

# Feeding the European hedgehog (*Erinaceus europaeus* L.)—risks of commercial diets for wildlife

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## Summary

The supplemental feeding of wildlife is a worldwide phenomenon. The most widespread and socially accepted example is bird feeding. Commercial hedgehog (*Erinaceus europaeus* L.) diets are readily available in Switzerland. To test the hypothesis that commercial hedgehog diets are nutritionally inadequate, the following parameters (as taken from the label) of five commercial diets (three dry and two wet) were compared to the natural diet of *E. europaeus*: List of feed materials, crude ash (CA), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen-free extracts (NfE). To test the second hypothesis, that feed labels of commercially available hedgehog diets in Switzerland are in accordance with Swiss and European law, the following parameters were assessed: Type of feed, net quantity, moisture content, instructions for proper use, list of the feed materials and claims. In all dry diets, the first ingredient was cereals (38.8%–50%), whereas in both wet diets, it was meat and meat by-products (51% in one product). Only one product had a CP content comparable to that of the natural diet and four products had a higher NfE content. Overall, the wet products were more comparable to the natural diet, especially regarding CP and NfE content. Of the five examined diets, three were labelled as complete feeds and two as compound feeds. The label analysis revealed inaccuracies and possible misleading information on two products. In conclusion, the use of commercial dry hedgehog diets should be discouraged as they do not resemble the natural diet of *E. europaeus* and are likely nutritionally inadequate. The commercial wet hedgehog diets should only be used supplementary. The feed labels of commercially available hedgehog diets were not always in compliance with Swiss and European law. The public should be educated about feeding *E. europaeus* and the risks of commercial diets for wildlife.

## KEYWORDS

backyard feeding, hedgehog health, label analysis, pathogen transmission, supplemental wildlife feeding, wildlife health

## 1 | INTRODUCTION

The supplemental feeding of wildlife is a global phenomenon with various intentions and backgrounds (Murray et al., 2016). It occurs in the context of recreational purposes (e.g. backyard bird feeding), research, wildlife management, education and tourism (Dubois & Fraser, 2013).

Globally, backyard bird feeding is occurring on an immense scale (Jones, 2011). In the northern hemisphere alone, numerous surveys have found 34–75% of households in the USA and UK were engaged in the practice (Jones, 2011). The supplemental wildlife feed industry in the USA is worth \$4.5 billion USD (approx. €3.7 billion) annually, while in the UK recent estimates suggest it is worth £240–290 million

(approx. €270–325 million), annually (Fair, 2006; Jones & Reynolds, 2008). Little is known about the full ecological effect that supplemental feeding has on wildlife, but it tends to increase the risk of inter- and/or intraspecies pathogen transmission and promotes pathogen accumulation at feeding stations or the surrounding environment (Murray et al., 2016). In addition, nutritionally inappropriate feed, poor quality feed or feed contaminants (mycotoxins, medication) can all have negative effects on the health and wellbeing of wildlife (Murray et al., 2016).

European hedgehogs (*Erinaceus europaeus* L.) are nocturnal, solitary insectivores, who also feed on earthworms, snails, eggs, carrion and negligible amounts of plant material (Struck & Meyer, 1998). In urban settlements, *E. europaeus* densities tend to be higher than in rural areas as a consequence of habitat loss due to agricultural intensification, among other reasons (Braaker et al., 2014). Therefore, *E. europaeus* are quite easy to observe in urban areas compared to other native mammals. Also, the unique appearance and popularity make *E. europaeus* dear to the public. For that reason, *E. europaeus* is often intentionally, or unintentionally (e.g. leaving feed outside for domestic animals) fed in Switzerland. Ecological risks of feeding *E. europaeus* a supplemental diet are as follows. Firstly, *E. europaeus* that receive supplemental feed in autumn may not hibernate as would normally be expected for the species. A study in the United Kingdom showed that supplemental feeding increases levels of activity during the winter when hedgehogs would naturally be hibernating (Gazzard & Baker, 2020). Secondly, *E. europaeus* that are fed tend to congregate at supplemental feeding sites, thereby increasing intraspecific transfer of pathogens (Tysnes, 2016). It is known that *E. europaeus* host several parasites with an overall endo- and ectoparasite prevalence of more than 90% (Gaglio et al., 2010). Most endoparasites are excreted through faeces, where they either infect other hedgehogs directly or indirectly through a secondary host. Possible secondary hosts are snails, different insects or earthworms. Snails in particular become conditioned by a single feeding episode to locate food which they were unable to locate prior to feeding (Teyke, 1995). So, once they know where to find food, they find it again very quickly and tend to come back, thus enabling the endoparasites to continue their cycle and to reinfect hedgehogs that congregate at the feeding site. Supplementary feeding of hedgehogs seems to increase *E. europaeus* presence and density (Tysnes, 2016), thereby leading to a crowding effect that can induce stress, particularly in these solitary animals, and negative consequences for host immunity (Murray et al., 2016). This combination (intraspecific pathogen transfer and higher stress) can potentially be very harmful. A third negative effect of supplementary wildlife feeding is a reduced natural selection, as has been shown for other species (Schmidt & Hoi, 2002). The same could be true for *E. europaeus*, where literature states, that the survival rate of the young in their first winter is between 31–79% (Rasmussen, 2019). And lastly, supplemental feeding can cause wildlife to lose their fear of people, leading to nuisance and/or aggressive behaviours (Dubois & Fraser, 2013). Despite these potential negative effects, special commercial hedgehog diets are widely available in stores and can easily be bought by members of the public.

