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The effect of dietary fat source on feed digestibility in chinchillas (*Chinchilla lanigera*)

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Abstract: *The effect of dietary fat source on feed digestibility in chinchillas (Chinchilla lanigera).* The objective of this study was to determine the effects of the inclusion of the vegetal and animal fat to the diet on the apparent digestibility in chinchillas. 18 young chinchillas were assigned to three groups and fed control diet or with the addition of either linseed (VF) or lard (AF). The apparent digestibility coefficient (ADC) was calculated for dry matter (DM), organic matter (OM), crude protein (CP), crude fibre (CF), nitrogen free extract (NFE) and ether extract (EE). The results showed that there was no significant effects of fat addition on most of the studied constituents except for increased digestibility of EE.

Key words: chinchilla, digestion, fat, palatability

INTRODUCTION

Among companion mammals, small herbivores constitute a substantial majority. One of them, chinchilla (*Chinchilla lanigera*), originating from South America, can be regarded popular, yet scarcely described in scientific literature. The basic specifics of its nutrition were reported by Wolf et al. (2008), who suggested that the crude fibre level in the chinchilla diet should not exceed 15%. Alike in guinea-pigs, crude fibre is digested more efficiently by chinchillas than by rabbits or rats (Sakaguchi 2003).

The ability to utilize fibrous feed in chinchillas is attributed to their voluminous colon and caecum as it was showed also in other rodents (Langer 2002, Pérez 2011). The colonic separation mechanism, leading to the accumulation of microorganisms in caecum, results in the formation of re-ingested caecotrophes (Holtenius and Björnhag 1985), rich in microbial derived protein that contribute to overall nutritional balance (van Zyl and Delport 2010).

Fat supplementation in animal diets is usually performed either to increase the energy value of the feed or to improve the nutritional quality of products derived from animals (Doreau and Chiliard 1997). Interesting aspects of rabbit dietary fat supplementation were discussed by Casado et al. (2012), who claimed that (first) it does not decrease the fibre content, resulting in a reduction of production costs and (second) improves feed palatability. The latter is a matter of great concern for chinchilla housing in captivity due to their rather refined preferences (unpublished observations).

Little is known about the digestion of supranutritional doses of fat in companion rodents on the contrary to rats, probably the most common laboratory species (Wang et al. 2011). In the case of chinchillas and guinea-pigs, despite major resemblances, the considerable differences were reported in their metabolic patterns (Holtenius and Björnhag 1985). Moreover, the nutrients digestion in guinea-pigs, as compared to rabbits, also showed substantial differences (Franz et al. 2011). Therefore, regarding the above we found justifiable to study the possible effects of dietary addition of animal and vegetal fats on the feed consumption and digestion in chinchillas.

MATERIALS AND METHODS

Animal, diets anad mnagement

A total of 18 young chinchillas (±74 days old) were assigned to three groups (n = 6) and placed in metabolic cages for 2 weeks. The environmental conditions were as follows: temperature 18–19°C and humidity 30–35%. Chinchillas in control group (C) were fed commercial pelleted chinchilla feed (Table 1), and with the 3% (of feed DM) addition of either vegetable (linseed oil – VF group) or animal fats (lard – AF group). Deliberately measured amounts of pellets (35 g per 1 chinchilla) were thoroughly mixed with the appropriate amount of linseed oil. Similar procedure was performed for lard, but before mixing it was slightly heated in the water bath (Table 2). Drinking water was constantly available.

TABLE 1. Composition of the basal diet

Ingredients	Content (per 1 kg of feed)	
Protein	175	g
Fibre	120	g
Fat	40	g
Ash	65	g
Lysine	12	g
Methionine + Cysteine	10	g
Metabolizable energy	9.8	MJ
Ca	8.5	g
P	6.5	g
Na	2	g
Vitamin A	12 000	i.u.
Vitamin D_3	1 200	i.u.
Vitamin E	72	mg
Cu	10	mg

TABLE 2. The chemical composition of diets offered to control and experimental animals (%)

Item	C	VF	AF
DM	88.58	89.52	89.96
OM	81.50	82.63	82.92
CP	19.35	18.90	18.77
EE	3.58	6.61	6.22
CF	8.73	8.13	8.16
NFE	49.84	48.99	49.77

C – control group; VF – vegetable fat group; AF – animal fat group; DM – dry matter; OM – organic matter; CP – crude protein; EE – ether extract; CF – crude fibre; NFE – nitrogen-free extract.

