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WILD FELINE FEED: APPARENT DIGESTIBILITY AND URINARY PH EVALUATION IN DOMESTIC CATS (FELIS CATUS)

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ABSTRACT

The digestibility of nutrients in commercial diets of domestic cats are well characterized and documented, however, for felids it does not occur. Even the research shows the digestibility of raw food for wild cats are limited. Therefore, this work aims to evaluate the digestibility, urinary pH, fecal score and weight maintenance of domestic cats fed an extruded wild cat food. Six domestic cats were used, without defined breed, with an average age of 6.3 years, being four females and two males. The experiment and urinary pH evaluation were performed at the Cattery of the Experimental Farm of Iguatemi, belonging to the State University of Maringá, Paraná. The evaluation of feces to determine apparent digestibility was performed at the Laboratory of Animal Nutrition, at the State University of Londrina, Paraná. All variables found were submitted to descriptive analysis of variance and means compared to Tukey's test. The statistical models were performed using the RStudio software, with a significance level of 0.05. The feed presented satisfactory results regarding weight maintenance, urinary pH and digestibility index in domestic cats.

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INTRODUÇÃO

Animal nutrition is a relatively new science, especially when referring to wild animals, which dates to the 19th century. It was only at that time that great importance was given to food constituents: proteins, fats, carbohydrates, minerals and fibers. The adequate food management of wild animals in captivity must incorporate the knowledge of animal nutrition science in order to maintain longevity and to prevent diseases (Dieferenfeld, 1997). Commercial cat food can be used in cats, and they are generally well accepted by small cats, as long as they are initially added meat for adaptation and acceptance. Adania et al. (2014) reports that small cats can be kept only with commercial feed for domestic cats butemphasizes the need to take care of animal welfare aspects, since by feeding them only with feed the hunting behavior is suppressed. In this case it is recommended to provide prey as part of environmental enrichment. Felines kept in captivity in Brazil are fed with raw food, and a good portion of the establishments provides commercial pet food to complement of the diet (Buchini & Gobetti, 2021). It is relevant to consider that the diet needs to have a balanced amount of nutrients, because although cats have high needs of protein and essential amino acids for example, the excess of protein in the diet can lead them toputrefaction of fecal components.

It is believed that the greater was the digestibility of protein provided in the diet, the lower will be the amount of protein that reaches the large intestine, with this there is a decrease in the formation of putrefactive compounds, and thus improve intestinal health and consequently the general health of the animal (Vester et al., 2008). The consequences of the inadequate nutritional and environmental management for the health of wild and exotic animals have been observed with a relatively high frequency in veterinary clinics, and 56.9% are related to nutritional management error (Ribeiro et al., 2017). Several authors highlight the need to improve the understanding of the effects of raw food diets and the feed base on felids, especially the effects on gastrointestinal function and general health of these animals (Depauw et al., 2011 and, Vester et al., 2008). Specific studies on nutrition for the diversity of animals kept in captivity are essential, because although the digestibility of nutrients from commercial diets of domestic cats are well characterized and documented, for cats kept in captivity it does not occur. Even studies showing the digestibility of raw food for felids are limited, and this is mainly due to the restricted number of animals available in zoos for testing, so the nutritional requirements of these species are often determined from the extrapolation of the domestic cat, but it is believed that even with raw food the use of a single diet for all felids may not be appropriate for each species (Vester et al., 2008). In this sense, this work aims to evaluate digestibility, urinary pH, fecal score and weight maintenance of domestic cats fed an extruded feed formulated for wild cats. Research is essential to investigate the

feasibility of testing with this same food in wild cats kept in captivity in Brazil.

METHODOLOGY

The collections of the experiment and the evaluation of urinary pH were carried out in the Cattery of the Experimental Farm of Iguatemi, located in the district of Iguatemi, Paraná, that belongs to the State University of Maringá (UEM). The evaluation of feces to determine digestibility was performed at the Laboratory of Animal Nutrition (LANA), of the State Universityof Londrina (UEL). Six domestic cats were used, without defined breed, with an average age of 6.3 years, being four females and two males. Digestibility was estimated per individual, in which each animal was considered a group, and this had seven repetitions, using only the method of total collection of feces. The ration used in the experiment was formulated and donated by Quimtia S.A., with headquarters in Colombo-PR, being elaborated only for scientific purposes and made available for this research project. The parameters used to support the ration by the company follow the requirements proposed by Aza (2016) and NRC (2006), it is of the extruded type with circular granules of 0. 7 cm in diameter, and has the following nutritional formulation: Poultry bowels flour, greaves flour, gelatinized rice flour, swine blood plasma powder, soy protein concentrate, egg powder, chicken fat, hydrolyzed pork liver, dehydrated pig red blood cells, sodium chloride (common salt), beet pulp, potato starch, Dehydrated pea, nucleotides, calcium limestone, vitamin A, vitamin D3, vitamin E, vitamin k3, vitamin B1, vitamin B2, vitamin B6, vitamin C, inositol, vitamin B12, choline chloride, potassium chloride, niacin, calcium pantothenate , folic acid, biotin, DL-methionine. Having as chemical composition the Humidity (max) 120 g/kg; Crude Protein (min) 350 g/kg; Extract Ether (min) 180 g/kg; Fibrous Matter (max) 40 g/kg; Mineral Matter 75 g/kg. The experimental management was conducted in two phases: adaptation and harvest. The adaptation period took place over five days, with the objective of adapting the animals to the diet, the facilities, and adjusting the food intake. The harvest phase lasted seven days, the food consumption of which was rigorously measured and recorded. In this phase the urine was collected until three samples were obtained to measure the pH, in addition, all fecal excretion in this period was collected, quantified and evaluated the fecal score following the Abinpet classification (2017).

