

## Taking a bite into rabbit diet research

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**Categories :** [Exotics](#), [Vets](#)

**Date :** June 27, 2016

**An estimated 1 million to 1.7 million rabbits are kept as pets in the UK, making them the third most common mammalian pet, after dogs and cats.**



However, according to the BVA, one in five vets have serious concerns about the health and welfare of pet rabbits in the UK and 21.6% feel the public should be discouraged from keeping them, especially when looked after by children. The main health and welfare issues are inappropriate diet, loneliness and unsuitable housing (Kernot, 2016).

Diet plays an important role in maintaining rabbit health. Feeding an incorrect diet, particularly a low-fibre one, has been linked with digestive, dental and urinary tract disease. However, food intake and dietary requirements have been poorly studied in pet rabbits (Prebble and Meredith, 2014).

Provision of adequate rabbit care is essential to meet an increased demand from owners requiring the best treatment for their beloved pets. Rabbits' dentition and gastrointestinal anatomy are adapted to digest coarse, high-fibre foods, such as grass and hay (Meredith and Lord, 2014), so it is important this makes up the bulk of their diet.

This article aims to review the latest research in relation to rabbit diets.

### **Food and water intake on different feeding regimes**

It is generally advised to feed domestic rabbits a forage-based diet mimicking, as closely as possible, that of the wild rabbit, made up predominantly of grasses (Williams and Wells, 1974; Harcourt-Brown, 2002; Meredith, 2006; Clauss, 2012).

Commercially available concentrate rations (including both muesli mixes and extruded/pelleted nuggets) normally produced for domesticated rabbits can be high in energy (carbohydrates and fats) and low in fibre compared to a natural diet (Meredith, 2006).

Using lower fibre feeds has often been implicated in the development of dental disease (Crossley, 2003), as well as digestive and behavioural disorders in pet rabbits, but, to date, the specific dietary requirements of pet rabbits are not fully understood.

Rabbits are selective feeders, tend to pick plants with the highest nitrogen/protein content to obtain their nutrients and are even capable of distinguishing between varieties of the same plant. This behaviour remains in pet rabbits that may selectively feed on concentrate foods leading to nutrient imbalances; for example, high starch and protein components are selected, while high-fibre pellets with vitamin and mineral supplements are rejected (Harcourt-Brown, 1996).

Rabbits' water intake is affected by multiple factors, including age, environmental temperature, reproductive status, husbandry and diet (Prebble and Meredith, 2014). Tschudin et al (2011) stated total water intake was highest when the diet had high moisture content (90%), when compared with hay-based or concentrate-based diets, with the majority of water consumed from the diet. When foods with low moisture content are fed, water intake is higher with hay or high-fibre foods in contrast to low-fibre pellets or seed mixes.

In their study, Prebble and Meredith (2014) aimed to assess patterns of food and water intake of 32 pet Dutch rabbits fed four diets:

- extruded nuggets with hay
- muesli with hay
- ad libitum hay
- ad libitum muesli

Results revealed dry matter (DM) intake was greater in the rabbits fed only hay and lower in rabbits fed only muesli, compared to the groups fed hay with nuggets and hay with muesli, respectively.

Water intake was positively correlated with DM intake and greatest in the group of animals fed hay only. Selective feeding occurred in all rabbit groups fed muesli, whether hay was also available. Pellets were rejected, and grains and extrudates selected. The presence of selective feeding in all rabbits fed muesli leads to the consumption of an unbalanced diet (with respect to vitamins and minerals). In addition, hay and water intake were lower when muesli was fed.

This study demonstrates the feeding of muesli diets cannot be recommended and should be considered unsuitable for domestic rabbits, as rabbits on muesli-only diets demonstrated high levels of selective feeding, and lower timothy hay and water intake. Hay and grass should constitute the bulk of a domestic rabbit's diet.

