University of Veterinary Medicine Budapest
Institute for Animal Breeding, Nutrition, and Laboratory Animal Science
Department of Animal Nutrition and Clinical Dietetics

Dental diseases in rabbits: malocclusion and their consequences

Melina Edith Berger

Supervisor:
Dr. Nikoletta Hetényi, research fellow

Institute for Animal Breeding, Nutrition, and Laboratory Animal Science
Department of Animal Nutrition and Clinical Dietetics

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List of abbreviation

mm	millimeter
mmol/L	millimole per liter
I	Incisor
C	Canine teeth
P	Premolar
M	Molar
PSADD	Progressive syndrome of acquired dental disease
MBD	Metabolic bone disease
CT	Computer tomography
n	Amount
L	Left
R	Right
CT	Cheek teeth

1. Introduction

Pet rabbits suffering from dental disease is a very common situation nowadays and it belongs to the everyday procedure in many veterinarian practices. Because the outcome of dental procedures can be frustrating many practitioners are unsure about how to proceed with these cases. Even after dental intervention, the teeth can regrow within a short time, and eating difficulties and clinical signs can persist. The long and narrow oral cavity of a rabbit makes a proper dental examination difficult. Dental problems in pet rabbits can be caused by several factors, which makes it even more difficult. The most common cases may be problems, such as acquired incisor malocclusion, cheek teeth spurs, and abscess formation. The interpretation of skull radiographs requires a complex knowledge of the normal anatomy and pathological changes. It happens that veterinarians advise euthanasia for patients with dental disease because of a lack of knowledge. This fatal decision could be avoided with an improved understanding of the progression of dental disease in rabbits [1]. The fact that the teeth of rabbits grow continuously throughout life, makes a constant balance between growth and wear even more important. Inappropriate physical form and diet composition can be the most important reasons for dental disease [2]. Dental alterations are typically seen in pet rabbits having a specific lifestyle, namely housed indoors, bedded on hay, and fed with mixed cereal rations. Wild rabbits or those who live outside and have unrestricted access to grazing do not develop dental disease [3]. This is why owner education is essential in the successful prevention of dental disease. Many owners fed their rabbits with an inappropriate diet because of a lack of knowledge [2].

2. Literature review

2.1. Normal dentition

Pet rabbits count to the order of lagomorphs with characteristic four upper incisors. There are small second incisors behind the large primary maxillary incisors, called “peg teeth”. All teeth of lagomorphs are open-rooted and grow continuously lifelong [2]. The incisors are growing 2 to 2.4 mm per week [1, 4]. They can be also described as aradicular hypsodonts, meaning that they are open-rooted and have a long crown [4]. The rabbits’ teeth are diphyodont, which are characterized by two sets of teeth, one deciduous and one permanent set. The deciduous set is prenatally lost or immediately following birth [5]. Eruption of the permanent teeth happens throughout the first five weeks of life [2]. The rabbits’ maxillary denture consists of two first incisors with the second incisor behind, called peg teeth, three premolars, and three molars on each side. The mandibular comprises

one incisor, two premolars, and three molars on each side and canine teeth are missing [4]. A rabbit has 14 teeth on each side and 28 teeth with the dental formula: Maxilla: I:2 C:0 P:3 M:3 and Mandibular: I:1 C:0 P:2 M:3 [1]. As with other animals, rabbits' teeth have the same structure including dentine, enamel, cementum, and pulp cavity (Figure 1) [2].

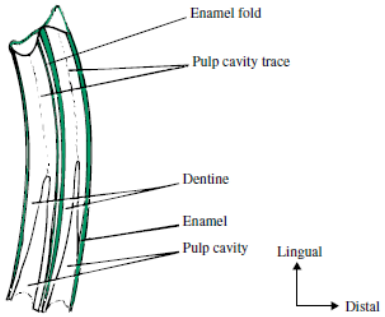

Figure 1: longitudinal section through the second lower right molar, from the book: Textbook of Rabbit Medicine, author: Harcourt-Brown, Frances, date: 2003, page: 167

The expression "anatomical crown" describes the complete tooth, whereas the compartment which is salient is called "exposed" or "clinical crown". The buried part of the tooth is described as "reserve crown" [1]. A thick layer of enamel covers the labial aspect of the large upper primary incisors, but none on the lingual aspect. In comparison, the other incisors have enamel on both sides. This dispersion of enamel allows the formation of sharp cutting edges to the tips of the teeth. The main task of the incisors is slicing through vegetation, and they can be used for gnawing and biting. A large diastema divides the incisors from the cheek teeth [2]. Similarly, to the incisors, cheek teeth maintain their shape by constantly growing and wearing. At first, the soft cementum and dentine on the occlusal surface is worn off. Meanwhile, the enamel is more resistant and remains as sharp edges creating a potent shredding surface [2]. This arrangement of the occlusal pattern forms sharp transverse enamel ridges that indent with the space between the two opposing teeth. On lateral radiographs, this order is seen as a characteristic zigzag line [1, 2].

2.1.1 Mastication

Rabbits are adapted to a fibrous diet containing plants, as well as bark and coarse material. The colon plays a special role in the digestive tract by separating the content into two fractions. The undigested large particles are transited quickly through the alimentary tract. Indeed these large particles have no nutritional value but they are significant for the motility of the gut. In contrast, the small particles are degraded by the caecal microflora

and have a nutritional value. The rabbits' cheek teeth reduce the food into small particles. The function of the incisors is on the one hand gnawing and biting vegetation and on the other hand fighting and grooming [1]. Rabbits are anisognathous animals meaning a wider maxillary arch than the mandibular one [4]. Because of that chewing happens only on one side. The movements of the jaw are conditioned on the type of food. For example, hay is eaten with a shearing movement whereas carrots are chowed down by crushing. The cheek teeth have vertical and backward movements, cutting the food along the enamel ridges [1]. The temporomandibular joint tolerates extensive lateral movements but has fewer rostrocaudal directions[4].

2.1.2 The tooth shape

The maintenance of the tooth shape is influenced by the continual growth and abrasion which is also affected by the structure of the dental tissue and the composition of the supporting bone [1]. For proper occlusion, the rate of abrasion and growth must be in balance. In clinical practice, it is seen that insufficient wear causes dental abnormalities [6]. The natural diet of rabbits consists of plants containing lignin, cellulose, and silicate phytoliths [1]. These substances are significantly involved in blunting the teeth and are therefore called internal abrasives [1, 6]. External abrasives can be dust or grit [6]. But for maintaining the shape of the continually growing teeth tooth-to-tooth contact plays a major role. These grinding movements can be seen when rabbits are at rest and are not eating. Tooth-to-tooth contact also determines the shape of the incisors. The mandibular incisors glide along the caudal aspect of the large maxillary incisors for sharpening the tips [1].

2.1.3 Nasolacrimal duct

The nasolacrimal duct runs from the lacrimal sac located anteromedially in the orbit and opens as a point-like orifice at the lower eyelid. The most important role of the nasolacrimal duct is the drainage of tears as a defence against infections [1]. Elongated roots of the upper primary incisors can cause obstruction of the nasolacrimal duct and therefore lead to epiphora[3].

2.2 Clinical signs of dental disease

The symptoms of dental disease in pet rabbits are varied and are shown as a wide range of clinical signs [7]. Specifically, primary signs related to dental disease are decreased food intake and therefore emaciation and general loss of condition. The faeces can be altered in

size, quantity, and appearance. Excessive salivation and or grooming, epiphora, exophtalmus, purulent nasal discharge, dyspnoe, and facial swellings are also very characteristic. Secondary effects of dental disease include systemic diseases associated with emaciation, dermatitis, poor coat, ocular diseases, dacrocystitis, gastric impaction bloat, and even death [7, 8]. It can be characteristic for rabbits to dissemble clinical signs of a disease. This is why missing clinical signs do not exclude the possibility of a dental disease [8]. Mullan and Main demonstrate in a health survey of 102 domestic rabbits that 30 rabbits had dental disease and only 6 of the owners mentioned that problem. This study shows that owners are often unaware of their rabbits' dental disease [9]. Furthermore, a thick hair coat can mask signs like weight loss and facial swellings [7].

2.3 Pathophysiology of dental disease

The origin of dental problems in pet rabbits is multifactorial. Common dental diseases can be summarized as "progressive syndrome of acquired dental disease (PSADD)" that may include incisor malocclusion, distortion of the premolar-molar occlusal plane, sharp points or spikes, periodontal disease, periapical changes, apical elongation, oral soft tissue lesions, and maxillofacial abscess formation" [1, 4]. The precise aetiology of this syndrome is not fully understood and many factors must be taken into account, including age, gender, breed, genetic predisposition, husbandry, and diet [1].

2.3.1 Malocclusion

Insufficient occlusion of the incisors results in severe incisor malocclusion because no normal tooth wear leads to unregulated incisor growth. In this case, it is often seen that the maxillary incisors curl inwards into the mouth or escape laterally [6]. The causes of dental malocclusion can be classified into congenital and acquired origins. Younger rabbits are often diagnosed with congenital malocclusion showing incisor overgrowth. [6]. Congenital maxillary brachygnathia seen in dwarf breeds is highly mentionable. These breeds are characterized by a too short maxilla in combination with a normal mandibular [4]. Edge-to-edge occlusion of the incisors can be seen in mild stages but severe forms with no connection between the upper and lower teeth can occur which results in uncontrolled growth as well [1].

On the one hand incisor malocclusion can occur isolated at an early age which is potentially genetic origin [4]. While on the other hand in addition to incisor malocclusion,

check teeth malocclusion may be present either as part of the primary problem or a secondary issue [4, 5]. Additionally, it may be possible that cheek teeth malocclusion is the primary complication [5].