The 'Stiftung Wildstation Landshut' is a non-profit wildlife rehabilitation centre in Switzerland that receives roughly 900 *E.*

*europaeus* annually. During the veterinary examination and consultation, supplemental feeding of hedgehogs and the benefit of commercial hedgehog diets are often discussed. Most people buying dog food are overwhelmed with the task of reading and understanding feed labels (Gerstner & Liesegang, 2020), therefore, if people want to feed hedgehogs, products marketed specifically for *E. europaeus* are attractive. They are advertised as being specifically for this species and therefore beneficial. However, most manufacturers produce hedgehog diets as a side business without special care or knowledge in hedgehog nutrition (Neumeier & Schiller, 2019). To test the hypothesis that commercial hedgehog diets are nutritionally inadequate and should not be used for the supplemental feeding of *E. europaeus* in the wild or during the rehabilitation process, the information of five different commercial hedgehog diets (as taken from the label) were compared with the natural diet of *E. europaeus*. The second aim of this study was to test the hypothesis that feed labels of commercially available hedgehog diets in Switzerland are in accordance with Swiss (Federal internal law SR 916.307 & SR 916.307.1) and European (Commission Regulation EC 767/2009) law.

## 2 | MATERIALS AND METHODS

A total of five products from three different brands were compared in this study, as two brands offered a wet and a dry diet. Nutritional adequacy of each commercial diet was assessed by comparing the nutritional parameters crude ash (CA), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen-free extracts (NfE) recorded on the label to the mid-range values of the natural diet of *E. europaeus* suggested by Struck and Meyer (1998). For this comparison, all parameters were calculated on dry matter basis (DMB). For the dry diets, a dry matter content of 90% was assumed as recommended by Kamphues et al. (2014), because no exact information on dry matter content could be obtained. The list of feed material was compared to the natural diet of *E. europaeus* suggested by Struck and Meyer (1998). In addition, the metabolizable energy (ME) was calculated with the predictive equation for metabolizable energy in cat food (National Research Council, 2006).

To assess the accordance of the labels of feed marketed specifically for *E. europaeus* to Swiss (Federal internal law SR 916.307 & SR 916.307.1) and European (Commission Regulation EC 767/2009) law, the information concerning type of feed, net quantity, moisture content, instructions for proper use, list of the feed materials and special advertising/claims were recorded from the label of each commercial diet and subsequently compared to the legal requirements summarized in Table 1.

## 3 | RESULTS

The comparison of the declared nutritional parameter of each commercial diet with the mid-range values of the suggested natural diet of *E. europaeus* is shown in Table 2. Only one product (brand 1 wet)

**TABLE 1** Summary of criteria of Swiss (Federal internal law SR 916.307 & SR 916.307.1) and European law (Commission Regulation EC 767/2009) for feed labels