Sample collection

After 7 days of adaptation period, feces and urine were collected daily for next week. The feed and water intake were also recorded.

Sample analytical determinations

Content analyses in collected material were performed by Weenden's method, a conventional laboratory procedure.

The apparent digestibility coefficients (ADC) of nutrients were calculated as:

$$\text{ADC} = \frac{\text{intake} - \text{excretion (g)}}{\text{intake (g)}} \times 100\ (\%)$$

Statistical analysis

One-way ANOVA analysis of variance was performed using Statistica 9 software (StatSoft Poland, Cracov). Differences were considered significant at $p < 0.05$.

Data are presented in tables as means ± standard deviation.

RESULTS AND DISCUSSION

The addition of fat had an effect of the feed intake in chinchillas (Table 3). Compared to control, animals offered diet supplemented with linseed oil consumed lower amounts of feed and animal fat supplementation caused higher intake in chinchillas.

Interestingly, inverse effects were noted for water intake. Animals receiving pellets with linseed oil drank significantly more water than those, who consumed lard enriched diet. However it should be noted, that the water intake in VF group was substantially higher also than that in control group, which possibly indicates that the dietary addition of linseed oil had stronger effect on animals than that of lard.

Wolf et al. (2003) reported higher amounts of feed and water intake for chinchillas fed complete (pelleted) diet, but it has to be noted that the feed composition in our study was apparently different. Thus, neither the feed's quality nor palatability effects on the intake cannot be dismissed. In captive chinchillas nutrition, the quality of the complete dry feed is essential. Poor quality of pelleted feed often implicates digestive disorders and low palatability may cause starvation in chinchillas (unpublished observations).

Early studies on rats showed that the preference for diets with high level of beef tallow (34%) was similar to that for a diet with quite low content of saturated animal fat (5%) and significantly lower than that for a corn oil (Mullen and Martin 1990). These results were attributed to the chemical composition of fats added, suggesting differential alterations in membrane composition and cellular function possibly occurring in central nervous system (e.g. brain).

One plausible explanation of the reversed relation between feed and water consumption in both experimental groups can be of a behavioral type. Possibly, increased water drinking compensated the decrease in feed ingestion as it was proposed by Wolf et al. (2008). Considering numerous reports on strong preference for diets supplemented with saturated/solid fats in rats, the claim that the addition of linseed oil decreased the palatability of feed in chinchillas is justifiable (Mullen and Martin 1990, Wang et al. 2011).

The addition of linseed oil significantly increased water intake in chinchillas, compared to C and AF groups. However, our results are more similar to those recorded for animals fed diet mixed of native components (Wolf et al. 2003). Interestingly, chinchillas fed hay-only and complete feed diets showed substantially higher water intake. The most striking difference was an enormously high water consumption reported for chinchillas fed fresh grass. To our knowledge it is extremely unusual to offer fresh forage (grass) for captive chinchillas. The extensive feeding of greens and fresh fruits to chinchillas was reported a cause of bloat, serious digestive system disease (Richardson 2003). Therefore there is a need for a gradual and sparingly serving of fresh feedstuffs in chinchillas.

The rearing conditions like temperature and humidity are crucial not only for the well-being but also for the reproduction of chinchillas (Richardson 2003, Busso et al. 2012). Since such data are missing in Wolf et al. (2003) paper, the conception that above mentioned discrepancies occurred due to the effect of environmental factors cannot be dismissed.

There were no significant differences in the amount of excreted feces observed in our study but the volume of urea in VF group was significantly higher than that in control, which likely reflects the increased intake of water (Table 3).

The DM digestibility coefficients of all diets were similar (Table 4). Our results confirmed that feeds with high DM content are relatively well digested by chinchillas. Compared to other small rodent species, only guinea-pigs show similarly high rate of DM digestion as chinchillas – 70.9 *vs.* 71.13 respectively (Sakaguchi et al. 1987). However, higher ADC values were recently reported for greater cane rat, related to chinchillas as well as to guinea-pigs (van Zyl and Delport 2010). It was suggested that the coprophagy significantly contributed to cane rats ability to utilize high fibrous food. Although in our study we did not measure coprophagy, it's impact on ADC in chinchillas cannot be dismissed, regardless of dietary fat level or source.