Acquired causes of malocclusion are mainly diet and management related. Mineral imbalance can cause metabolic bone disease, which induces osteodystrophy and dental tissue malformation. Diets that are easy to digest and low in fibre are considered to be responsible for dental abnormalities as they result in insufficient chewing activity and insufficient dentin attrition [6]. Another reason for incisor overgrowth can be traumatic injuries causing complete loss or fracture of an opposing incisor. Common situations are falling rabbits on the ground [4].

2.3.2 Spike formation and deviation of the cheek teeth occlusal plane

Deformation of the premolar-molar occlusal plane together with spike formation generates a “step-mouth” (undulating occlusal plane) or “wave-mouth” (stair-like differences in tooth length) appearance [4, 8]. Typically spikes have a high incidence on the buccal part of the upper teeth, as Figure 2 shows, and on the lingual part of the lower teeth [4]. These spurs create injuries to the oral mucosa and therefore suffering from pain. The outcome is inappetence, increased saliva production, and decreased chewing, which causes more tooth elongation. Wetting of the fur at the chin and forelimbs can be seen as a consequence of intensive salivation [5].

Figure 2: Premolar 2 shows spike formation in the buccal direction, source: own illustration

2.3.3 Apical elongation

Extension of the clinical crown is normally followed by elongation of the reserve crown as well as lengthening of the tooth apices into periapical tissue. The outcome of this can be palpable swellings on the ventral border of the mandible [5]. Refusal to eat hard food is very characteristic because the elongated apices compress the nerve supply of the teeth. Furthermore, the elongation of the maxillary incisors results in compression of the nasolacrimal duct when it runs around the apex, leading to epiphora, a typical clinical sign [1]. If purulent ocular or nasal discharge occurs this is evidence of periapical abscess formation. Whenever the maxillary zygomatic process and the ground of the orbit are affected, signs like conjunctivitis, exophthalmos, and epiphora arise [5].

2.3.4 Abscess formation

Abscess formation is a frequent issue in pet rabbits and is mainly caused by a primary dental disease. Slowly development and comparative less pain are properties of these abscesses. A large thick fibrous capsule surrounds the abscess containing a dense caseous substance [10]. Besides rabbits missing a lysosomal enzyme, found in other animals such as dogs and cats, that converts extinct cells into liquid. Therefore the thick pus is even more difficult to eliminate after opening the abscess (Figure 3, 4, and 5) [11]. Because the capsule is very strict and fixed it does not collapse easily even after opening. The remaining microorganisms can cause recurrent inflammation and pus formation in the capsule. Because of poor blood supply in the capsule and the pus antibiotics are not able to penetrate [10]. Because of all these reasons, treatment of abscesses may be complicated and unsatisfactory and frequently ends with euthanasia [11]. The most frequent reason for jaw abscess formation is periapical infection of aggrieved teeth, whereas primary bacterial infection is an improbable cause. Regardless periapical abscesses can be seen in animals with healthy dentition too [10]. A combination of aerobic and anaerobic Gram-positive and Gram-negative bacteria have been found in these abscesses such as *Pasteurella multocida*, *Pseudomonas aeroginosa*, *Staphylococcus*, *Escherichia coli*, *Bacteroides*, *Proteus* and *Fusiformis* species [10, 11].

Permeating lesions provoked by fight wounds, foreign bodies, or spurs induce abscesses as well by importing infection. Gnawing wooden material such as splinters reaches the periodontal space, particularly the incisors, and causes periapical abscesses. Foreign bodies

like seeds, pieces of hay, or awns can remain easily between the teeth because of extended interdental spaces. Incisor removal can be the reason for iatrogenic abscess formation when parts of teeth remain in the cavern after extraction [10].

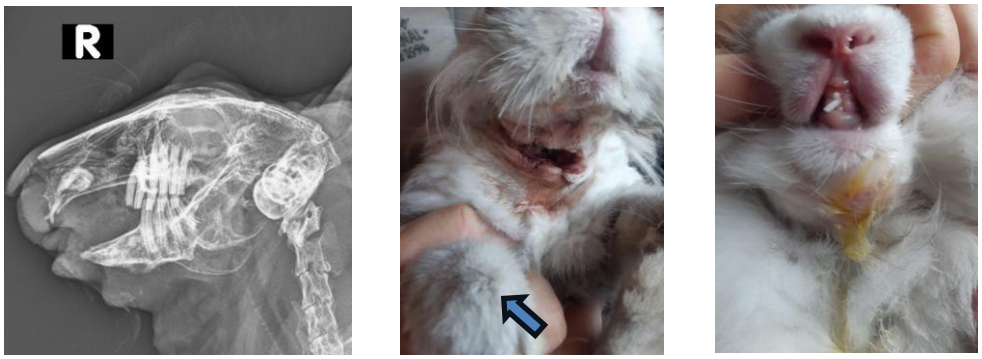

Figure 3, 4, and 5. X-ray of a rabbit with abscess. The absence of incisors is also visible (left). The same rabbit after surgery (middle). The same rabbit after wound healing. Incisivus malocclusion is also visible (right). Source: Exo-Pet Veterinary Center, Budapest

2.4 Aetiology of PSADD

Many theories have been proposed about the aetiology of PSADD and there are differing opinions regarding their importance and role. All in all metabolic bone disease and insufficient dental wear can be described as the most important and popular causes for PSADD [1].

2.4.1 Metabolic bone disease – overview of calcium metabolism in rabbits

Rabbits differ from other mammals. The main calcium regulation is passive absorption and can proceed without vitamin D when dietary calcium is sufficient. Nevertheless, vitamin D stimulates intestinal calcium absorption and is needed in the case when dietary calcium is low [12]. Contrary to other mammals in rabbits nearly all dietary calcium is absorbed by the intestine and the surplus is excreted via urine. This is why rabbits' blood calcium levels is higher than that of the other mammal, 3.25 – 3.75 mmol/ vs. 1.25 – 1.6 mmol/L. Additionally, the calcium levels are connected in proportion to the calcium intake via the diet. Rabbits have an increased calcium demand compared with other animals, because of their constantly growing teeth. To meet this higher demand, they are reliant on its efficient intestinal calcium absorption. Besides normal dental wear releases calcium from the tooth into the gut and can be reabsorbed [13]. If the dietary calcium intake is extremely high in

rabbits, compared with other mammals, the intestinal absorption is not decreased but the kidneys excrete a higher degree of calcium [14]. Phosphorus-rich phytates are complexes that cannot be degraded by endogenous enzymes, but rabbits are able to produce phytase with the help of microorganisms in the caecum. Recycling of phosphorus through coprophagy should imply a nearly complete reutilization of phytate phosphorus. Excessive dietary phosphorus intake results in increased phosphorus excretion via urine and faeces [14].

2.4.2 Metabolic bone disease

Metabolic bone disease (MBD) compromises a large size of conditions, for instance, rickets, osteoporosis, nutritional osteodystrophy, and dietary secondary hyperparathyroidism. Rabbits are prone to calcium metabolism problems if they are housed indoors and consume food that does not correspond to their natural diet. The availability of calcium, phosphate, and vitamin D affects the mineral deposition in the teeth [2].

Calcium and vitamin D deficiency can be described as one of the most important causes of MBD. There are a few theories about the origin of these deficiencies, the first one is the lack of chewing theory. If rabbits are provided mixed feed, they show the tendency to select food with higher energy and less fibre content. Even some of them prefer only their favourite ingredients and refuse the remaining [14]. Prebble and Meredith have shown that pet rabbits choose voluntary energy-dense pellets instead of roughage [15]. The major reason for food refusal, especially hay, is dental disease. This is why dental disease can lead to calcium deficiency because hay and fresh grass are proper calcium and phosphorus sources. On the other hand grains, legumes, and vegetables, such as apples and carrots, have low calcium contents and therefore this diet can lead to calcium deficiency [14]. As the calcium content of grass and hay varies greatly, even a seemingly healthy diet consisting of hay, fruit, and root vegetables may be lacking in calcium [1].

Progressive demineralization of bone, enamel, and dentine is a consequence of calcium and vitamin D deficiency [1]. Hartcourt-Brown concludes that alveolar bone loss leads to apical elongation [14]. As a result of alveolar bone loss, the periodontal spaces become wider, allowing the teeth to rotate within the socket. In turn, widening periodontal spaces and apical tissue necrosis tend to cause abscesses. Bone demineralization of the teeth can

result in enamel loss, uneven wear, eroded crowns, and fractured teeth [1]. The rabbits' constantly growing teeth have a high demand for calcium to mineralize new tissue, this is why they can be more prone to calcium deficiency [1]. Mehrotra *et al*. have shown that a low calcium diet leads to nutritional secondary hyperparathyroidism in young rabbits inducing hypocalcaemia, hypophosphatemia, increased alkaline phosphatase activity, parathyroid hormone, and calcitriol concentrations [14]. Nevertheless, calcium and vitamin D deficiency is a controversial issue as a cause of dental disease, because excessive amounts of calcium can cause urinary tract diseases in rabbits [1]. Rabbits with calcium oversupply may develop urinary sediment inducing urolith formation or sludgy urine [14]. These rabbits require a low-calcium diet [1].