The animals that participated in the trial were clinically healthy and were weighed before the beginning and after the end of the experiment. The food consumption calculations were made according to Abinpet's (2017) proposals. During the first three days of adaptation, the animals were housed in individual palatability cages only during feeding times, from 8:00 a.m. to 10:00 a.m., and from 2:00 p.m. to 4:00 p.m. The amount of daily feed required for each animal was provided in two portions, half in the morning, and the other half in the afternoon, at these times the animals had only food available for consumption, and the leftovers were weighed. The rest of the time the animals stayed in the collective cattery only with water available at will and the other cats in the collective cattery received food at the same time as the test animals, and then remained only with water at will. From the fourth to the twelfth day, the test animals stayed full time in the digestibility cage. Feed was provided from 8:00 a.m. to 10:00 a.m., and from 2:00 p.m. to 4:00 p.m., in two portions, half of the daily amount of feed in the morning and the other half in the afternoon. The water was supplied at will and the leftovers were weighed. From the fifth day on, the feces were collected when completing 24 hours. For each animal there was an appropriate plastic bag with hermetic closure and identified, in which the feces were collected composing a Pool of each animal. As soon as collected they were weighed, evaluated the fecal score and then stored immediately in a freezer at -15°C. The urine was collected from the fifth day to the ninth day, consisting of three samples from each animal, and it was collected concomitantly with the feces. In each metabolic cage there was an appropriate collector flask, identified, properly cleaned, containing 0.1g thymol to preserve the urine. The individual urine production for each 24-hour interval was filtered and homogenized, and subsequently measured pH at digital pHmeter. At the end of the tests, the animals were weighed again, and the feces were transported in an appropriate container to the Laboratory of Animal Nutrition of the State University of Londrina, Paraná, where they were immediately homogenized and packed in a tray for pre-drying in a forced ventilation oven at a temperature of 55°C for a period of 72 hours. Finally, laboratory analyses were performed for crude protein, dry matter, mineral matter, crude fiber, ether extract and crude energy from feces, following the methodology proposed by Mizubuti (2009). All variables found were submitted to descriptive analysis: mean, standard deviation, coefficient of variation and correlation coefficient. Weights, consumption, urinary pH as well as digestibility coefficients were submitted to analysis of variance and means compared to Tukey's test to verify the effect of the animal on the values found. The statistical models were performed using the RStudio software, with a significance level of 0.05.

RESULTS AND DISCUSSION

According to Adania et al. (1998) in a clinical evaluation performed on cats kept in captivity in Brazil, 50% of the individuals presented changes related to unsatisfactory management and physical conditions, and relevant nutritional deficiencies were also found, of which 21% of the kittens (*Leopardus tigrinus*) were underweight and 29.2% of the ocelots (*Leopardus pardalis*) were obese. In a study on food management of cats kept in captivity in Brazil by Buchini & Gobetti (2021), inconsistencies in food management were found, suggesting that it is still possible to find cats with health problems associated with poor nutrition or out of ideal weight. Studies with domestic cats have shown that obesity has important implications for feline health and wellbeing, as it can predispose to type two diabetes melittus, hepaticlipidosis, oral cavity diseases, urinary tract diseases, dermatology and neoplasms (Tarkosova et al., 2016). Hope & Deem (2006) report that hepatic lipidosisis among the most common kidney diseases found in jaguars (*Panthera onca*) and that it is associated with overweight animals kept in captivity.

Table 1. Initial weight (IP) and Final weight (FP) of the experimental animals

Animal	PI (Kg)	PF (Kg)	Average (Kg)
1	4,48 [a]	4,54[a]	6,43
2	3,82[b]	3,86 [b]	6,74
3	3,32[c]	3,32[c]	6,46
4	3,16[d]	3,16 [d]	6,66
5	4,50 [a]	4,50 [a]	6,56
6	3,88 [b]	3,84 [b]	6,60

[a-d]Averages that do not have the same superscript letter are significantly different based on Tukey's test (P<0.05).

