Lucerne – Friend or Foe

Kathryn McKay – Willowmist Cavies ©2019

It is hard to know just where and when the demonization of lucerne as an inclusion in the cavy diet began. It is a widespread belief in the 21st century endorsed by groups including the RSPCA, the Australian Veterinary Association as well as various University Vet Schools. Scrolling through the internet everyone from cavy rescue sites to online forums and cage supply companies warn about the dangers of feeding lucerne to adult guinea pigs. It is emphasised lucerne, if fed at all, should be reserved for babies less than six months old or pregnant and lactating mothers. The policy statement on the Australian Veterinary Association website says "Rabbits (and likely guinea pigs) exhibit increased calcium load associated with lucerne hay diets" (Australian Veterinary Association 2015). It references a study on the influence of diet on calcium metabolism in rabbits (Clauss et al 2012) and another on food and water intake and selective feeding in rabbits (Prebble & Meredith 2014). Neither paper studied cavies. RSPCA Australia states "Guinea pigs should not be fed Lucerne (alfalfa) or Clover hays as they are too high in protein and calcium" (RSPCA 2018).

The cavy diet

Cavies (*Cavia porcellus*) are obligate herbivores originating in Andes region in South America. They are hindgut fermenters sharing a similar digestive system to horses. Compared with rabbits and rats, cavies are more efficient at digesting plant fibre in the cecum and proximal colon (Sakaguchi, 2003). Cavies are also more efficient at extracting crude protein from food (Chiou, Yu & Kuo, 2000). In their wild form they were largely graminivorous (grass-eating) and grazed continuously and selectively in areas where vegetation quality was not high (Asher, Spinelli de Oliveira, & Sachser, 2004, McBride, 2017). Individuals actively searched for a variety of plants especially grasses and herbs that provided a nutritionally balanced diet (McBride, 2017).

Lucerne as fodder

Lucerne (*Medicago sativa*) or alfalfa as it is known in some countries is a legume. Most other fodder crops are cereal or grass based. Lucerne has a higher calcium and protein content. Pre-flowering lucerne hay has an average protein content of 15 Metabolizable Energy (ME) per kilogram (kg) dropping to 14 ME/kg after flowering (Courtney 2002). Ryegrass hay incorporating clover has an average protein content of 9 ME/kg before flowering and 8ME/kg after flowering, and oaten hay cut at flowering is 7 ME/kg, at milk stage is 5 ME/kg and at ripe seed stage is just 3 ME/kg (Courtney 2002). The calcium content of early flowering lucerne is approximately 16 grams (g) per kilogram (kg), dropping to about 14 g/kg in late flowering lucerne (Blackwood 2007). In contrast ryegrass/clover blends average 6-8 g/kg and oaten hay about 3 g/kg (Blackwood 2007).

The case against lucerne

This high calcium and protein content has led to speculation that lucerne should not be part of the standard diet in adult cavies. At the most many recommend limiting it to immature animals, or pregnant and lactating females. Some researchers explain there is a link between high calcium levels the incidence of kidney and bladder stones in cavies. Cavy urine is naturally alkaline and is thick and cloudy. It contains minute calcium particles and ranges in colour from white to pale yellow (Greenacre 2011). There are numerous journal articles describing kidney and bladder stone formation as being a renal health problem for cavies. Greenacre (2011) states urolithiasis is a common complaint in guinea pigs, particularly sows older than three years of age. Calculi can occur in the kidneys and bladder and can be composed of calcium carbonate, but calcium oxalate and other forms are also found (Greenacre 2011). A study from Turkey found a single guinea pig calculus with both calcium carbonate and calcium oxalate (Dokuzeylül et al 2013). There are also multiple studies referencing calcium oxalate stones in cavies. One significant study examines the death of 364 (46%) animals in a colony of 800 Dunkin-Hartley strain guinea pigs (Okewole et al 1991). The deaths followed an outbreak of *Streptococcus pyogenes* infection that was associated with calcium oxalate urolithiasis (Okewole et al 1991). The findings of Hawkins et al (2009) indicate that between 83% and 93% of calculi were made up of 100% calcium carbonate which is in contradiction to other studies (Okewole et al 1991, Minarikova et al, 2015). For this reason it was recommended diet and husbandry practices be examined to help prevent the development of calcium carbonate stones (Hawkins et al 2009). It would seem that this study in particular has resulted in an interpretation that lucerne should be excluded from the cavy diet. However, a recent retrospective study of 1000 cavies showed urological disorders occurred in 42 animals with females more likely to be affected than males (Minarikova et al, 2015). Animals aged greater than two years old were most likely to be affected and in the cases where uroliths were found, all contained calcium salts (Minarikova et al, 2015). A range of factors are proposed to contribute to the formation of uroliths in guinea pigs, however studies have not clarified the greatest risk factors (Osborne et al 2009). Likely a combination of factors including diet, inadequate water intake, lethargy, obesity, poor cage hygiene, infection and genetic predisposition contribute to calculi formation (Osborne et al 2009). Interestingly cavies given vitamin c supplements on top of fresh vegetables and pellets containing stabilised vitamin c are seen to be more likely to develop calculi (Minarikova et al, 2015). So it would seem likely that the case to exclude lucerne is complex and likely speculative in healthy cavies.