2.4.3 Diet and dental wear

The consensus is that rabbits eating a high amount of hay, grass, and natural vegetation are rarely diseased. In comparison, rabbits consuming muesli-type mixes and kept indoors in houses or hutches have a higher incidence of dental diseases [1]. Numerous studies have shown that diet influences dental growth and wear, especially hay promotes adequate movement and wear during chewing. In the study by Meredith *et al*., it was discovered that rabbits without access to hay develop dental disease more frequently [16]. There is evidence that missing dental exercise and tooth wear contribute to the development of acquired dental disease, but the exact mechanism is still not clear. Wild living rabbits and pet rabbits fed with unlimited access to grazing are not prone to develop acquired dental disease. Pet rabbits with a large intake of hay are also much less affected by dental problems than rabbits with picky eating behaviour. Crossley *et al.* ascribe root elongation to missing dental wear, leading to coronal elongation, an extension of the masseter muscle, and an increased intraoclusal pressure at rest. The enhanced pressure results in an extensive load on the teeth which induces negative growth and elongation of the tooth roots [2].

Rabbits on a high-energy pellet diet have a high incidence of dental disease, as well as other conditions such as enteritis, gastrointestinal stasis, obesity, pododermatitis, and behavioural changes. A diet low in forage results in less abrasiveness, and only little chewing movements, and therefore causes an imbalance in wear and growth of the teeth. The basic food items of pet rabbits should consist of hay, grass, herbs, and leafy green

vegetables. But the problem is that owners feed surplus in the form of vitamins and minerals, or basically to avoid boredom [15].

2.5 Diagnosis of dental diseases

Diagnosis of dental problems compromises three diagnostic possibilities: clinical examination of the oral cavity, along with supportive diagnostics including radiology (implicating CT). The latter will be discussed only briefly. Performing examination of the incisors is uncomplicated and is part of the routine physical examination. However, cheek teeth evaluation can be much more complex, and for a complete examination general anaesthesia is advisable [8].

2.5.1 Oral examination

Following an overall examination, external palpation is performed to determine if bone irregularities or facial swellings are present, turning attention, especially to the ventral aspect of the mandible and temporomandibular joint. Inspection of the incisors is conducted from a frontal and lateral view, while the cheek teeth are examined by lateral mobility of the mandible. In non-sedated animals, the oral cavity can be inspected with careful restraint and an otoscope [7]. Typically, the rabbit's oral cavity has a small opening and a long, narrow shape which makes an entire examination very difficult, especially when the patient is awake. Additional restraint is very stressful for rabbits. This is why a complete oral examination is recommended under general anaesthesia [4].

A thorough oral examination is facilitated with instruments, for example, a mouth gag and cheek dilator to laterally retract the cheeks. An assistant holding the head in position is also required. All aspects of each tooth, tongue, buccal, and lingual mucosa have to be examined [8]. To assess tooth mobility and increase probing depth, it is recommended to use a periodontal probe and dental explorer [4]. Additionally, the examination of the eye and patency of the nasolacrimal duct is recommended to be part of the dental examination in rabbits (Figure 8 and 9) [7].

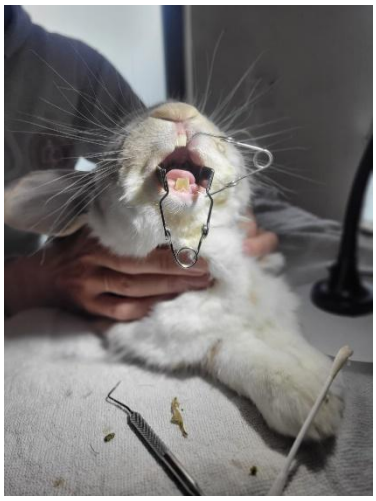

Figure 8: oral examination using cheek dilator, source: own illustration

Figure 9: assistant holding the head in position during oral examination, source: own illustration

2.5.2 Radiology

Since oral anatomy makes a thorough oral examination difficult, diagnostic imaging has high importance in the evaluation of teeth, for example in rabbits suffering from malocclusion, periapical lesions, or bone disease [4, 7]. Most dental structures are hidden and are not visible on clinical examination, including the reserve crown, this is why radiography is one of the most important diagnostic methods [7]. The minimum survey radiographs enclose one or two lateral-lateral, right, and left lateral-oblique and dorsoventral or ventrodorsal views. It is agreed that later-lateral projection is the most useful and essential view [7, 8]. Additional oblique and rostrocaudal views are advised for the evaluation of specific areas. For a later-lateral view, it is advisable to open the mouth a couple of millimeter to separate the cheek teeth and therefore enhances the definition of the occlusal line [17]. Computer tomography scan of the skull is an important diagnostic tool for the diagnosis of dental diseases in rabbits and their associated complications, for example, osteomyelitis and empyemas of the bony cavities.

2.6 Treatment of dental diseases

The main aim of treatment is a rearrangement of the teeth to normal length, restoration of the occlusal plane, extraction of diseased teeth, treatment of abscessation, and thereby improvement of function and prevention of secondary inflammation. Surgical treatment

under general anaesthesia together with diet and management is essential for successful recovery [8].

2.6.1 Incisors

A proper length reduction is performed with the help of high-speed precision dental hard pieces and burrs, in combination with saline solution to cool down the teeth. Using cutting instruments like clippers or rongeurs should be strictly avoided, since it often causes fractures, and root damage followed by abscess formation [8]. The goal is to restore the normal occlusal plane angulation without damaging the pulp [4]. Incisors that are not capable of being restored to normal length and occlusion as a result of congenital or long-term acquired malocclusion should be extracted. Normal eating without incisors is possible in rabbits because they can use their lips and tongue to intake food. Malocclusion which requires frequent restoring, fractures, and abscess formation are indications for incisor extraction [8].

2.6.2 Cheek teeth

Occlusal adjustment includes height reduction and smoothing sharp spikes. A spatula can be used to protect the tongue and soft tissue. Restoration of the normal occlusal plane angulation is the most important aspect of taking care of [4]. Indications for cheek teeth extraction are excessive malocclusion, fractured or loose teeth, as well as periapical infection and abscess formation. The general aim should be the preservation of as many cheek teeth as possible to guarantee adequate grinding of food. Normally there is no need for removing the opposing tooth as well because the dentition of rabbits allows occlusion with more than one opposite tooth. However, it has to be taken into account that the opposing teeth can be diseased, too [8].

3. Aims

Two studies were conducted. The German survey aimed to investigate pet rabbits' nutrition, husbandry, and health with special emphasis on dental disease. The Hungarian study aimed to collect data from rabbits diagnosed with malocclusion or incisivus malocclusion by using the database of Exo-Pet Veterinary Center, Budapest.

4. Materials and methods

4.1. Study participants and questionnaire

In the German study, I worked together with pet rabbit owners, collecting from three different sectors. One part of the participants represents pet rabbit owners I know from my surroundings and therefore I could ask them directly from person to person. For another target group, I published my questionnaire in Facebook groups and collected participants with the help of an online survey from the 31st of April 2023 until the 31st of August 2023. The groups were “Veterinary Exotic Small Talk” with 23.853 members, “Pet rabbit keepers and friends” with 20.010 members “Pet rabbit advice” with 40.406 members. The last part of the participants comprises pet rabbit owners I met during my work in a small animal practice, with whom I was able to go through the questionnaire in person. After a brief overview of the owner demographics, such as age, gender, and how many rabbits are currently in possession, characteristics about the rabbit were requested. These properties include the breed of the rabbit, sex, age, and neuter status. Questions regarding nutrition cover the next topic, starting with what type of concentrate was given. The differentiation was between Pellets (complete feed) and Mixed feed (Muesli-type), whereas feeding frequency and preferred and disliked ingredients were asked as well. The next aspect was about what type of vegetables are given and in what kind of frequency. Likewise, the access to hay was inquired, as well as how often treats were given. The last topic of the questionnaire includes questions about the health status of the rabbit. It was requested, whether the rabbit is healthy at the moment and if not, what kind of disease can be seen. Besides it was asked, if the rabbit had visited a veterinarian in the past and why. In conclusion, specific questions about dental disease were inquired, for example, which teeth were affected, whether abscess formation was observed, if the rabbit had dental surgery in the past, and if the surgery was successful or not.

In the Hungarian study, data were collected at the Exo-Pet Veterinary Clinic in Budapest, Hungary. The randomly selected rabbits visited the clinic between 01.11.2022. and 01.09.2023. Only rabbits diagnosed with malocclusion or incisivus malocclusion were selected. Recorded data were the age, sex, breed, diagnosis, number of veterinary visits, and affected teeth.

4.2 Statistical methods

Besides the descriptive statistics, Fisher's exact test was used to evaluate the association between the age (< 4 years old, > 4 years old), breed (dwarf or other), or gender (male or female) and the number of diagnosed health problems (< 3 or more) and diseases. The same test was used to check the association between neutering status and obesity. R version 4.3.1 (2023) was used for the calculations, p-values lower than 0.05 were significant.

4.3 Results

4.3.1 German survey

Owner demographics

The questionnaire yielded 82 responses. The female pet rabbit owners formed the majority in this study (n=68, 85%) and most of the participants owned 2 rabbits (n=27, 42.9%). Twenty owners (31.8%) had 1 rabbit, seven (11.1%) had 3 rabbits, three (4.8%) had 4 rabbits and four (6.3%) owned 10 or more rabbits. The majority of the pet rabbit owners were between 25 and 34 years old (n=36, 45%), 20% (n=16) were 18 – 24 years, 18.8% (n=15) were 35 – 44 years, 7.5% (n=6) were 45 – 54 years, 5% (n=4) were 55 – 64 years, two were under 18 years old (2.5%) and one was between 65 – 74 years (1.3%). An average age of 32.9 years was obtained, in which the assumption was: <18 = 10 years, 18 – 24 = 20 years, 25 – 34 = 30 years, 35 – 44 = 40 years, 45 – 54 = 50 years, 55 – 64 = 60 years, 65 – 74 = 70 years.

Rabbit information

Figure 10 shows that most participants did not own a specific breed, but rather had mixed breeds (n=31, 40.3%). Among the breeds dwarf lop was the most represented breed (n=9, 11.7%).