According to Apinpet (2017), a food is characterized as light when it suffers a 15% reduction in energy density in relation to products of the same line and category. Thus, when compared to a similar food of exotic cats Mazuri® Exotic Feline - Large, one can say that the feed used in this experiment is not the light type.

Table 2. Estimated feed consumption (EC) and actual feed consumption (CR) of animals during the entire experimental period

Animal	CE (g)	CR (g)
1	576 [a]	547 [a]
2	516 [a]	506 [a]
3	468 [a]	441 [a]
4	444 [a]	400 [a]
5	576 [a]	576 [a]
6	516 [a]	496 [a]

[a]Averages with the same letter do not differ significantly based on Tukey's test (P<0.05).

It is believed that, as with domestic cats in this research, cats fed only with this food will not have an increase or reduction in body weight, since there was no significant difference between the initial and final weight of the animals (Table 1). Due to the limited space in the enclosures or housing of animals kept in captivity, it is essential to pay attention to the reduction of expending energy, and diets should be observed about the amount of fat they contain, in order to avoid the prevalence of obesity in animals. Buchini et al. (2020) concluded that one of the rations analyzed in her research could be tested on wild cats, since the domestic cats in the experiment had a good acceptance. Regarding the feed of this experiment that contains the same nutritional parameters of feed B studied by Buchini et al. (2020), it was also observed an excellent acceptance by domestic cats, confirming again that the feed has an excellent palatability as described in table 2, and will probably have a good acceptance by wild cats. Domestic cats in this study had excellent feed consumption, and although there were only leftovers in the first three days of adaptation, they did not differ significantly (Table 2), and this is justified by the "neophobic" behavior when there is a change in feed, as described by Menolli et al. (2018). No animals failed to consume the feed throughout the experimental period.

Table 3. pH indices of urine collected during the experiment

Animal	Sample 1	Sample 2	Sample 3	Average
1	6,48[a]	6,45[a]	6,36[a]	6,43
2	6,87[a]	6,76[a]	6,58[a]	6,74
3	6,48[a]	6,49[a]	6,41[a]	6,46
4	6,76[a]	6,5[a]	6,71[a]	6,66
5	6,58[a]	6,78[a]	6,35[a]	6,56
6	6,46[a]	6,4[a]	6,94[a]	6,60

[a]Averages with the same letter do not differ significantly based on Tukey's test (P<0.05).

Feline lower urinary tract disease reaches 1% of the world's population, its predisposing factor is the formation of uroliths, and its incidence is related to food, especially the content of macrominerals. The physiological urinary pH of feline urine can vary between 5.5 and 8.5, but to avoid the formation of struvite crystals it should vary between 6.2 and 6.4, while to avoid the formation of calcium oxalate it should vary between 6.6 and 6.8 (González et al., 2003). The mean urinary pH of the cats evaluated in this study varied between 6.43 and 6.74 and there was no significant difference between individuals (Table 3), so it is assumed that the feed can help prevent uroliths in cats. According to Abinpet (2017)struviteuroliths are formed at alkaline urinary pH and calcium oxalate uroliths at acid urinary pH, so the urine pH should vary between 6.2 and 6.8. It is necessary to investigate in wild cats to see if the consumption of feed influences the ideal urinary pH for the species. Causes of mortality related to kidney and urinary problems are more frequent in cats over 5 years of age (Hope & Deem, 2006).

Table 4: Effect of the animal on the apparent digestibility coefficients (DDA) of Dry Matter (MS), Gross Faecal Energy (EB), Gross Protein (PB), Ethereal Extract (EE) and Mineral Matter (MM)

Animal	CDA MS%	CDAE B%	CDAF B%	CDAP B%	CDAE E%	CDA MM%
1	78,06[a]	78,06[a]	78,06[a]	78,11[a]	78,06[a]	78,06[a]
2	77,87[a]	77,87[a]	77,87[a]	79,45[a]	77,87[a]	77,87[a]
3	78,46[a]	78,46[a]	78,46[a]	75,16[ab]	78,46[a]	78,46[a]
4	69,5[b]	69,5[b]	69,5[b]	60,9[c]	69,50[b]	69,50[b]
5	81,25[a]	81,25[a]	81,25[a]	79,73[a]	81,25[a]	81,25[a]
6	69,76[b]	69,76[b]	69,76[b]	68,4[bc]	69,76[b]	69,76[b]
Média	75,82	75,82	75,82	73,63	75,82	75,82

[a-c]Averages that do not have the same superscript letter are significantly different based on Tukey's test (P<0.05).

