High palatability for dogs and domestic cats of sliced Katsuobushi (smoked-dried bonito) and other dried treats

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Under the belief that feeding dogs and cats reflects the guardians family's dietary habits, we evaluated the palatability of sliced smoked-dried bonito, sliced low-salt smoked-dried bonito, sliced smoked-dried bonito 'fermented', sliced smoked-dried tuna, sliced low-salt smoked-dried tuna, a mixture of sliced dried chicken and sliced smoked-dried bonito, a mixture of sliced dried sardine and sliced smoked-dried bonito, and low-salt dried sardine for 100 dogs and 100 cats. Results indicated that 92–99 dogs and 89–93 cats voluntarily consumed each product. When these products were sprinkled on dog or cat food that the animals had never been fed, the ration of the new foods which the animals took was increased. Because of the high palatability of these evaluated products, which are preferred by dogs and cats, these dried treats are regarded as able to enrich the guardians' life and satisfaction with companion animals.

Keywords: bonito, cat, dog, Katsuobushi, palatability, pet food, treat.

1. Introduction

Many years ago in Japan, dogs and domestic cats were kept as watchdogs or ratting cats. By contrast, they are usually kept as members of their guardian's family in recent years. Therefore, the animals are now not merely pets, but are instead companions for humans. Naturally, such a guardian would want dog or cat foods that seem delicious and healthy for the guardians' animals. Dog or cat foods (including treats) of high palatability for the animals will certainly satisfy the guardians. Feeding dogs and cats must be considered, so to speak, as a part of guardians' dietary habits.

Creation of dog or cat foods with high palatability for animals should be a responsibility of dog-food or cat-food supplying manufacturers because those high-quality foods will enrich the guardians' life and satisfaction with companion animals. When developing new foods for dogs and cats, detailed surveys should be conducted to assure their palatability for animals. However, few scientific reports have described studies of the palatability of dog or cat foods. For the present study, we have examined sliced dried bonito and similar dried products to assess their relation to utilization as treats for dogs and cats. Therefore, in the course of their introduction to market, we evaluated the palatability of those products for animals. During this evaluation, a guardians' satisfaction survey was done for palatability. The objective of this study was clarification of the usefulness of those products for dogs and cats and for their guardians.

2. Materials and Methods

2-1 Evaluated products

This study evaluated sliced smoked-dried bonito and seven similar dried products of other kinds: sliced *Katsuobushi* (smoked-dried bonito), sliced low-salt *Katsuobushi* (smoked-dried bonito), sliced *Katsuokarebushi* (smoked-dried bonito 'fermented'), sliced *Magurobushi* (smoked-dried tuna), sliced low-salt *Magurobushi* (smoked-dried tuna), a mixture of

Table 1 Summary of the evaluated products, sliced *Katsuobushi* (smoked-dried bonito) and other dried treats

Trade name	Raw material	Characteristic
'Katsuo-daisuki'	*Katsuobushi* (smoked-dried bonito)	Sliced *Katsuobushi*
'Genen Katsuo-daisuki'	*Katsuobushi* (smoked-dried bonito)	Sliced low-salt *Katsuobushi*
'Katsuo-daisuki Premium'	*Katsuokarebushi* (smoked-dried bonito 'fermented')	Sliced *Katsuokarebushi*
'Maguro-daisuki'	*Magurobushi* (smoked-dried tuna)	Sliced *Magurobushi*
'Genen Maguro-daisuki'	*Magurobushi* (smoked-dried tuna)	Sliced low-salt *Magurobushi*
'Chikin-daisuki'	*Chikin* (dried chicken) and *Katsuobushi* (smoked-dried bonito)	Mixture of sliced *Chikin* and sliced *Katsuobushi*
'Furikake-daisuki'	*Iwashi Niboshi* (dried sardine) and *Katsuobushi* (smoked-dried bonito)	Mixture of sliced *Iwashi Niboshi* and sliced *Katsuobushi*
'Genen Niboshi-daisuki'	*Katakuchi Iwashi* (dried sardine)	Low-salt *Katakuchi Iwashi*