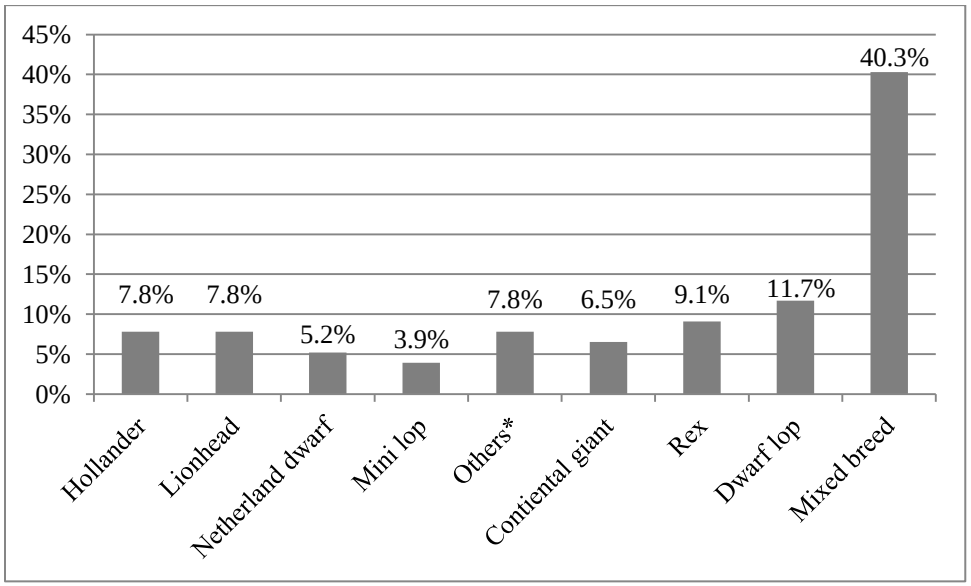

Figure 10: Breed of the rabbits

*French lop (n=1), German giant (n=1), Dutch (n=1), Tan (n=1), Belgian hare (n=1), Flemish (n=1)

The majority of the rabbits in this study were between 3 and 4 years old (n=25, 32.5%) (Table 1). An average age of 5.41 years was obtained, in which the assumption was: <1 year = 0.5 years, 1-2 years = 1.5 years, 3-4 years = 3.5 years, 5-6 years = 5.5 years, 7-8 years = 7.5 years, 9-10 years = 9.5 years, 11-12 years = 11.5 years.

Table 1: Age of the rabbits

< 1 year	1-2 years	3-4 years	5-6 years	7-8 years	9-10 years	11-12 years
1 (1.3%)	9 (11.7%)	25 (32.5%)	16 (20.8%)	12 (15.6%)	12 (15.6%)	2 (2.6%)

Although a higher proportion of males compared to females was observed in this study (n=40, 52.6% vs. n=36, 47.4%), the discrepancy between the values was minor. Therefore, it can be determined that the dispersal of females and males was approximately 50-50. Regarding neuter status, the majority of the rabbits were neutered (n=54, 71.1%), 26.3% (n=20) were intact and not planning to neuter, and 2.6% (n=2) were intact, but planning to neuter. There was no association between neutering status and obesity ($p>0.05$).

Nutrition

Figure 11 indicates that the majority of the owners fed their rabbits with concentrates (n=68, 87.2%). Complete pelleted feed was the most fed concentrate (n=59, 75.6%), 11.5% (n=9) were fed mixed feed and 12.8 % (n=10) did not feed concentrates at all. Among the owners who fed concentrates the majority fed concentrates once a day (n=44, 57.1%). Ten owners (13%) fed concentrates once or twice a week, eight (10.4%) twice a day or more, seven (9.1%) unlimited, two (2.6 %) less than once or twice a month, and one (1.3%) once or twice a month. Five owners (6.5%) did not give concentrates.

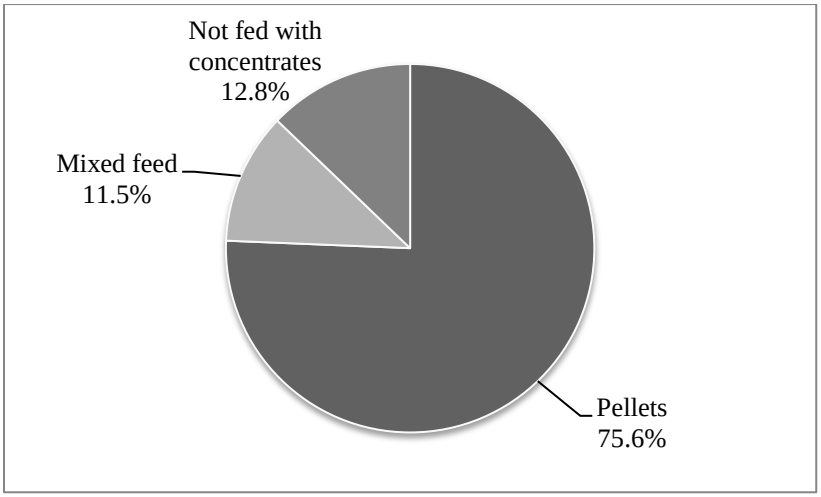

Figure 11: What type of concentrate is given regularly

When the rabbit was fed with mixed feed yogurt, peas, sunflower meal, and beans were mostly not preferred, as well as oats, nuts seeds, and corn were more or less disliked. In comparison with all ingredients, it can be highlighted that pellets (n=23, 28.5%), carrots (n=20, 24.4%), and hay (n=21, 25.6%) were preferred the most and were less disliked (Figure 12). Additionally, most of the owners fed fresh vegetables once a day (n=37, 47.4%), twenty two owners (28.2%) fed fresh vegetables twice a day or more, ten (12.9%) once or twice a week, seven (9%) unlimited, one (1.3%) once or twice a month and one (1.3%) less than twice a month. Romaine lettuce or spinach (n=47, 57.3%), dandelion leaves (n=46, 56.1%) and carrots (n=43, 52.4%) were given mostly. Peas (n=1, 1.2%), corn (n=4, 4.9%), and tomatoes (n=6, 7.3%) were rarely given (Figure 13). Furthermore, almost all rabbits (n=78, 96.2%) had permanent access to hay.

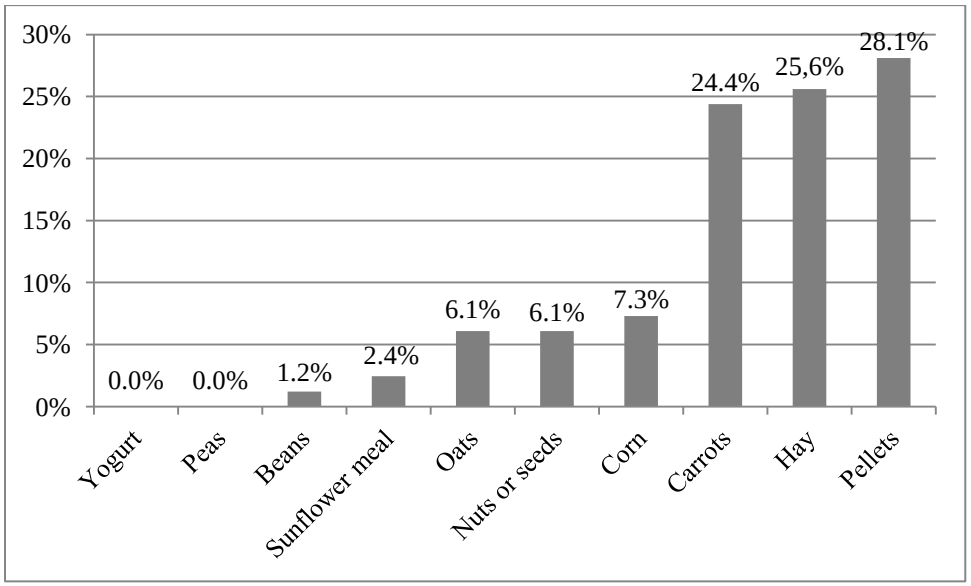

Figure 12: Preferred ingredients of mixed feed

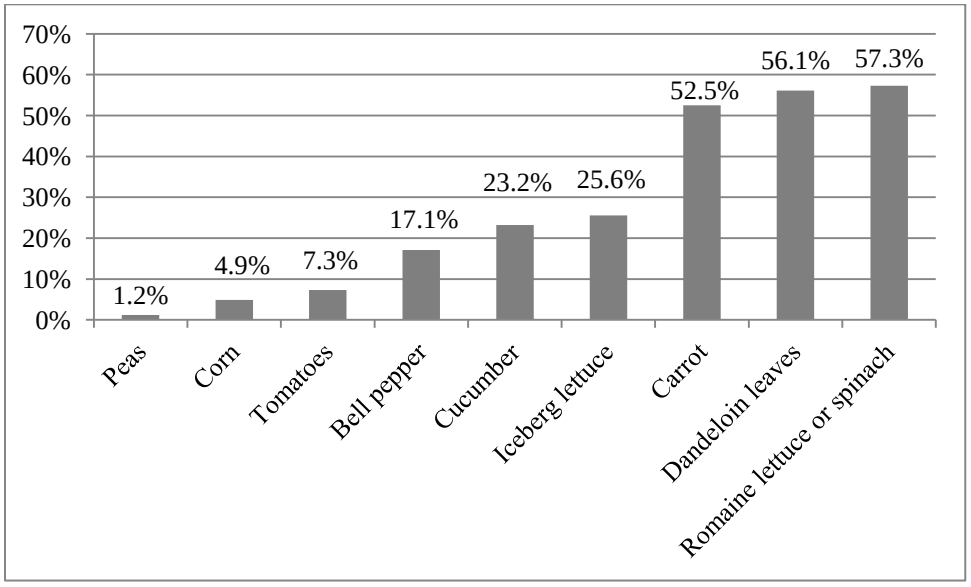

Figure 13: The most commonly fed vegetables

Regarding treats, most of the pet rabbit owners fed treats once or twice a week (n=32, 42.1%), 25% (n=19) gave treats daily, 15.8% (n=12) once or twice a month, 9.2% (n=7) never, 4% (n=3) less than once or twice a month, 2.6% (n=2) several times a day, 1.3% (n=1) unlimited. Figure 14 shows that herbs were given most frequently (n=39, 48.8%), following fruits (n=35, 43.8%), store-bought (n=29, 36.3%), and berries (n=23, 28.8%). read, crackers, human breakfast cereals, nuts, seeds, or pasta were given very rarely.

