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Determination of fat preferences of adult dogs

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Abstract: This study was carried out to determine the preferences of dogs for some commonly used fat sources in dog food. Three different types of food were produced using 5% additional sunflower oil, poultry fat, or beef tallow. The food was extruded using a twin-screw extruder at approximately 25% moisture and temperatures in the range of 90 °C to 135 °C. The extrudates were dried for 30–45 min at temperatures of up to 148 °C in a belt dryer. Next, the heated fats were sprayed onto the extrudates. The foods were cooled, sampled, and packaged. A total of 30 neutered adult (between 1 and 3 years old) male dogs were used. The preference of the dogs for the 3 different fat sources was determined via a 2-pan preference test. Preference tests were conducted for 12 days in pairs, and the dogs consumed each food for 8 days. The dogs had the greatest preference for food containing the additional sunflower oil, with a preference rate of 56%. Beef tallow was the least preferred fat, with a preference rate of 44%. Dogs preferred food containing sunflower oil more than food containing animal fats. It was concluded that dogs showed a preference in proportion to the linoleic acid level in each food.

Key words: Dog food, fat source, preference, palatability

1. Introduction

It is recognized that fat adds palatability and acceptable textures to food. This is obviously a critical function because no pet food, regardless of how well-formulated it is, can be nutritious if it is not eaten. Improved flavor can even cause excessive consumption of food. Fat provides essential fatty acids as well as energy, and is necessary for the supply of fat-soluble vitamins. At least 5.5%–8.5% fat should be found in the dry matter of adult dog diets [1–3].

Domestic dogs may consume both animal and vegetable oils. Corn, sunflower, safflower, and soy oils are mostly used as vegetable oil, and mammalian and poultry fats are mostly used as animal fat in dog foods. Sunflower oil is very rich in linoleic acid, whereas flaxseed and fish oils are used as sources of omega-3 fatty acid. The meat products used in dog food provide significant fat as well as protein [2]. Beef tallow, primarily composed of saturated and monounsaturated fatty acids, is one of the most palatable fats for dogs. Dogs may consume large amounts of tallow without it imposing a health risk. Hence, although tallow is considered an unhealthy fat for humans, it is merely facilitative for dogs [4]. However, the use of beef tallow alone is not suitable due to its low linoleic acid content; therefore, it is recommended to combine beef tallow with a vegetable oil [1].

There is a clear need to enhance our understanding of the most robust techniques to evaluate preference, and thereby discern whether or not dogs truly like a food product. This notion of liking it is important, because we often try to entice dogs to eat foods that differ substantially from their native foods. In addition, dog owners must be convinced that their pet relishes the food or they may discontinue purchasing it. Therefore, some techniques have been developed to monitor the behavior of pets during a meal to discern whether they like a food, or have a preference for one food over another [5].

An important factor in the selection of food is its acceptance by the dog. This can be determined by different methods. Consumption amounts are recorded by feeding the food for a certain period. The animal's smelling, eating behavior, eating times can be monitored. Preference or palatability testing is a widely used method of choice for dog food. During preference tests, 2 foods are placed in front of the animal at the same time and in equal amounts. After a certain period of time, the amount of remaining food in the two pans is measured and the preference rate is calculated [6–8]. However, a sufficient sample size of dogs should be used in the test, with sample sizes of 20 dogs [9] and 30 dogs [10] reported in previous studies.

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In the preference test, which is also called the 2-pan palatability test, the amount of food to be given to a dog was determined by the amount of food eaten daily. On day 2 of feeding, the foods were placed in different places to avoid choice based on the place of the pan. The consumption of each food is registered and the rates are calculated. The preference is calculated from the consumption amounts of the control and test food [7,9].

The literature comprises only 1 experimental study regarding the fat preferences of dogs [11]. Fat is an important component that contributes flavor to dog foods. Therefore, in the present study, it was aimed to determine which of 3 major sources of fat (sunflower oil, poultry fat, or beef tallow) were preferred by dogs.

2. Materials and methods

2.1. Experimental diets

At a private plant in Ankara, 3 different extruded foods were manufactured. The dietary ingredients were identical except for the source of fat, which was either sunflower oil, poultry fat, or beef tallow. Sunflower oil was purchased from a supermarket. Animal fats were obtained fresh from rendering plants and did not contain antioxidants. The ingredients and nutrient composition of the diets are provided in Table 1. All of the intact ingredients were ground using a hammer mill with screen size of 0.4 mm and mixed for 15–20 min in a horizontal paddle mixer. At the conditioner phase, water was added to obtain a content of 250 g moisture/kg diet. Diets were extruded at a maximum temperature of 135 °C on a corotating twin-screw extruder with a die size of 6 mm. After extrusion, the wet diets were dried at gradually increasing temperatures, with a maximum temperature of 148 °C for 30–45 min in the belt dryer. Finally, 5% hot sunflower oil, poultry fat, or beef tallow was sprayed onto the food. Animal fats were heated (55 °C) using a gas-powered heater prior to spraying to enhance permeation properties. The foods were cooled to room temperature and placed into air-permeable feed bags.