Type of feed	The type of feed: 'feed material', 'complete feed' or 'complementary feed', as appropriate. For pets other than cats and dogs, 'complete feed' or 'complementary feed' may be replaced by 'compound feed'
Net quantity	The net quantity expressed in units of mass in the case of solid products, and in units of mass or volume in the case of liquid products
Moisture content	The moisture content of the feed must be stated if it exceeds: <ul style="list-style-type: none"> <li>• 5% in the case of mineral feed containing no organic substances,</li> <li>• 7% in the case of milk replacer feeds and other compound feed with a milk-product content exceeding 40%,</li> <li>• 10% in the case of mineral feed containing organic substances,</li> <li>• 14% in the case of other feed.</li> </ul>
Instructions for proper use	The instructions for proper use indicating the purpose for which the feed is intended
List of the feed materials	A list of the feed materials of which the feed is composed, bearing the heading 'composition' and indicating the name of each feed material in accordance with Article 16(1)(a), and listing those feed materials in descending order by weight calculated on the moisture content in the compound feed; that list may include the percentage by weight
Special advertising	The labelling and the presentation of feed shall not mislead the user, in particular: <ol style="list-style-type: none"> <li>a. as to the intended use or characteristics of the feed, in particular, the nature, method of manufacture or production, properties, composition, quantity, durability, species or categories of animals for which it is intended;</li> <li>b. by attributing to the feed effects or characteristics that it does not possess or by suggesting that it possesses special characteristics when in fact all similar feeds possess such characteristics</li> </ol>

**TABLE 2** Declared crude ash (CA), crude protein (CP), crude fibre (CF), ether extract (EE), nitrogen-free extracts (NfE) and metabolizable energy (ME) of 5 different commercially available hedgehog (*Erinaceus europaeus*) diets (brand 1–3, dry or wet) compared to the natural diet of the *E. europaeus*. All numbers on dry matter basis

	Natural diet <sup>a</sup>	Brand 1 dry	Brand 2 dry	Brand 3 dry	Brand 1 wet	Brand 3 wet
CA [%]	8.9	7.7	11.0	8.3	11.1	10.0
CP [%]	58.0	31.1	15.1	33.3	52.8	42.5
CF/Chitin [%]	10.0	3.3	4.7	3.3	2.8	3.0
EE [%]	15.0	21.1	27.9	20.0	30.6	25.0
NfE [%]	8.1	36.8	41.3	35.0	2.7	19.5
ME (kJ/100 g) <sup>b</sup>	1624.3	1819.9	1833.6	1796.3	2015.3	1895.9

<sup>a</sup>Struck & Meyer, 1998, mid-range

<sup>b</sup>Calculated with: Predictive Equations for Metabolizable Energy in Cat Food, National Research Council., 2006. Nutrient Requirements of Dogs and Cats. Washington, DC: The National Academies Press, page 31, table 3.2

had a CP and NfE content comparable to that of the natural diet, while all the other examined diets had a lower CP and higher NfE content than natural diet (Table 2). The three available dry diets had protein contents ranging from 24.4% to 60.5% of the protein content of the natural diet of *E. europaeus*. In the dry diets, the ingredients occurring in the highest concentration were cereals (38.8%–50%), followed by meat and meat by-products or fish and fish by-products (22%–24%; Table 3). In both wet diets, the ingredients occurring in the highest concentration were meat and meat by-products (labelled 51% in one diet;

Table 3). Regarding ME, all diets showed a higher calculated value than the suggested natural diet of *E. europaeus* (Table 2). Overall, the wet products were more similar to the natural diet than the dry products, especially regarding CP and NfE content (Table 2).

Feed label analysis showed, that of the five examined diets, three were labelled as complete feeds and two as compound feeds (Table 3). The legal labelling requirements as defined by Swiss and European law were in general not followed. Brand 2 dry did not provide any feeding instructions and was labelled as compound feed,

TABLE 3 Information of five commercial diet for the European hedgehog (*Erinaceus europaeus*) available in Switzerland according to the label