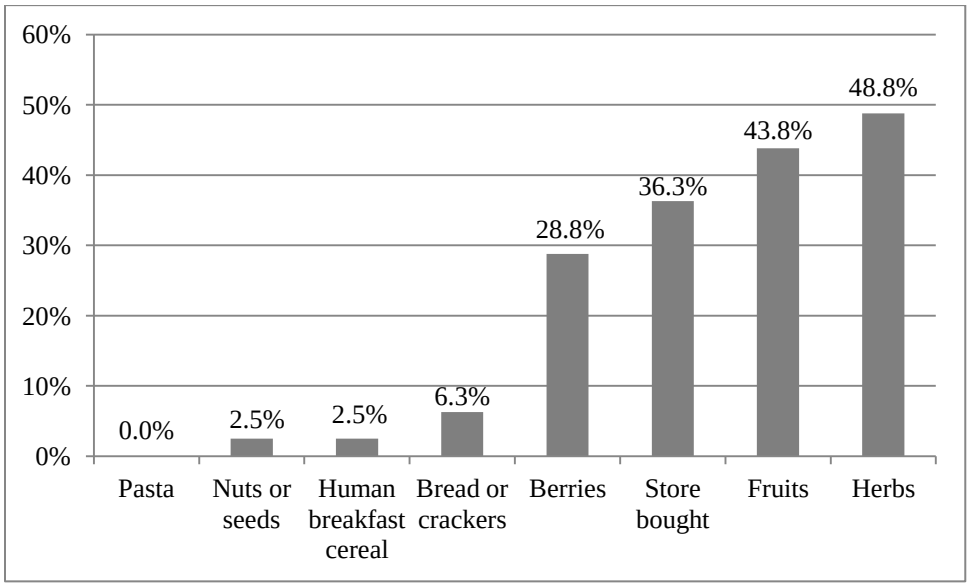

Figure 14: The most given treats

Rabbit health

Regarding the health status of the rabbits, most of the owners considered their rabbits healthy at the current moment (n=64, 86.5%). Of the disease conditions epiphora (n=12, 15.8%), obesity (n=8, 10.5%), and weight loss (n=7, 9.2%) were the most common (Figure 15). The rabbits were mostly presented to the veterinarian for reasons other than clinical disease, such as preventive health check (n=37, 48.7%), vaccination (n=37, 48.7%), and neutering (n=31, 40.8%). Seven rabbits (9.2%) have never visited a vet (Figure 16).

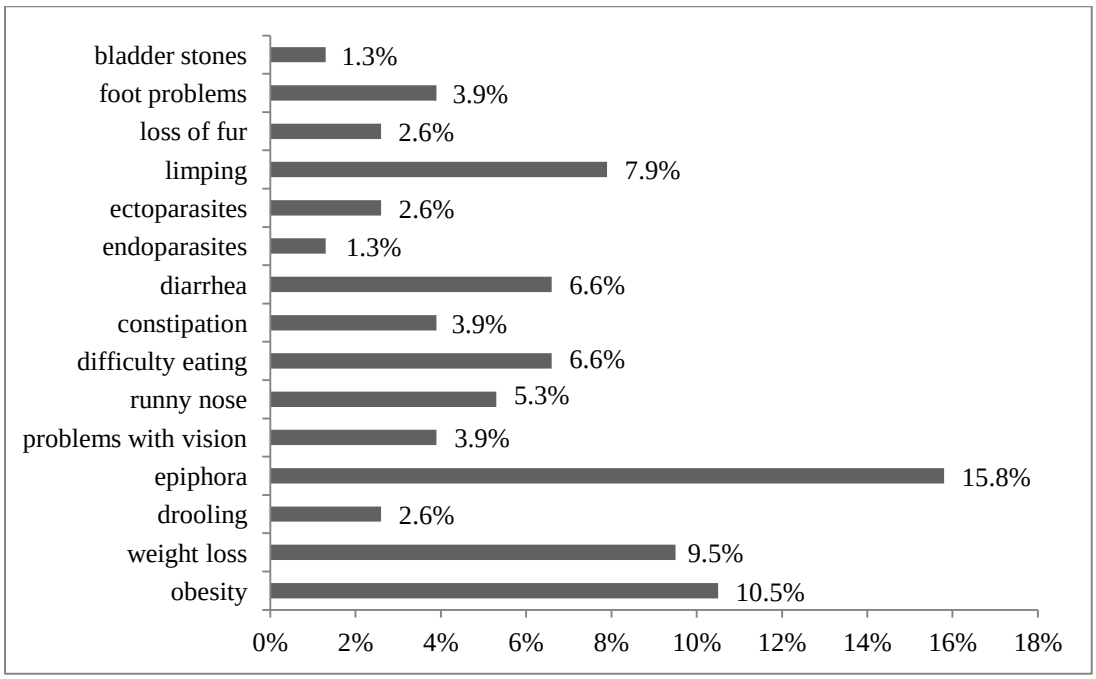

Figure 15: Experienced health conditions

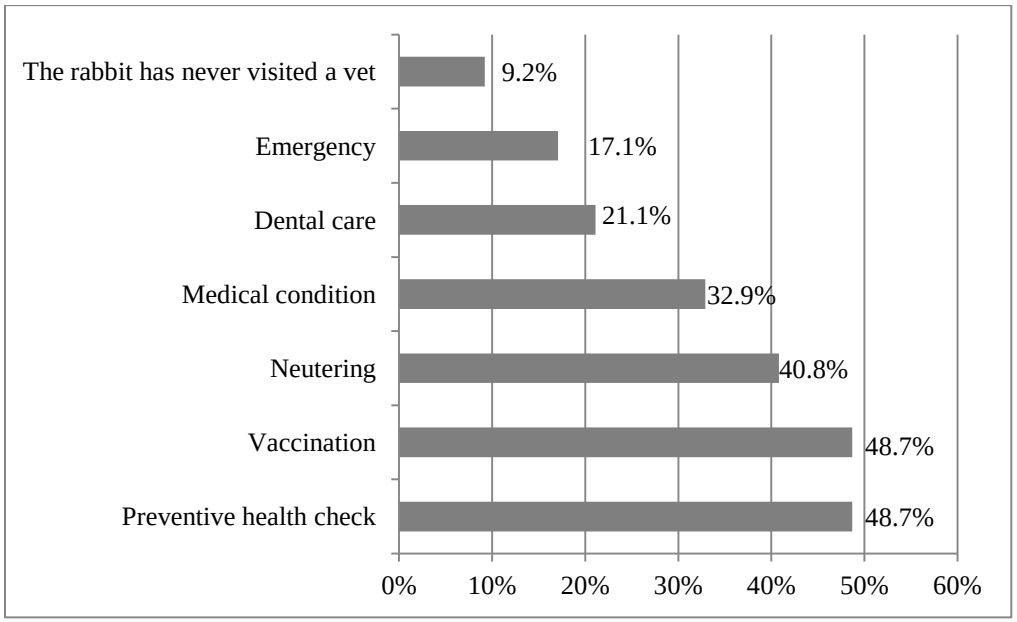

Figure 17: Reasons for presentation to the veterinarian

Dental disease

Table 2 shows that the frequency of dental disorders was higher in rabbits above 4 years (n=21, 50%) compared with rabbits less than 4 years (n=5, 15.2%). Among the rabbits above 4 years, 23.8% (n=10) had overgrown teeth, followed by dental disease (n=7, 16.7%) and tooth root abscess (n=4, 9.5%). Among the rabbits under 4 years 12.1% (n=4) had overgrown teeth, one rabbit had dental disease (3%), and no rabbit was presented with tooth root abscess.

Table 2: Characteristics of the pet rabbits based on age and number of dental disorders

	Age	
	≤4 years (n=33)	**> 4 years (n=42)**
Overgrown teeth	4 (12.1%)	10 (23.8%)
Dental disease	1 (3%)	7 (16.7%)
Tooth root abscess	0 (0%)	4 (9.5%)
Total number of diseases	5 (15.2%)	21 (50%)

Table 3 illustrates that dental disorders occurred mainly in males (n=15, 38.5%) compared to females (n=11, 31.4%). Among the female rabbits, 17.1% (n=6) had overgrown teeth, 14.3% (n=5) had dental disease and no female was presented with tooth root abscess.

Among the male rabbits 20.5% (n=8) had overgrown teeth, 7.7% (n=3) had dental disease and 10.3% (n=4) of the males were presented with tooth root abscess.