Approximately 500 g of sample was taken from each of the 3 foods for chemical analysis and the samples were ground to pass through a 1-mm sieve. All of the samples were stored in air-tight plastic containers at 4 °C before and during the analysis.

2.2. Animals and management

A total of 30 healthy, neutered adult male dogs of unknown breed, aged between 1 and 3 years old, with an average body weight of 24.7 ± 1.03 kg were used. The dogs were obtained from the local animal shelter. They were weighed, and internal and external antiparasitic drugs were administered, and they were then placed into their housing pens. The research was carried out with the

Table 1. Composition of the diets containing different fat sources (%).

Ingredient	Sunflower oil	Poultry fat	Beef tallow
Poultry meal	16.00	16.00	16.00
Barley	15.00	15.00	15.00
Corn	26.60	26.60	26.60
Corn gluten meal	11.50	11.50	11.50
Corn starch	8.00	8.00	8.00
Rice	15.00	15.00	15.00
Whey	2.00	2.00	2.00
Poultry fat	-	5.00	-
Sunflower oil	5.00	-	-
Beef tallow	-	-	5.00
Vitamin-mineral premix*	0.90	0.90	0.90
Calculated nutrients in 100 g DM			
Crude protein, g	23.66	24.08	23.80
Crude fiber, g	2.52	2.57	2.53
Linoleic acid, g	2.87	1.41	0.77

*: Provided per kilogram of diet, vitamin A: 67021 IU, vitamin D: 670 IU, vitamin E: 33 IU, thiamine: 8 mg, riboflavin: 8 mg, pyridoxine: 2 mg, pantothenic acid: 8 mg, vitamin B_{12}: 17 µg, choline: 229 mg, Ca: 43 mg, P: 230 mg, Mg: 7 mg, Na: 97 mg, K: 1647 mg, Cl: 1367 mg, Fe: 4.92 mg, Cu: 0.82 mg, Zn: 32 mg, Mn: 1.97 mg, I: 1.13 mg, Se: 32 µg.

approval of the local ethics committee (No: 2014/53) at the Dog Research Unit of the Veterinary Faculty.

The dogs were individually housed in a pen consisting of a 190 × 190-cm indoor area and a 510 × 230-cm outdoor area with concrete floors. Each animal had 2 identical 96-oz stainless steel metal feeding pans. The dogs were fed an extruded diet containing equal amounts of sunflower oil and beef tallow for 3 months before the experiment began. A week before the preference test, they were fed the same diet ad libitum to determine how much the dogs could eat per day.

2.3. Nutrient analysis

Dry matter, ash, crude protein, ether extract, and crude fiber analyses were performed using the methods of the AOAC [12]. The foods were analyzed for starch using the method of TS ISO 6493 [13]. The results of the analysis were then used to calculate the metabolic energies of the foods using the equations of the NRC [1] (Table 2).

2.4. Preference test

This experiment was designed as a 2-pan, free-choice test, which is the most common palatability test in the pet food industry [6,7]. In this method, 2 foods can be compared at the same time. Since there were 3 foods in this study, the foods were compared 2 by 2. Equal feeding times were set for each food. The placement of the pans was alternated each day to eliminate any bowl-placement bias by the dogs. Each dog was provided with the 3 preference test foods (sunflower oil vs. poultry fat, sunflower oil vs. beef tallow, and poultry fat vs. beef tallow). All of the tests were performed consecutively. Each dog was fed each food 4 times during each test, for a total of 8 times. Thus, the dogs ate each food for 8 days (Figure 1).

The amount of food that would meet the daily energy needs of adult and normal-activity dogs was estimated as approximately 250–450 g [1]. However, to determine their preferences clearly, each dog was offered 500 g of each food as a meal at the same time each morning. Of the dogs, 3 were more active and gourmand, and therefore required more food, so they were offered 750 g of each food. The dogs were taken to the outside areas of their pens while the food pans were placed, and then taken to the inside areas of their pens for the tests. Water was available for consumption ad libitum.