Vester et al. (2008) states that there are differences in digestibility among felid species, and although the requirements of domestic cats can be considered for wild cats, he suggests studies with varying nutritional levels to determine which diet is more species-specific. As with domestic animals, knowledge of digestibility for a determined species guides the best choice of ingredients (Carvalho, 2010). A large part of Brazilian zoos is based on the experience of trial and errorand body condition to determine the feeding protocol of felids (Clauss et al., 2010 and Buchini & Gobetti, 2021). Vester et al. (2010) suggest that the use of feed could result in digestibility coefficients like the raw meat diet, and that thus the feed could be an alteration to complement the diet of cats kept in captivity. Carvalho (2010) tested domestic cat food in ocelots (*Leopardus pardalis*) and according to him, there was influence of the animal on the apparent digestibility coefficients for gross fecal energy (EB) and gross protein (PB). In this experiment the influence of the animal effect on the apparent digestibility for dry matter, raw energy of feces, raw fiber, raw protein, ether extract and mineral matter was examined (Table 4). When individual digestibility is analyzed, it was observed that animals 1, 2 and 5 did not have significant differences between the digestibility coefficients for dry matter, raw stool energy, crude fiber, crude protein, ether extract and mineral matter (Table 4). The apparent digestibility indices for crude protein were the most influenced by the animal effect, as found by Carvalho (2010) and Crissey et al. (1997). In Brazil, the Ministry of Agriculture, Livestock and Supply (MAPA) is responsible for regulating dog and cat food and wild species feeds. Foodstuffs are classified according to the commercial segmentation instituted by the industry itself and are based on the quality of the raw material and concentration of nutrients (Carciofi et al., 2006). According to these criteria feed is classified as Premium, Super Premium and Standard or Economic type. Considering only the digestibility index, it is believed that the ration of this work is the Standard type, since the digestibility index for 75% of the ration is classified as Standard type, 87% for Premium type and 92% for Super Premium type. The average index of digestibility found in domestic cats in this research was 75.45%. Studies in felids are fundamental to affirm that this classification is also maintained in these species. Even for domestic animals, there is a variation on this type of classification and there is no regulation yet that regulates this type of cataloguing.

Table 5. Feces Volume (FV) and Fecal Score (EF) of the animals during the experiment period

Animal	VF (g)	EF
1	120	4,2
2	112	4
3	95	4
4	122	4,1
5	108	4,1
6	150	3,5
Average	118	4

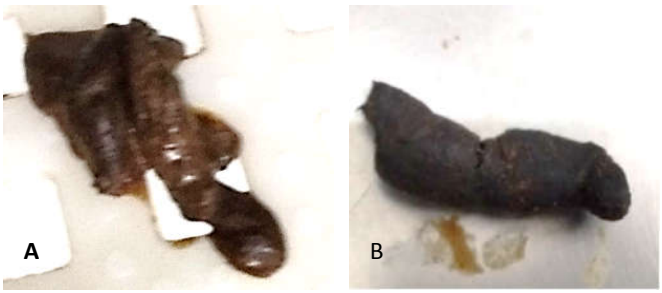

Figure 1:A - Fecal score 2.5; B - Fecal score 4 (Image: Buchini, 2021).

Both Carvalho (2010) and Vester et al. (2010) reported a concern with fecal volume in individuals who were fed a diet based on feed, since a higher fecal volume was observed in felids, and with that there would be a need for more time for hygiene of the enclosures and consequently higher costs. Oak (2010) also observed the fecal score of ocelots (*Leopardus pardalis*) fed commercial cat food, which reports that the animals had a low score, and thus suggests studies with differentiated fiber contents as well as the use of high fermentability fibers. The fecal score test is important to ensure that the food sold does not cause changes in volume and quality of the animal's feces. Within the classification proposed by Abinpet (2017), the fecal score receives a classification from zero to five, where zero

feces are liquid, and five feces are well formed, hard and dry. In this work it was found that the animals had a good fecal score, in other words, classification four (Figure 1), whose feces are well formed and consistent that do not mark the floor. In addition, for the experiment period, the fecal volume was also evaluated as normal, since was expected a volume between 80g and 120g of feces per animal. Only one animal had a fecal score below three (Figure 1), no animal had liquid or diarrheal feces. It is assumed the relationship with the type of fiber in the ration of this experiment, which presents in its composition fermentable and non-fermentable fibers, whose combination is recommended by Kerr et al. (2013) for felids.

CONCLUSION

The feed presented satisfactory results in terms of weight maintenance, urinary pH, and digestibility index for domestic cats. Researchis necessary in cats kept in captivity to investigate the digestibility of the ingredients that make up the feed studied in this work, as well as the gastrointestinal physiology and the reflexes on the general health of the animals.

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Ethics Committee Note: This work is part of the project submitted and approved by the Ethics Committee on the Use of Animals of the State University of Londrina, Paraná, under number 051.2020.

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