Table 3: Characteristics of the pet rabbits based on gender and number of dental disorders

	Gender	
	Female (n=35)	**Male (n=39)**
Overgrown teeth	6 (17.1%)	8 (20.5%)
Dental disease	5 (14.3%)	3 (7.7%)
Tooth root abscess	0 (0%)	4 (10.3%)
Total number of diseases	11 (31.4%)	15 (38.5%)

The only significant association was found between the age and tooth root abscess (p = 0.4591) as it was more common in dwarf rabbits. Dental disorders were reported in 21 rabbits (33.3%), and it was observed with a higher percentage in the cheek teeth (n=13, 20.6%) compared with front teeth (n=6, 9.5%) or both (n=2, 3.2%) (Figure 18 and 19). 11 rabbits (16.4%) had dental surgery in the past and in 90.9% (n=10) the surgery was successful.

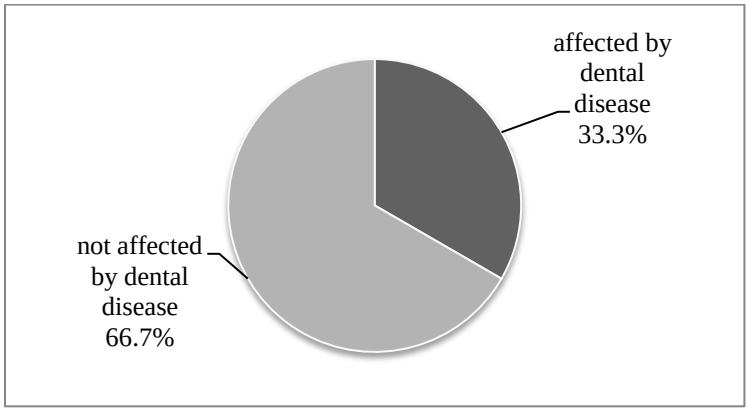

Figure 18: Rabbits affected or not affected by dental disease

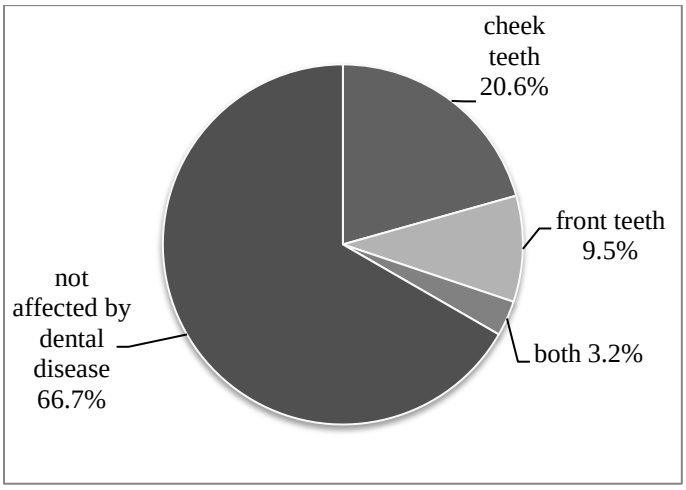

Figure 19: The affected teeth with dental disease

4.3.2 Hungarian study

The number of records was 150. The age of the rabbits was between 12-144 months (average 76.7±31.80). Most of the rabbits were male (n=92, 61.3%). More than 90% of the rabbits were dwarf (92.7%, n=139; Figure 20). More rabbits were diagnosed only with malocclusion (n=114, 76.0%) and thirty-six animals had both malocclusion and incisivus malocclusion (24.0%). The body weight of dwarf and mini rabbits was 1.84±0.45 kg.

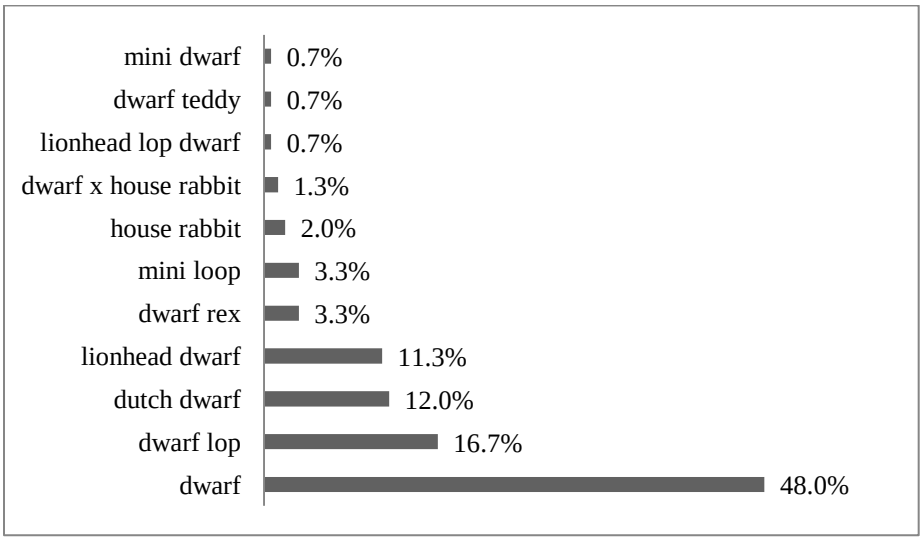

Figure 20. The rabbit breeds

The number of total veterinary visits and veterinary visits due to dental disease was 1-5 (2.6±1.3 and 3.2±1.4, respectively). The number of diagnosed conditions varied between 1-7 (2.4±1.2). Twenty-six rabbits (17.4%) were hospitalized mostly because of ileus or

gastric stasis syndrome. In two rabbits — at some level — every tooth was affected by malocclusion. The affected teeth of the rabbits are shown in Figure 21. The least affected teeth were the upper-left cheek teeth no.6 (1.7%, n=19 of the affected teeth) and upper-right cheek teeth no.6 (2.1%, n=23). Incisors were also among the less affected teeth (3.2%, n=36). The most affected teeth were the lower-right cheek teeth no.2 (6.5%, n=72) and upper-right cheek teeth no.2 (6.3%, n=70). Twenty-six rabbits (17.4%) had dental abscesses, and 10 (38.5%) had surgery during the examined period. The only significant association was found between age and the number of diagnosed health problems ($p = 0.01735$) as older rabbits had more diseases.

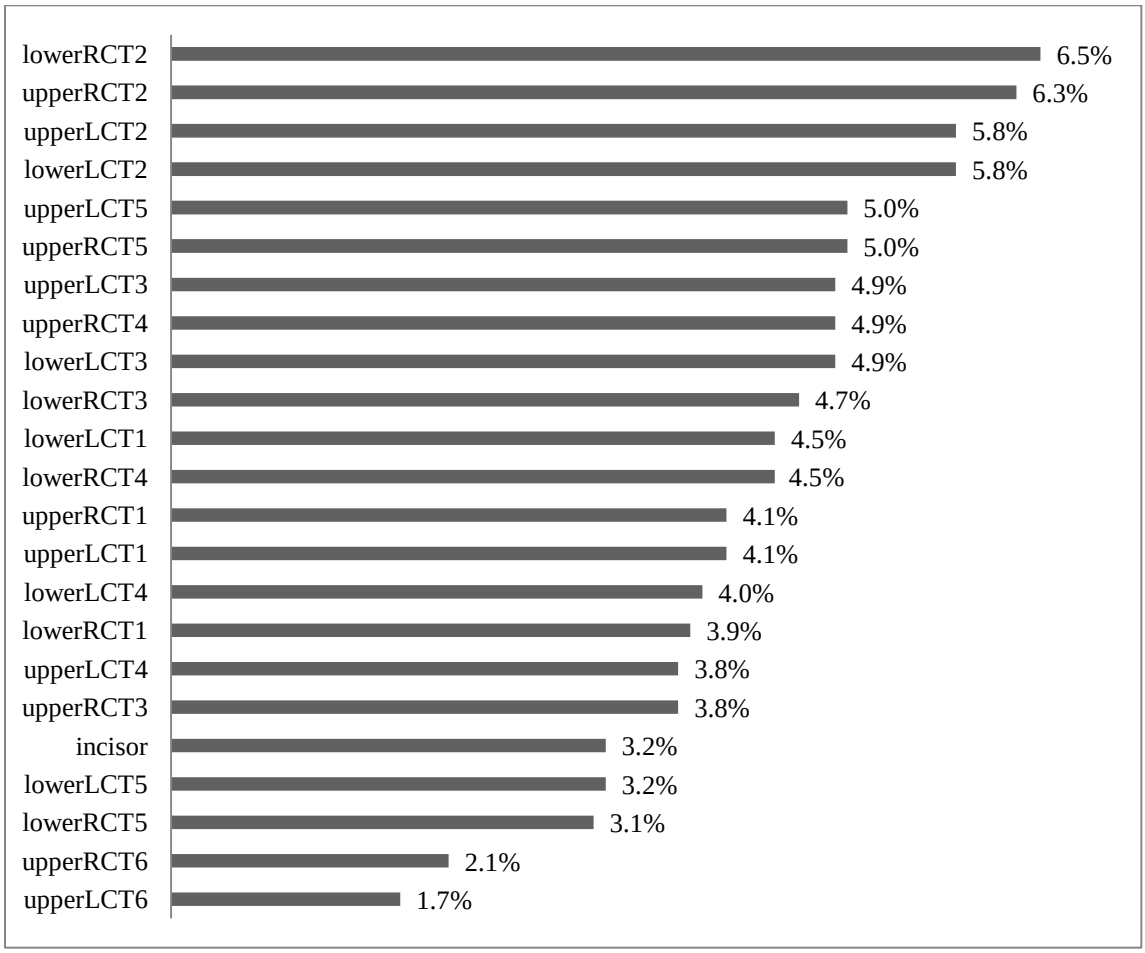

Figure 21. The affected teeth of the rabbits. R=right, L=left, CT=cheek teeth

Other diseases of rabbits besides malocclusion or incisivus malocclusion are shown in Figure 22. Obesity was seen in 19 rabbits (14.8% of the diseases). This was followed by epiphora (n=14; 10.9%) which is frequently associated with dental problems.

