bodyweight in dry matter per day, together with 10 per cent of their bodyweight in water. Rabbits require a diet of 2,200 kcal/kg of diet (Cheeke, 1994). Where a high quality pelleted diet is fed, the consumption of five per cent bodyweight of this diet will result in excess calorie intake and ultimately obesity. It is, therefore, important that a high-fibre, low-calorie diet be fed if obesity is to be prevented.

Dietary fibre also provides rabbits with the required amount of daily dental exercise and ensures the rabbit's continuously growing teeth are worn down, maintaining normal dental occlusion (Crossley, 1995).

The precise crude fibre (CF) content of different forages will vary considerably. Crude fibre content increases with the maturity of the forage. Early bloom alfalfa may have a CF content of 23 per cent, increasing to 38 per cent in mature alfalfa. Unfortunately, the quality of hay also varies tremendously with region, season, farming techniques and storage. Timothy hay is often suggested as the best for rabbits. Early bloom Timothy hay may have a CF content of 28 per cent. Grass hays such as Timothy are lower in calories, protein and calcium than legume hay, such as alfalfa, and are recommended for mature rabbits. Alfalfa hay is a major feed source in commercial rabbitries, where it is suitable for the nutritional, higher-protein needs of growing rabbits. Alfalfa hay, however, is unsuitable for obese and geriatric pet rabbits and is not generally recommended for pet animals.

Starch

High starch diets are often incompletely digested in the rabbit small intestine due to the rapid gastrointestinal transit time. This incomplete chemical digestion of the starch makes it available to organisms within the hindgut. Rapid microbial growth can occur as a result of this carbohydrate overload, leading to enteritis and possible death.

Grains and feeds high in starch and sugar are, therefore, generally not recommended. Where

grains are fed, they should be coarsely ground and preferably low energy; oats are thus preferred over corn or wheat. The high sugar content of root vegetables such as carrots means that such items should only be fed in moderation. This is even more important when selecting fruits to offer a rabbit: high-fibre fruits such as apples and pears should be offered in preference to sugary fruits such as grapes and bananas.

Protein

In ruminants, microbial protein satisfies the major amino acid requirements of the animal. This is not true for rabbits. Rabbits have been shown to be able to digest protein in forage quite well and research has shown that microbial protein plays only a minor role in meeting the rabbit's amino acid and protein requirements (McNitt et al, 1996).

Low protein concentrations in the diet do, however, increase caecotrophy, whereas high levels decrease caecotroph consumption. Clearly, bacterial amino acids are available via coprophagy and can be used when necessary.

Pellets

Commercially milled alfalfa meal-based pellets are the predominant feed for rabbits. The fibre content of these pellets ranges from 10 per cent to 20-22 per cent, with the average being 15-16 per cent. A fibre content less than 15 per cent is likely to increase the potential for gut hypomotility disorders, anorexia and diarrhoea. Fibre contents above 16 per cent, however, may be accompanied by a reduction in feed palatability. Pellets with a fibre content of 18-22 per cent are indicated in the prevention of obesity.

Perhaps the main advantage of a pelleted food is that rabbits are unable to select for an imbalanced diet. Rabbits allowed to select their own diet in a natural setting will select the most tender, succulent plant parts. These are nutrient dense, but low in available cell wall material. Rabbits thus actively select for concentrates to meet the requirements for their high metabolic rate. Similarly, where rabbits are offered a commercial mix, they are again likely to demonstrate selective feeding, resulting in dietary imbalances. Not surprisingly, this can lead to problems. Ideally, any pellets fed should be high in fibre and low in calories and should never be fed as a complete diet.

Greens and others

A varied diet will contribute to the enrichment of a rabbit's environment, providing valuable nutrients and stimulating foraging behaviour.

It is suggested that a minimum of three different greens a day be fed and that these be rotated to discourage fussy eating. Darker green vegetables are generally rich in antioxidants and other

nutrients.

Suitable greens include kale, beetroot tops, carrot tops, broccoli leaves and florets, parsley, dandelion leaves, romaine lettuce, cabbage leaves, chicory, peppermint and raspberry leaves. Dandelion leaves are reputed to be an appetite stimulant and should be offered to postoperative rabbit patients and anorexic rabbits.

Frequency of feeding

It is important that the ration is eaten entirely to ensure the rabbit is not allowed to actively select the more nutrient-dense ingredients. Where a rabbit mix is fed, small quantities should be given and owners advised not to renew the mix until it has all been consumed. Similarly, with alfalfa hay, rabbits should be encouraged to eat the stems as well as the leaves. The bulk of the diet should, however, be offered ad libitum.