	Brand 1 dry	Brand 2 dry	Brand 3 dry	Brand 1 wet	Brand 3 wet
Type of feed	complete feed	compound feed	complete feed	compound feed	complete feed
Net quantity	500 g	750 g	600 g	100 g	100 g
Moisture content	<14%	<14%	<14%	82%	80%
Instructions for proper use	2–4 tablespoons of food per animal per day OR 30 g of feed for a 1000 g hedgehog	no specific instructions, amount of feed dependent on number of animals, weight and activity level	2–4 tablespoons of food per animal per day	100 g per animal per day	2–3 tablespoons of food per animal in the evening
List of the feed materials	Cereals (38.8% (corn 22%, wheat flakes 9.8%), meat and meat by-products (22%), molluscs and crustaceans (13%), rapeseed oil (9.9%), poultry fat (2.9%), peanuts (1.5%), raisins (1.5%), carrots (1%), yeast, inulin, plant by-products, minerals	Oat flakes 50%, sunflower seeds, hulled 24%, peanut kernels 10%, carbonic shell-bearing limestone 5%, raisins 4%, oils and fats 4%, cranberries 1%, shrimps 1%, mealworms 1%	Cereals, meat and animal derivatives 22.3%, molluscs and crustaceans 15%, oils and fats 12.1%, derivatives of vegetable origin, nuts 2%, fruits 2%, insects (mealworms 1%), vegetables, yeast, minerals	Meat and animal derivatives and fish derivatives, minerals, inulin (0.4%)	Meat and animal derivatives 51%, fish and fish derivatives 11.7%, minerals, inulin
Special advertising/claims	No added sugars, no added artificial colorants, tailored to the needs of hedgehogs, contains vitamins and minerals, with animal fat	Suitable for all hedgehogs, 100% natural, ambrosia controlled, mix of mealworms and oat flakes rich in fat and protein	Sugar free recipe, wildlife protection, >70% animal protein, plus mealworms, with essential vitamins and minerals, guarantees healthy nutrition and improves survival chances of weakened hedgehogs	No added artificial colorants or preservatives, tailored to the needs of hedgehogs, with animal protein	Sugar free recipe, wildlife protection, animal protein, with vitamins and minerals

which is not the correct term to use. Similarly, brand 1 wet was also labelled as compound feed. In addition, two labels were misleading regarding their claims (see Table 3 for claims and Table 1 for summary of legal requirements). Brand 2 dry informs on the label that the diet is a mix of mealworms and oat flakes rich in fat and protein. It contains a substantial amount of oat flakes (50%), however, the next ingredient is sunflower seeds, hulled (24%) while mealworms (1%) are the last item on the ingredient list. Brand 3 dry advertises guaranteed healthy nutrition and improved survival chances of weakened *E. europaeus*. Both claims are misleading.

## 4 | DISCUSSION

The primary goal of this study was to compare the different commercially available hedgehog diets in Switzerland with the natural diet of *E. europaeus*. For this purpose, dry and wet diets were evaluated separately. All dry diets had cereals at the beginning of their list of feed materials. This list records the feed materials in descending order by weight calculated on the moisture content in the compound feed. However, *E. europaeus* do not feed on cereals in the wild. The high occurrence of cereals in the examined feeds is reflected in the NfE content of these diets, which is between 35% and 41.3% DMB. The NfE content is calculated and contains  $\alpha$ -glycosidic polysaccharides (starch, glycogen), soluble sugar (glucose, fructose, saccharose, lactose, maltose and oligosaccharides) as well as the soluble parts of cellulose, hemicellulose and pectin (Kamphues et al., 2014). The value is therefore mainly used to represent the highly digestible carbohydrates, although it can be inaccurate (Cheeke & Dierenfeld, 2010). Feeding high levels of highly digestible carbohydrates to insectivores or carnivores could lead to health problems like obesity, as observed in cats (Verbrugghe & Hesta, 2017). *E. europaeus* has a propensity to overeat (they will forage even when additional food is provided) and obesity in *E. europaeus* that receive a lot of supplementary feed with a high energy content is common (Reeve, 1994). In addition to health problems, obesity may prevent *E. europaeus* from balling up, which is an important defence mechanism for this species (Reeve, 1994). Dental tartar and gingivitis are often seen in *E. europaeus* and supplementary feeding is hypothesized to have deleterious consequences on oral health (Robinson & Routh, 1999). The role of digestible carbohydrates or sugars in the development of dental caries has been well documented in people and rodents (Hand & Lewis, 2010). Further studies are needed to confirm this effect in *E. europaeus*. While digestible carbohydrates are not essential dietary nutrients, carbohydrate in the form of glucose is physiologically essential for all mammals (Verbrugghe & Hesta, 2017). Endogenous glucose demand of the brain as well as other obligate glucose-consuming tissues cannot be met by the amount of carbohydrates present in the natural prey-based diet of carnivores/insectivores (Verbrugghe & Hesta, 2017). Therefore, true carnivores and insectivores use protein, which is abundant in animal prey, for gluconeogenesis (Verbrugghe & Hesta, 2017). The three available dry diets had protein contents ranging from 24.4 to 60.5% of the protein

content of the natural diet of *E. europaeus*. Proteins are an integral part of animal structure and metabolism (Cheeke & Dierenfeld, 2010). They constitute a major part of the body structure, as components of muscle, connective tissues and cell membranes (Cheeke & Dierenfeld, 2010). All metabolic reactions are dependent on proteinaceous enzymes (Cheeke & Dierenfeld, 2010). Continued failure to consume protein results in muscle atrophy and decreased blood levels of albumin, transferrin, thyroxine-binding protein and retinol-binding protein because carbon skeletons from these proteins are used as an energy source to supply glucose through gluconeogenesis, which is especially important for carnivores and insectivores as discussed above (Hand & Lewis, 2010). Commercial dry hedgehog diets do not closely resemble the natural diet of *E. europaeus* and are unlikely to meet their nutritional needs.