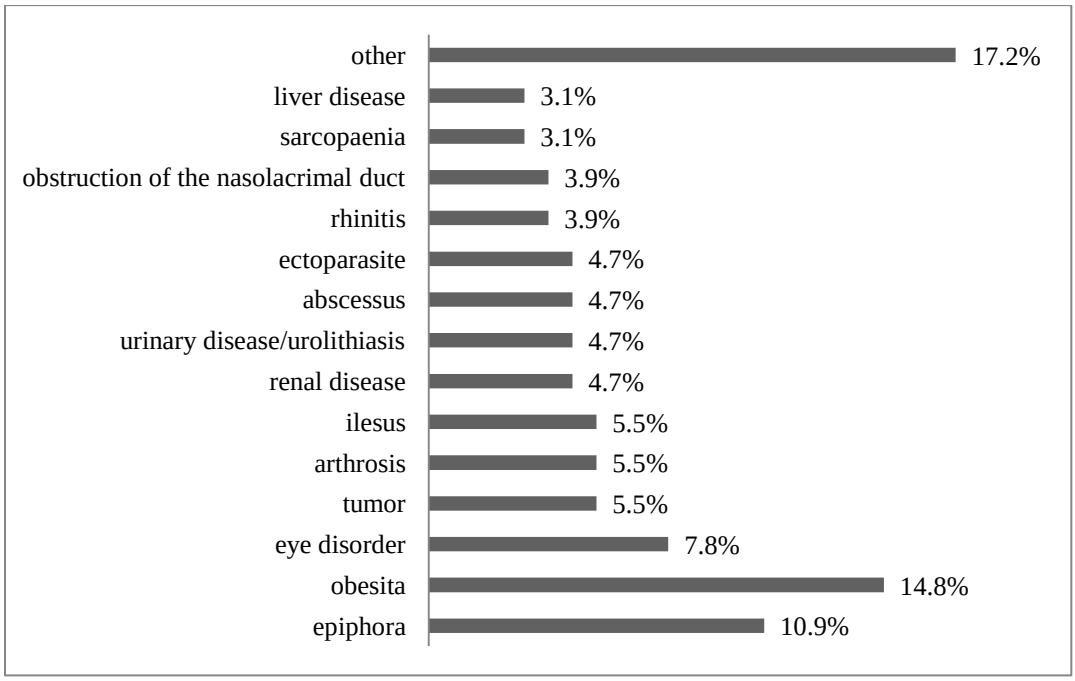

Figure 22. Disorders of rabbits (Hungarian Study). Other: gastrointestinal stasis syndrome (n=3), papilloma (n=3), *Encephalitozoo cuniculi* (n=3), dyspnoe (n=3), cachexia (n=3), heart disease (n=2), diarrhoea (n=2), pulmonary disease (n=1), anorexia (n=1), dehydration (n=1)

5. Discussion

Similar to the study by Kristensen, *et al.* most of the pet rabbit owners in the present study were female [18]. Concerning the number of currently owned rabbits, the results of this study were similar to other studies by Rooney, *et al.* or Kristensen, *et al.* where most of the owners had 2 rabbits [18, 19]. Like, in a previous study, most of the rabbits were mixed breeds (39.2%) according to the results from this study (40.3%) [18]. Among the purebred rabbits, the dwarf loop was the most common breed, as it is shown in other studies by Mäkitaipale, *et al*., Mullan and Main, Hetényi and Sátorhelyi [9, 20, 21]. Likewise, the dispersal of female and male rabbits was approximately 50-50 in this study, which is also shown in the previous studies [9, 20, 21]. The diversity of breeds in this study is reflective of the wide range of available animals since the rabbit became a popular pet in Victorian times. The dwarf lop became the favoured breed, because they are manageable in size, have a pleasing appearance, and have a good temperament [9].

This study shows that the majority of the owners fed their rabbits with concentrates (87.2%), mostly pellet-type (75.6%) together with freely available hay (96.2%) and vegetables. The fact that hay was a regular part of the diet of almost all rabbits corresponds

with other studies, in which fibre-rich feed was given in high proportions [9, 19, 21]. These diet records accord with the findings in the study by Kristensen, *et al.* in which 97.5% had permanent access to hay and complete feed was the most prevalent type of concentrate (95.9%) [18]. In the present study, only 11.5% were fed with mixed feed, which is contrary to a previous study by Harcourt-Brown in which 99% received mixed feed [22]. Perhaps the owners taking part in this present study were aware of the health risks connected to this kind of feed and were educated in rabbit keeping. Moreover, in this study mostly herbs, fruits, store-bought, and berries were given as treats, agreeing with the study of Kristensen, *et al.* [18].

The majority of the owners considered their rabbit healthy at the current moment, as also shown in the study by Kristensen, *et al.* Neutering and general health check was the most frequent reason for veterinarian visit in the present study, similar to a previous study[18]. Besides, there was no association between neutering status and obesity in the present study. Neutering status and its effect on the prevalence of obesity in rabbits have been evaluated in a couple of studies [23]. Sweet, *et al.* indicate in a study of 150 pet rabbits, that 48% of the females were overweight compared to males with 17% [24]. In the study by Courcier, *et al* it was defined that neutered rabbits are 5.4 times more at risk to overweight in comparison to intact rabbits, but the difference between males and females was not statistically significant [25]. Thompson, *et al.* reported in a study of 72 rabbits that neutered males were more prone to obesity (27%) compared to neutered females (19%). Indeed, these findings may be impaired by the relatively small sample size [23, 26]. Therefore, the effect of the relationship between neutering status on obesity risk should be further evaluated [23].

Dental disease

Dental disorders were reported in 33.3% of the rabbits, which correlates with previous studies where a prevalence between 30% and 40% was obtained [9, 16, 27]. In this study, the frequency of dental disease was higher in rabbits above 4 years (50%) than in rabbits under 4 years (15.2%), as seen in Table 2. Considering these results, most of the rabbits having dental disease corresponded to the adult age group. The explanation for that may be as time must elapse during factors, such as diet and lifestyle, which influence the development of dental disease. At older ages there is a longer exposure time of these factors, resulting in dental alterations [16]. Illustrated by several studies, Palma-Medel, *et*

al. show that age was a significant variable, which acts as a factor that increases the risk of acquired dental disease [16]. Likewise, Artiles, *et al.* evaluated risk factors of dental disease in their study and it was demonstrated that age was the only significant variable. This was associated with the fact that dental disease is progressive in time [16, 28]. Brommage, *et al.* revealed in their study that malocclusion of the premolars and molars has been more reported in old rabbits [29]. Also, Mosallanejad, *et al.* demonstrate in their study, that the prevalence of dental disease was significantly higher in rabbits above 3 years compared with rabbits less than 3 years [3]. In contrast, other authors described that in addition to adults, juvenile rabbits were also part of the majority of rabbits with dental disease [16]. This fact can be connected because at juvenile ages there is a higher demand for calcium for growth. Lower calcium concentrations can lead to dental alterations, such as enamel defects [30].

When evaluating sex in this study, dental disease occurred mainly in males (38.5%) compared to females (31.4%) (Table 3). Also, in the Hungarian study, most of the rabbits were males (61.3%). Several studies demonstrated that male rabbits show an increased risk of dental disease compared to females [31–33]. Palma-Medel, *et al.* reported in a study of 361 rabbits diagnosed with acquired dental disease a higher proportion of males (62%) compared to females (38%), and sex was a significant variable, where being male increases the risk of acquired dental disease [16]. This can be related to the hormone estrogen, which is present in females and increases the calcium serum concentration, taking part in its intestinal absorption and influencing the conversion to active vitamin D [34] and consequently facilitating the formation of enamel and dentin [16]. The literature also describes a greater susceptibility to the development of osteoporosis and dental alteration in castrated females due to the lack of estrogen resulting in calcium deficiency [35, 36].

Feeding of concentrate and its effect on dental disease is a controversial issue in the literature. “Unnatural” food, such as pellets, in contrast to the natural diet of wild rabbits, is crushed between the teeth followed by much higher axial strain on the cheek teeth. Lateral gliding movements are decreased which grinds the cheek teeth optimally in the long term, resulting in insufficient tooth wear and a tendency to retrograde elongation [27, 37]. The form of compressed pellets can alter the chewing pattern and decrease the chewing duration [5]. As hay is tougher and stiffer than pellets, it requires more chewing which results in longer chewing periods compared to pellets [27]. Another aspect is, that the

optimal dietary content of pellets has an opposed character to what is found in the wild, allowing maximal mineralization of the teeth and therefore facilitating the resistance to wear [5]. For the prophylaxis of dental disease, grass and/or good quality hay with substantial leafy green plants are advised. Adequate portions of concentrated food, as pellets, are recommended only to skinny rabbits, however they are never vital if the rabbit is able to consume grass or hay [1]. On the other hand, a study by Müller, *et al.* shows that pellets with high fiber content do not increase the risk of dental disease in the short term [6]. The aberration can be declared by the food quality and the exposure time that leads to tooth alterations [16]. The present study did not evaluate the quality of each ingredient in the diet, which may answer die discrepancy in the results according to the literature.

5.2 Hungarian study

Regarding breed, more than 90 % of the rabbits in this study belonged to the dwarf breed. Correspondingly, in the literature, it is observed that dwarf breeds are more frequently affected by dental disease than animals of larger breeds. The inherited mandibular prognathism and maxillary brachygnathism in dwarf breeds lead to incisor malocclusion [16]. Therefore, there is a genetic susceptibility to the development of dental disease, whereas dwarf breeds are predisposed to incisor malocclusion. Additionally, the short maxilla can alter the anatomy of the nasolacrimal duct and lead to blockage [2]. In a study by Siriporn, *et al.* it was shown that brachycephalic breeds were 3.19 times at risk of dental disease compared to normal breeds [33].