Table 2 Voluntary consumption of the evaluated products, sliced *Katsuobushi* (smoked-dried bonito) and other dried treats, by dogs

Product*	No. of dogs used	No. of dogs voluntarily consuming the products
Sliced *Katsuobushi*	100	98
Sliced low-salt *Katsuobushi*	100	98
Sliced *Katsuokarebushi*	100	99
Sliced *Magurobushi*	100	97
Sliced low-salt *Magurobushi*	100	97
Mixture of sliced *Chikin* and sliced *Katsuobushi*	100	96
Mixture of sliced *Iwashi Niboshi* and sliced *Katsuobushi*	100	94
Low-salt *Katakuchi Iwashi*	100	92

* Product names are presented based on their characteristics (see Table 1).

Table 3 Voluntary consumption of the evaluated products, sliced *Katsuobushi* (smoked-dried bonito) and other dried treats, by cats

Product*	No. of cats used	No. of cats voluntarily consuming the products
Sliced *Katsuobushi*	100	92
Sliced low-salt *Katsuobushi*	100	91
Sliced *Katsuokarebushi*	100	92
Sliced *Magurobushi*	100	93
Sliced low-salt *Magurobushi*	100	92
Mixture of sliced *Chikin* and sliced *Katsuobushi*	100	89
Mixture of sliced *Iwashi Niboshi* and sliced *Katsuobushi*	100	91
Low-salt *Katakuchi Iwashi*	100	90

* Product names are presented based on their characteristics (see Table 1).

sliced *Chikin* (dried chicken) and sliced *Katsuobushi* (smoked-dried bonito), a mixture of sliced *Iwashi Niboshi* (dried sardine) and sliced *Katsuobushi* (smoked-dried bonito), and low-salt *Katakuchi Iwashi* (dried sardine). All had been manufactured as treats for dogs and cats by Marutomo Co., Ltd., Ehime, Japan. Details of the respective products are presented in Table 1.

2-2 Animals

This study examined 100 dogs and 100 cats, all clinically healthy, kept at common households in Japan, based on agreement with each guardian. The dogs were of various breeds: 4 months – 13 years old; 2.8–32.5 kg body weight; of the 46 females, 34 had been ovariohysterectomized or ovariectomized; of the 54 males, 40 had been orchiectomized. The cats were