Any food remaining after an hour of the feeding trials was weighed, and consumption was calculated by the difference. To determine the palatability of the food, the consumption rate was calculated using the formula: relative consumption (%) = (food 1 consumption × 100) / (food 1 consumption + food 2 consumption). Dogs with a ratio greater than 0.51 were classified as preferring food 1, and dogs with a ratio less than 0.49 were classified as preferring food 2 [9].

2.5. Statistical analyses

ANOVA was performed on the data obtained in the preference test. The significance of the differences between the means was determined using Duncan's multiple range test and SPSS v.22 (IBM Corp., Armonk, NY, USA).

3. Results

Chemical composition of diets is reported in Table 2. All of diets contained similar concentrations of ash, EE, CP, and CF. Starch content was the lowest in the poultry fat diet, presumably due to the sampling. According to the nutrient analysis results, the amounts of fat and energy in the 3 foods were very similar (Table 2). This means that in this study, consumption of the food was not affected by the level of fat or energy within it.

The average daily intake from each of the 3 foods is given in Figure 2. Of the dogs, 3 were larger and more gourmand, so they were offered 750 g of each food, whereas all other the dogs (n = 27) were offered 500 g of each food. Food consumption was significantly affected by the type of fat in the food ($P < 0.05$). Dogs consumed on average 387 g of the food containing sunflower oil, 305 g of the food containing beef tallow, and 342 g of the food containing poultry fat.

4. Discussion

At the end of the preference test, it was determined that the dogs preferred the sunflower oil food (preference score of 56.26%, $P < 0.05$). This means that of the 30 dogs, 21 preferred the sunflower oil. The food containing beef tallow was the least preferred diet (44.96%, 12 of the 30 dogs). Linoleic acid content is the highest in sunflower oil, followed by poultry fat and finally, beef tallow (Table 1). Therefore, the dogs appeared to prefer the source of fat

Table 2. Nutrient analysis results of the foods (% DM).

Food	DM	Ash	EE	CF	CP	Starch	ME, kcal*
Food with sunflower oil	92.33	4.68	6.27	3.35	22.09	51.57	376
Food with poultry fat	92.27	5.09	6.46	3.38	22.97	48.70	375
Food with beef tallow	93.63	4.89	6.37	3.38	22.24	50.85	375

*: Calculated according to the NRC [1] equations.

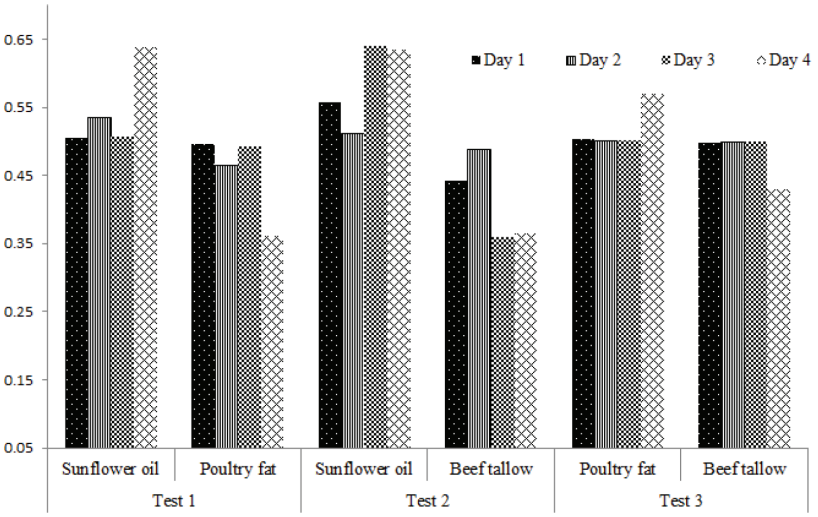

Figure 1. Experimental design of the palatability tests and preference ratios of the fat sources, n = 30

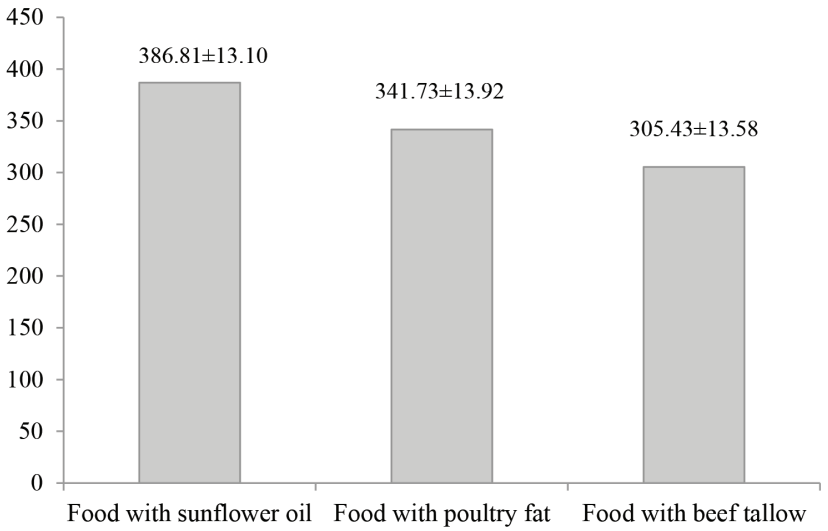

Figure 2. Daily food consumption, g; n = 30.