In the present study we did not observe significant differences in OM digestibility between groups. Overall value of ADC for OM in chinchillas resembled that, reported for rabbits fed diets with the intermediate level of fibre (Gidenne et al. 2000). Interestingly, Sakaguchi et al. (1987) described lower OM digestibility in guinea-pigs, rabbits, rats and hamsters fed diet containing different levels of CP and CF than those used in

TABLE 3. Daily feed and water consumption with feces and urine excretion (g)

Item	C		VF		AF	
Feed intake	22.95	±1.95[a]	21.35	±1.99[b]	23.04	±3.65
Feces excretion	11.30	±3.70	10.81	±2.31	11.71	±2.86
Water intake	21.67	±4.50[a]	26.90	±8.44[b]	21.50	±6.62
Urea excretion	12.33	±4.48 [a]	17.57	±6.56[b]	13.31	±5.51

a–b – difference significant at $p < 0.05$.
C – control group; VF – vegetable fat group; AF – animal fat group.

TABLE 4. ADC of nutrients (%)

Item	C		VF		AF	
DM	71.13	±4.87	71.02	±2.86	71.20	±2.65
OM	73.79	±4.60	74.01	±2.54	73.91	±2.38
CP	71.18	±9.87	70.85	±7.22	69.49	±6.59
CF	37.55	±9.58	32.87	±6.14	33.56	±5.80
NFE	80.38	±2.70	79.68	±1.45	80.08	±1.77
EE	84.51	±5.19[a]	91.66	±1.96[b]	90.80	±1.55[b]

a–b – difference significant at $p < 0.05$.
C – control group; VF – vegetable fat group; AF – animal fat group; DM – dry matter; OM – organic matter; CP – crude protein; CF – crude fibre; NFE – nitrogen-free extract; EE – ether extract.

our study (196 and 126 *vs.* 175 and 120 g per 1 kg of CP/CF, respectively). On the other hand, in guinea-pigs and rabbits fed hay only diet – 72 g per 1 kg of CP (Franz et al. 2011), the digestibility of OM was even lower than observed in chinchillas. Therefore it seems reasonable to elucidate the differences in OM digestion in chinchillas with the effect of the dietary CP level, a dependency confirmed by Rogier (1971).

The dietary addition of fat did not alter the CP digestibility. Interestingly, the ADC for protein previously reported for other rodent species (rat, hamster) was substantially higher (Sakaguchi et al. 1987). However, our results are in accordance with those reported by Rogier (1971), suggesting that typical CP digestibility in chinchillas, regardless of coprophagy level, is about 70%.

The digestibility of CF was lower in experimental groups as compared to control. This effect can be most likely attributed to the detrimental effect of high fat diet on the number of cellulolytic bacteria, previously reported for ruminants as well as for non-ruminants (Doreau and Chiliard 1997).

Differences in NFE digestion, observed in our study, were negligible. The apparent digestion of NFE in chinchillas was similar to that, recorded for guinea-pigs and other non-ruminant species (horses, ponies and rabbits) fed alfalfa-grain diet in digestibility comparison trial (Slade and Hintz 1969).

The significant effect of dietary fat addition on digestibility was found in EE. Chinchillas in both experimental groups digested EE more effectively than those in control. Noticeably, the animals in VF and AF groups revealed similar EE digestive efficiency, regardless of the type of added fat (Table 4). It seems likely that the the heating of lard just before adding it to the feed, made it more accessible to the digestive enzymes, therefore improving its absorption (Wang et al. 2011).

CONCLUSIONS

The study showed that the addition of fat to chinchilla diet had a moderate effect on the apparent digestion of most of the constituents. Taken together with the feed intake results it may be suggested, that the differences in chemical composition of dietary fats may contribute to their effects on diet preference and consequently have an influence on the intake of protein and carbohydrates in chinchillas.

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Streszczenie: *Wpływ dodatku tłuszczu na strawność paszy u szynszyli.* Celem badań było określenie wpływu dodatku tłuszczu roślinnego i zwierzęcego na współczynnik strawności pozornej u szynszyli. 18 młodych osobników przyporządkowano do trzech grup żywieniowych, które otrzymywały paszę podstawową (grupa kontrolna) bądź wzbogaconą o dodatek oleju lnianego (VF) lub łoju (AF). Poziom strawności pozornej (ADC) oznaczono dla suchej masy (DM), materii organicznej (OM), białka surowego (CP), włókna surowego (CF), związków bezazotowych wyciągowych (NFE) oraz ekstraktu eterowego (EE). Wykazano brak istotnych różnic w wynikach oceny strawności pomiędzy grupami, z wyjątkiem EE.

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