The most frequent other signs of the rabbits besides dental disease were obesity (14.8%), epiphora (10.9%), and digestive disorders, such as gastrointestinal stasis syndrome and ileus (5.5%). The results of the present study corresponded with the literature, as in the study by Artiles, *et al.* one of the most common clinical signs was epiphora [28]. Similarly, in the study by Mäkitaipale, *et al.* epiphora was strongly connected with dental disease during physical examination [20]. Increased ocular discharge is caused by the elongation of the maxillary incisor which constricts the nasolacrimal duct. This blockage leads to tears running down the face [1]. Digestive disorders can be associated with the impairment of rabbits to groom themselves and the difficulty of feeding because of dental alterations and pain [16]. When rabbits suffer from dental disease some actions can be painful for them, especially chewing fibrous vegetation and hay. However, the indigestible fiber is necessary for optimal gut motility, as well as pain and stress resulting from dental disease can

decrease gastrointestinal motility. All these factors increase the risk of gastrointestinal stasis syndrome and ileus. Additionally, poor teeth cause insufficient grooming and therefore mats can develop. Small intestinal blockage is often caused by felts of matted hair [2]. Due to the progress of the disease, it also affects other body systems besides dentition, which makes it even more difficult to diagnose and not always detectable for the owners [16]. Dental disease should be suspected in all rabbits showing signs, such as epiphora, pain, anorexia, disability of grooming, dermatological problems, digestive disorders, and salivation [3].

As was shown by both studies, front teeth are less affected by malocclusion than cheek teeth. A higher prevalence of the disease was observed in the location of the cheek teeth which can be connected with the chewing mechanism, which is altered more easily if the rabbit is not fed with an adequate diet [16]. According to Harcourt-Brown and Chitty acquired dental disease spurs begin to appear on the second, third, or fourth lower cheek teeth [38]. In the same way, Artiles, *et al.* demonstrate in their study, where 100 rabbits with dental disease were examined by CT, that greater alterations in the cheek teeth were observed compared to the incisors [28]. Similarly, in the study by Palma-Medel, *et al.* the disease was observed in 55% of the cheek teeth, in 26% on the incisors, and 19% in all teeth [16].

6. Abstracts

6.1. English abstract

The teeth of rabbits grow continuously lifelong, a type of dentition that predisposes to the development of acquired dental disease, which can be described as a multifactorial disease including tooth quality alterations and malocclusion, as well as non-dental consequences.

Two studies were conducted. The German study was based on a questionnaire survey performed among 82 pet rabbit owners and aimed to investigate pet rabbits' nutrition, husbandry and health with special emphasis on dental disease. The majority of the owners fed their rabbits with concentrates (87.2%) once a day (57.1%), mostly pellet-type (75.6%) with freely available hay (96.2%) and vegetables once a day (47.4%). Dental disease was reported in 33.3% of the rabbits and mostly on the cheek teeth (20.6%) compared with front teeth (9.5%) or both (3.2%) and it occurs mostly in males (38.5%). The group of rabbits affected with dental disease was predominated by the older age group (above 4 years, 50%).

The Hungarian study aimed to collect data from rabbits diagnosed with malocclusion or incisivus malocclusion by using the database of the Exo-Pet Veterinary Centre (n=150). Most of the rabbits were male (61.3%) and more than 90% of the rabbits were dwarf. More rabbits were diagnosed only with malocclusion (76.0%) and 24% had both malocclusion and incisivus malocclusion. The least affected teeth were the upper-left cheek teeth no. 6 (1.7%) and upper-right no. 6 (2.1%), as well as incisors (3.2%). The most affected teeth were lower-right cheek teeth no. 2 (6.5%) and upper-right cheek teeth no. 2 (6.3%). 17.4% had dental abscesses and 38.5% of them had surgery during the examined period. The most frequent other clinical signs of the rabbits besides dental disease were obesity (14.8%), epiphora (10.9%), and digestive disorders, such as gastrointestinal stasis syndrome and ileus (5.5%).

Finally, and as a conclusion, multiple causes have been investigated for the presentation of dental disease. In this study age and dwarf breed turned out to be the most important variables. In addition, it was shown by both studies, that front teeth were less affected by malocclusion than cheek teeth. As rabbits were properly fed with hay-based diets (German survey) there was no connection between dental disease and nutrition.

6.2 Hungarian abstract

Összefoglaló (Nyulak fogászati betegségei: malocclusio és következményei)

A nyulak fogai egész életükön át folyamatosan nőnek, ami hajlamosít a fogászati rendellenességek kialakulására. Ez az összetett oktanú kórkép magában foglalja a fogak minőségi változását, a fogak rendellenes záródását (malocclusio) és a nem fogászati eredetű következményeket.

Két adatgyűjtéses vizsgálat történt. Az elsőben német nyúltartók állatainak (n=82) tartási körülményeiről, takarmányozásáról és egészségi állapotáról gyűjtöttem adatokat, különös tekintettel a fogászati betegségekre. Az állattartók többsége (87,2%) naponta egyszer (57,1%) etetett tápot, jellemzően pellet típusút (75,6%). A széna az esetek 96,2%-ában folyamatosan a nyulak rendelkezésére állt és az állatartók jelentős része (47,4%) naponta etetett zöldségféléket is. A nyulak 33,3%-ánál alakult ki fogászati betegség, ami döntően az őrlőfogakat (20,6%), kisebb részben pedig a metszőfogakat (9,5%) vagy mindkettőt (3,2%) érintette. A bakoknál gyakrabban alakultak ki az elváltozások (38.5%). A fogászati betegségek nagyobb arányban érintették a 4 évnél idősebb nyulakat (50%), mint a fiatalabbakat.

A magyar eredmények az Exo-Pet Állatgyógyászati Centrum adatbázisában található azon nyulaktól származnak (n=150), amelyeket malocclusio-val vagy incisivus malocclusioval diagnosztizálták. Az állatok 61,3-a volt bak és >90% feletti volt a törpenyulak aránya. A nyulak többségét (76,0%) malocclusion-val, 24%-ot pedig malocclusion-val és incisivus malocclusion-val diagnosztizálták. A legkevésbé érintett fog a bal felső (1,7%) és a jobb felső 6-os (2,1%) rágófogak és a metszőfogak (2,1%) voltak. A leggyakrabban pedig a jobb alsó 2-es (6,5%) és a jobb felső 2-es (6,3%) metszőfogak szorultak korrekcióra. A nyulak 17,4%-ánál alakult ki fogászati tályog, közülük 38,5% esett át műtéten a vizsgált időszak alatt. A fogászati problémákon túl a legfontosabb kórképek között volt az elhízás (14,8%), a szemkönnyezés (10,9%) és az emésztőszervi probléma, mint csökkent bélmotilitás és az ileus (5,5%).

A következtetések levonása érdekében több tényező és a fogászati betegségek közötti összefüggés vizsgálatát végeztük el. Ezek alapján úgy tűnik, hogy az idősebb kor és a törpe fajta bizonyult a legfontosabbnak. Mindkét adatgyűjtésben igazolódott a metszőfogak kisebb mértékű malocclusio-val való érintettsége, mint a rágófogaké. Mivel a nyulakat alapvetően megfelelően, szénára alapozva etették (német adatok), a takarmányozás és a fogászati betegség között nem állt fenn összefüggés.

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Thesis statement for TDK thesis

I, the undersigned Nikoletta Hetényi, as the supervisor, declare that I have read and approved the thesis "Dental diseases in rabbits: malocclusion and their consequences" of the student Melina Edith Berger, 6th year, and support her participation in the Scientific Student Conference of the University of Veterinary Medicine in 2023. Furthermore, I declare that the uploaded TDK thesis has been successfully checked for plagiarism and that any matches found comply with the University guidelines/rules.

Budapest, 2023. 10.16.

supervisor

10. Thesis progress report

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Thesis progress report for veterinary students

Name of student: Melina Berger

Neptun code of the student: DRZZF0

Name and title of the supervisor: Nikoletta Hetényi, research fellow

Department: Department for Animal Nutrition and Clinical Dietetics

Thesis title: Dental diseases in rabbits: malocclusion and their consequences

Consultation – 1st semester

	Timing			Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2023	02	24	Online consultation: table of contents, references.	
2.	2023	03	22	Questionnaire content	
3.	2023	04	21	Online consultation, data collection, questionnaire	
4.	2023	05	30	Data collection	
5.	2023	06	08	Data collection	

Grade achieved at the end of the first semester: 5

Consultation – 2nd semester

	Timing			Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2023	09	04	Literature review	
2.	2023	09	14	Materials and Methods, Results	
3.	2023	10	02	Thesis review	
4.	2023	10	16	Plagiarism check	
5.	2023	10	18	Final thesis	

Grade achieved at the end of the second semester: 5

The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and found suitable to defence,

Dr. Hidi Mihály
signature of the supervisor

Signature of the student: .....

Signature of the secretary of the department: .....

Date of handing the thesis in..17. November 2023.

11. Thesis equivalency declaration

DECLARATION

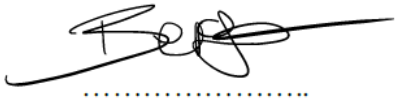
I hereby declare that the thesis entitled:

Dental diseases in rabbits: malocclusion and their consequences

is identical in terms of content and formal requirements to the TDK research paper submitted in 2023.

Date: Budapest, 14th November 2023

Melina Edith Berger



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