(sunflower oil) with the highest linoleic acid. Similarly, some studies have reported that linoleic acid was more preferred than saturated fatty acids by mice [14,15]. These results indicated that the palatability of fatty acids is affected by the saturation state of the fatty acid. However, it has also been reported that cats do not show a preference between vegetable oil or bleached tallow [16].

In the 2-pan preference test, the orientation of the dogs in relation to the food pans was taken into account, because the position of the food pans was changed every day to the right and left sides. According to this, 52.2% of the dogs preferred to eat from the right side (P = 0.06). Thus, there were no significant effects of the position of the food pans. In support of this result, Vondran [9] noted that only 5% of the dogs tested in their study showed a preference for the position of the food pans.

Verbrugghe et al. [11] reported that dogs preferred diets containing chicken lard over those containing nonrapid harvested salmon oil. Moreover, it was reported that they preferred animal fats [1]. Contrary to this, vegetable oil was preferred in the current study. The sunflower oil used in this study was purchased from the market and was meant for human consumption. Sunflower oil is cheaper than other vegetable oils in Turkey. There were no antioxidants in the vegetable oil or animal fats used in this study. Antioxidants added to oils for protective purposes may change the flavors and result in changes in the preferences of dogs.

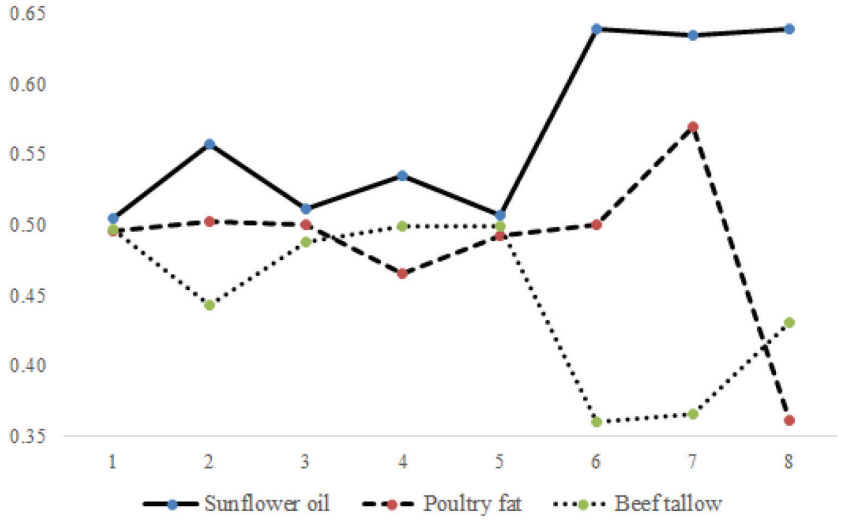

Figure 3. Preference ratios of fat sources that are given 8 times, n = 30.

It has been demonstrated that sunflower oil or poultry fat can be used as the only fat source in adult dog food. However, when beef tallow alone was used, the requirement for 1.32% of linoleic acid [3] of adult dogs could not be met. In this study, the level of linoleic acid was calculated as 0.77% in the food with beef tallow, which may lead to problems for the dogs, especially regarding skin and coat health over the long term. In addition, the immune system can be negatively affected [2].

After 4–5 days, the food preferences of the dogs tended to change (Figure 3). The preference for sunflower oil increased markedly from the sixth feeding trial onwards. In contrast, the preference for beef tallow significantly decreased during the same period. This suggests that a 4-day preference trial may not be sufficient in the 2-pan preference test. It was reported that palatability is determined by the flavor of the food and the animals' perception of its appearance, temperature, size, texture, and consistency, and perhaps prior experiences [5]. Consequently, it was concluded that increasing the number of days will improve the reliability of the test.

The results of the present study demonstrated that dogs showed a preference in proportion to the linoleic acid level in each food. Additional research on the contribution of linoleic acid or other fatty acids to palatability for dogs is necessary.

Acknowledgments

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