Brand 3 wet diet is labelled as a complete diet with feeding instructions of 2–3 tablespoons of diet per animal in the evening. Maintenance metabolic energy (MME) requirements for adult *E. europaeus* are roughly between 550 and 660 kJ ME/kg BW<sup>0.75</sup> (Kamphues et al., 2014). An average adult male *E. europaeus* weighs roughly 1 kg, therefore requiring 550–660 kJ MME/day. If we approximate that 3 tablespoons are roughly 60 g of wet diet, the hedgehog would receive 193 kJ MME/day, which would be insufficient and lead to malnutrition. Therefore, commercial hedgehog wet diets should only be fed supplementary and should not be considered complete feed.

Of the five examined diets, three were labelled as complete feeds and two as compound feeds. The definition of compound feed and complete feed according to Swiss and European law are the following: 'compound feed' means a mixture of at least two feed materials, whether or not containing feed additives, for oral animal-feeding in the form of complete or complementary feed. 'Complete feed' means 'compound feed' which, by reason of its composition, is sufficient for a daily ration (Commission Regulation EC 767/2009). Labelling a commercial diet as a compound feed is not in accordance with Swiss or European law, as the law states that it should be labelled as complete or complementary feed (Federal internal law SR 916.307 & SR 916.307.1; Commission Regulation EC 767/2009). Labelling a diet for *E. europaeus* as a 'complete feed' cannot be accurate, as *E. europaeus* will forage even if additional food is provided (Reeve, 1994). Brand 2 dry informs on the label that the diet is a mix of mealworms and oat flakes rich in fat and protein, indicating a diet with mainly mealworms and oat flakes. It contains a substantial amount of oat flakes (50%), but the next ingredient is sunflower seeds, hulled (24%) while mealworms (1%) are the last item on the ingredient list. The above statement, therefore, can be very misleading. Brand 3 dry advertises guaranteed healthy nutrition and improved survival chances of weakened *E. europaeus*. Considering the actual nutritional composition, this statement is a false claim and can mislead the customer. Overall, the marketing and labelling of these products give the impression, that the supplemental feeding of *E. europaeus* is essential and helpful. However, the use of commercial diets in many cases is neither essential nor beneficial and can actually be harmful for the insectivorous *E. europaeus*, as stated above.

## 5 | CONCLUSION

In conclusion, the use of the three analysed dry hedgehog diets should be discouraged as they do not resemble the natural diet of *E. europaeus* and are likely nutritionally inadequate. They therefore could potentially have a negative impact on the health of *E. europaeus*—especially if fed as a complete diet during rehabilitation. The commercial wet hedgehog diets should only be used supplementary and should not be considered as complete feed. The feed labels of commercially available hedgehog diets in Switzerland were not always in compliance with Swiss (Federal internal law SR 916.307 & SR 916.307.1) and European law (Commission Regulation EC 767/2009) and contained misleading information.

Further studies should be performed in *E. europaeus*, particularly with regards to the effects of supplemental feeding on overall health, hibernation and stress/endoparasite transmission. In addition, the public and the feed manufacturers should be educated about feeding *E. europaeus* and the risks of commercial diets for wildlife.

### ACKNOWLEDGMENTS

We thank Suzanne Aldana and Dr. Jennifer Riley for their English language editing.

### CONFLICT OF INTEREST

The authors declare no conflict of interest.

### ANIMAL WELFARE STATEMENT

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to. No ethical approval was required as no animals were used in this study.

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**How to cite this article:** Gimmel A, Eulenberger U, Liesegang A. Feeding the European hedgehog (*Erinaceus europaeus* L.)—risks of commercial diets for wildlife. *J Anim Physiol Anim Nutr*. 2021;105(Suppl. 1):91–96. <https://doi.org/10.1111/jpn.13561>