According to the authors, offering a measured amount of high-fibre nuggets prevents selective feeding, promotes a higher hay intake and provides a balanced diet with adequate hay and water intake to maintain health. Surveys have shown 29% of rabbits eat rabbit muesli as a main source of food, although these numbers are significantly lower compared to the 49% seen in 2011 (PDSA, 2015).

## **Impact on incisors and development of dental disease**

Inappropriate diet is frequently implicated in the development of acquired dental disease in pet rabbits (Harcourt-Brown, 1996; Crossley, 2003). However, its exact role in the aetiology of dental disease remains unclear and several theories have been proposed, including lack of attrition (Crossley, 2003; 2005) and calcium/phosphorus imbalance (Harcourt-Brown, 1996, Jekl et al, 2011a and b; Gumpenberger et al, 2012).

Rabbits have elodont teeth that grow continuously throughout their lives, with no anatomical roots. The eruption rate of their upper and lower incisors is reported to be about 2mm/week and 2.4mm/week, respectively. Cheek teeth grow at a rate of about 3mm per month, but studies have reported growth rates of 1.4mm/week to 3.2mm/week (Müller et al, 2014).

The eruption rate may be influenced by many factors, including abrasiveness of the diet (diets affect each type of tooth differently), tooth-on-tooth action during chewing and grinding of teeth during periods of rest, age and pregnancy.

In a complex, long-term study developed to assess the effect of diet on the health and welfare of pet rabbits, Meredith et al (2015) evaluated the impact of four different dietary regimes on tooth length and curvature, and incisor eruption and attrition rates:

- hay only
- extruded diet with hay
- muesli with hay
- muesli only

Data collected did not support the theory low calcium and/or high phosphorus content of the diets or abnormal calcium/phosphorus ratios are associated with tooth elongation and curvature, although this does not rule out multiple factors may be implicated in the development of dental disease.

Results showed early dental pathology was seen in rabbits fed only muesli or muesli and hay. These rabbits had increased sagittal plane curvature and widened interproximal spaces of the cheek teeth on lateral skull radiographs.

By month nine, a greater degree of tooth curvature was radiographically evident in rabbits fed muesli only compared to those fed hay only or extruded diet with hay. After 17 months, rabbits fed muesli only and muesli with hay had longer lower first cheek teeth and larger interdental spaces between the first two molars than rabbits fed extruded diet and hay only.

Prebble and Meredith (2014) suggested the lack of access to hay in the group of rabbits fed only muesli and the lower levels of hay intake in the group fed muesli and hay – in comparison to groups fed a hay-only diet or in association with extruded diet – could explain the differences in the radiographic appearance of the dental arcades between these groups.

Also, eruption and attrition rates of incisors were highest in the group fed only hay and lowest in the group fed only muesli without access to hay. Those rabbits in the groups consuming a combination of hay and concentrates, and hay and muesli had intermediate growth and attrition rates.

The study's conclusion was muesli-based diets were not suitable for pet rabbits, whether given with hay.

## **Bodyweight and body condition score on feeding regimes**

As part of a long-term study to assess the effect of diet on the health and welfare of pet rabbits, Prebble and Meredith (2014) assessed how two commonly recommended diet regimes – extruded diet with ad libitum hay and a muesli-type diet with ad libitum hay – alongside a hay-only diet and a muesli-only diet, influenced weight gain and body condition score (BCS).

Pets are considered overweight when their bodyweight exceeds 10% to 20% of their ideal weight and obese when it exceeds 20%. Obesity is a health concern, but it can be difficult to determine whether a rabbit is obese simply based on bodyweight due to the lack of standardisation for cross-breed rabbits.

Obesity can also be determined in terms of BCS and, in rabbits, a score of five out of five corresponds to obesity (PFMA, 2013). The study demonstrated diet can have a significant impact on bodyweight and BCS in growing rabbits.

In fact, rabbits fed ad libitum muesli with no access to hay were significantly heavier (2.59kg) by the end of the study than those on other diets (