Convalescent diets

Sick rabbits that are refusing food require a great deal of supportive nursing care. Part of this is directed at supporting the rabbit’s gastrointestinal tract. Convalescent diets are designed to provide foragebased fibre in an easy to administer form.

This fibre is required to stimulate both gut motility and appetite. It will also provide the caecal microflora with an appropriate substrate for fermentation.

In addition, the provision of fermentable fibre will stabilise the caecal pH and prevent proliferation of pathogenic bacteria.

Grass, hay and haylage

1. Rabbits have evolved to live on grass and will do well on natural grasslands, which are typically made up of a number of different grass species and other wild plants.

2. The fibre and silica content of grass, hay and haylage are essential for dental and digestive health.

3. Grass and hay are good sources of both fermentable (therefore digestible) fibre and indigestible fibre. Both are important components of a rabbit’s diet.

4. Where grass isn’t available, both hay and haylage can be offered as viable and healthy alternatives. Grass clippings should be avoided as these are likely to ferment quickly.

5. Warm, wet weather will usually encourage grass to grow, producing that distinctive flush of

green grass.

6. As grass matures, the lignin content increases and the grass tends to dry out. Hay is usually cut after a period of fine, dry weather, thus ensuring that it can be dried and baled as quickly as possible.

7. Species of grass found in hay depends on the type of pasture from which it is sourced. Older pastures used to contain a mixture of grasses, herbs and wild plants. More modern pastures are usually sown with perrenial ryegrass (*Lolium perenne*), but may alternatively be sown with Italian ryegrass (*L multiflorum*), Timothy (*Phleum pratense*) and the fescues.

8. Where hay is derived from a single grass (monoculture) it may not meet all the nutritional needs of a healthy rabbit. In addition, some monocultures are produced primarily for seed Dietary fibre plays a crucial role in maintaining gut health in rabbits, and hay or grass should be available at all times. production; in such cases the hay is a by-product and may not be nutritionally balanced.

9. Crude fibre is a measurement of the cellulose and lignin composition of the diet. Acid detergent fibre (ADF) provides a more accurate measurement, however, of the amount of indigestible fibre than crude fibre measurements. The higher the ADF, the less digestible the hay is and the lower its feed value. A poor quality hay can have values of crude fibre approaching 40 per cent (ADF 45.2 per cent), whereas a good quality hay will have a crude fibre reading of approximately 30 per cent and an ADF of 36.4 per cent (Cheeke, 1987).

Nutrition: 10 top tips

1. Free choice of good quality Timothy or grass hay. Hay should be made available at all times.

2. Controlled access to grass/the lawn. When lush spring grass is present, the rabbit should be introduced to this very gradually to allow the gut flora to adapt to this change in diet.

3. Feed small quantities of rabbit pellets. The crude fibre and protein content of the pellets should reflect the age and nutritional requirements of the rabbit. Protein levels of 16-18 per cent are suggested for growing rabbits, whereas levels of 14 per cent are proposed for mature pet rabbits.

4. Small quantities of fruit and root vegetables can be offered as treats. Sugary fruits such as bananas and grapes should be avoided or fed in moderation.

5. A minimum of three types of “greens” should be offered each day. Green vegetables may include collard, mustard, carrot and beetroot tops, broccoli tops, clover, parsley, endive, dandelion and cabbage. Fruit and lettuce with a high water content (tomatoes, cucumber and iceberg lettuce) contain little fibre and can lead to the production of soft, uneaten caecotrophs and should be avoided or fed in moderation.

6. Food should be provided in ways that stimulate foraging behaviour and contribute to environmental enrichment. Hay can be presented in a hay net hung from a height to encourage foraging. This should only be done if the hay is dust free, to avoid the risk of dust and hay fragments entering the nares and eyes.

7. A good, dust-free alternative to hay is haylage.

8. Locust beans, dried peas and sweetcorn have been incriminated in intestinal obstructions and should be avoided.

9. The provision of rabbit probiotics are indicated at times of stress, such as at weaning, and where there is likely to be any disturbance to the microflora of the gut.

10. Feed bowls should be elevated to reduce the risk of feed becoming contaminated with faeces.

Conclusions

Ultimately, the correct feeding of rabbits is underpinned by the provision of a high-fibre diet from grass hay. The diet as a whole should be low in starch and should contain moderate protein and calcium levels. This feeding strategy will ensure regular dental wear and the maintenance of a balanced gut microbial population.

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Further reading

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