Lucerne in the cavy diet

In Australia there are two galvanised schools of thought relating to feeding lucerne – those who feed it and those who religiously avoid it. Generally people who feed lucerne are part of the standard breed cavy fancy and include animal scientists, vets and animal nutritionists. Those who don't feed lucerne are often pet cavy owners. Members of the standard breed fancy tend to feed a diet comprised of 85 to 90% hay made up of whatever variety is in season. This can include lucerne, grassy (generally in Queensland, Rhodes grass), a grassy/lucerne blend, oaten, wheaten and barley. An advantage of feeding seasonally

available hay, including lucerne, is that it decreases the likelihood of sensory-specific satiety (Rolls 1986). This issue can occur when the diet, especially hay type, is monotonous, as is the case of single species bagged hay (Rolls 1986). There is a reported reduction in interest and consumption when sensory-specific satiety occurs (Rolls 1986, Favreau-Peigné et al. 2013). The rest of the diet comprises high quality, stabilised vitamin c enriched pellets (about and 1/8th to 1/4th cup per animal) and a small piece of vitamin c rich vegetable. This diet is designed to mimic a natural foraging diet to provide optimum health in which animals actively seek out food for maximum nutrition (McBride, 2017). Researchers suggest this type of food regime reduces diet related health issues in the cavy (Clauss, 2012). Clauss (2012) suggests that hays, fresh grass, leafy greens and herbs, supplemented by good quality pelleted feed to balance vitamins and minerals should provide the correct nutrient and roughage balance for good health. This diet emphasises the importance of avoiding reliance on grain or fruit based diets (Clauss, 2012). Lucerne hay is higher in energy than other hays, but this is a generalised statement as levels vary according to the season and growth phase at harvest. Lucerne is often used by fanciers because of its higher protein and calcium content which encourage better growth in show stock.

The recommended pet cavy diet generally consists of unlimited hay (not lucerne for adults), optional pellets and at least one cup of fresh vegetables each day (BBEVS, 2018). Pet owners are advised to avoid lucerne for adults and reserve it for animals less than six months because of high calcium levels (BBEVS, 2018). A variety of fresh vegetables especially those containing higher levels of vitamin c are recommended to provide a good vitamin and mineral ratio, as well as extra water for the gut (BBEVS, 2018). One thing pet owners complain about is the expense of trying to keep their cavies supplied with vegetables and occasional fruit. Pet cavy owners also seem to report an increased number of animals suffering from dental disease. One study found dental disease was the most common health problem seen in cavies, with malocclusion a major concern (Minarikova et al, 2015). In total 363 from 1000, or about a third of all animals examined, had dental issues (Minarikova et al, 2015). Factors seemingly associated with dental disease include diet, particularly a high energy, low fibre and low calcium, one lacking in abrasive materials, and genetics (Norman & Wills, 2016). Although the Norman & Wills (2016) failed to conclusively link diet and dental disease, other studies have suggested mineral imbalances as being a contributor (Müller et al, 2015). Regardless of whether lucerne or an increased amount of vegetables are fed, it is important for all owners to monitor individual animals' condition (chiefly through weighing or body scoring) as an indicator of health (Clauss, 2012).

Cavies in the laboratory

There is a great deal of information available on the guinea pig diet, however much of it remains either unpublished or unavailable to lay people (Witkowska et al, 2017). Laboratory diets are higher in protein, often around 17 – 18% and feature lucerne in the ingredients. Pelleted feed produced by West Australian company, Specialty Feeds, produces two fixed formulated diets for laboratory guinea pigs that are fortified with vitamins and minerals (Specialty Feeds, 2019). This company's pellet that is designed to be supplemented with fresh greens contains 17.80% protein and 1.10% calcium with lucerne listed a major ingredient (Specialty Feeds, 2019). It is recommended to be fed ad lib to animals

of all ages (Specialty Feeds, 2019). American laboratory feed supply company, Lab Supply, produces a similar pellet to be fed ad lib. It has a protein level of 18%, calcium of 1.10% and its main ingredient is alfalfa (lucerne) meal (Lab Supply, 2019). Witkowska et al (2017) recommend greater scope for research into cavy diet to assist pet and fancy owners.

The benefits of lucerne in the cavy diet

It could be argued there are benefits in introducing lucerne into the diet of healthy adult cavies in Australia. For years vets theorised that dietary calcium played a major role in calculi formation in rabbits, and that cavies and humans would be similar (Brown, 2006). Studies in rabbits fed large quantities of dietary calcium, much higher than the average pet diet, failed to elicit calculi formation (Brown, 2006). It is therefore surmised that as in rabbits and humans, stone formation is the result of a complex combination of metabolic, chemical and most likely genetic factors in individual cavies. If lucerne is fed with vegetables or grass containing oxalates it can reduce the risk of cavies developing calcium oxalate urolithiasis. Oxalate binds with calcium to form calcium oxalate. Approximately 10 - 20% of oxalate comes from dietary sources, 40 – 50% is synthesised in the liver and the remainder occurs as part of the metabolic process breaking down ascorbic acid (vitamin c) (Williams & Wandzilak, 1989). The process by which cavies excrete oxalate in the urine is very similar to that of humans (Holmes, Hurst, Assimos & Goodman, 1995). It follows that by reducing the influence of dietary oxalate, it may be possible to reduce its influence on stone formation. Many foods recommended for cavies are high in oxalates; these include spinach, kale, parsley, carrots, broccoli, apples and berries. Feeding calcium rich food at the same time as oxalate rich food allows the metabolic process to occur in the gut, rather than the kidneys (Bong, Vanhanen, & Savage, 2017). Calcium oxalate is then eliminated through the digestive process, rather than the renal process. The addition of even small amounts of calcium rich foods would make foodstuff higher in oxalates safer to consume (Bong, Vanhanen, & Savage, 2017). Special mention must be made of grasses and oxalate content. Depending on the season oxalate content will be higher, and in some species this content will exceed recommended levels. Buffel grass, green panic, setaria, kikuyu, guinea grass, para grass, pangola grass and signal grass are all species with high oxalate levels and are often referred to as tropical grasses (Allan, Hoare, R & Rose, 2007). In all cases oxalate levels exceed calcium levels, resulting in potential calcium deficiencies and other health problems (Allan, Hoare, R & Rose, 2007). Cavies have been shown to need a higher calcium and phosphorous daily dietary intake than some other rodents (National Research Council (US) Subcommittee on Laboratory Animal Nutrition, 1995). A ratio of 8 g Ca/kg and 4 g P/kg daily appears to fulfil dietary requirements of these minerals (National Research Council (US) Subcommittee on Laboratory Animal Nutrition, 1995). It is unclear why cavies require more calcium than rodents such as rats, or why an increase in phosphorus ratio would result in an increased risk for soft tissue calcification (National Research Council (US) Subcommittee on Laboratory Animal Nutrition, 1995).

Discussion

Whether to feed lucerne in the cavy diets very much comes down to personal choice. There is a strong case for it to be included in the diet of all cavies, especially in Australia. As more is understood about the role of dietary calcium in the prevention of certain types of kidney and bladder stones and the risks of oxalates, recommendations to avoid lucerne could be relaxed. There is a case for it to be included in the diet when leafy greens and other high oxalate foods are being used. It would also be a useful hay to add in areas where tropical grasses are being fed. Lucerne has an important role in the diet of young, pregnant and lactating cavies. It could be argued that there could be a continuing role throughout the cavy's adult life. Certainly in the absence of any other available hay it would be unwise to avoid it, simply because it was lucerne. Grassy-lucerne blends possibly best mimic a natural foraging diet and would provide continued food interest for the individual animal.

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