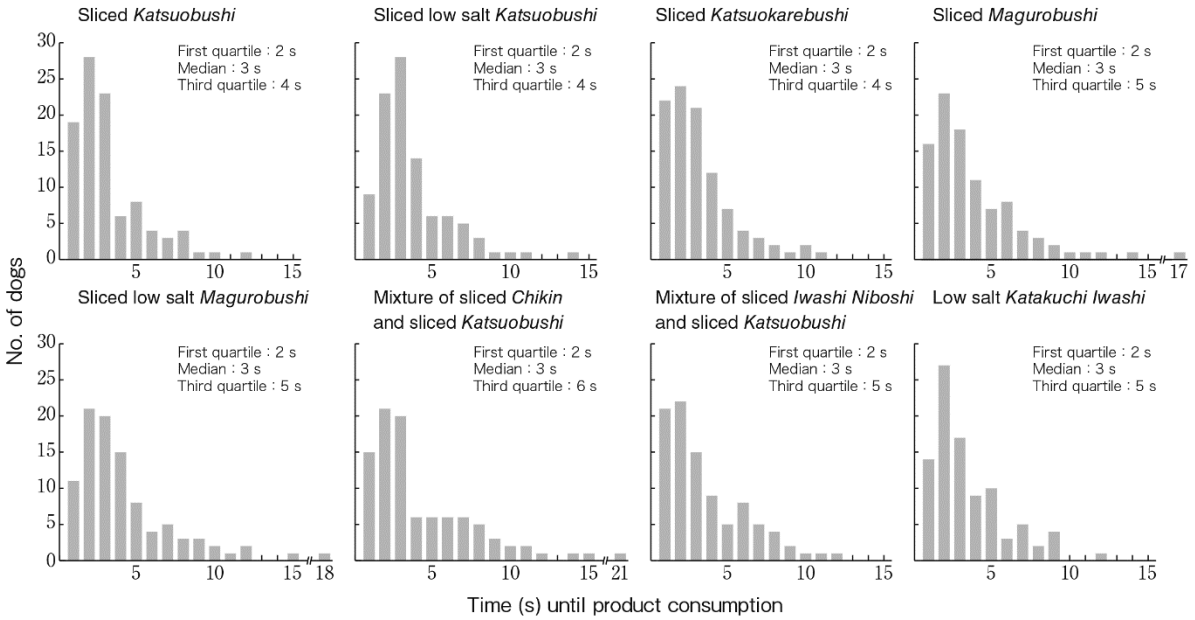

Fig. 1 Frequency distribution of times until voluntary consumption of the sliced *Katsuobushi* (smoked-dried bonito) and other dried treats by dogs

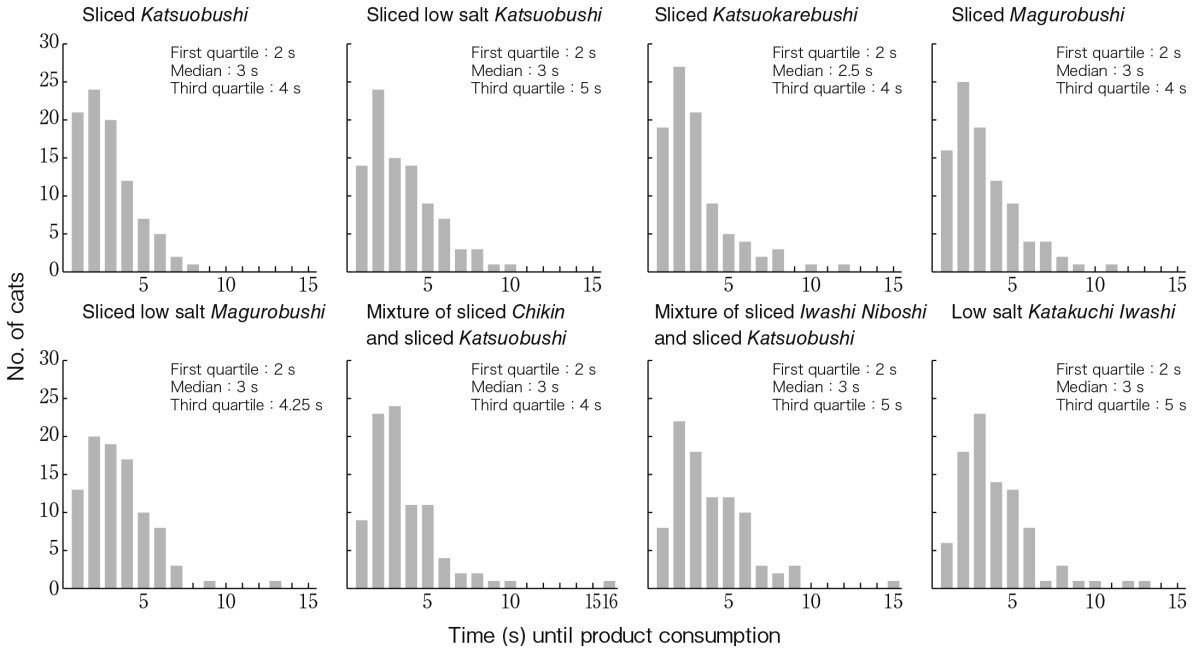

Fig. 2 Frequency distribution of times until voluntary consumption of the sliced *Katsuobushi* (smoked-dried bonito) and other dried treats by cats

of various breeds, but almost all were mongrels: 3 months – 18 years old; 2.1–5.8 kg body weight; of the 41 females, 33 had been ovariohysterectomized or ovariectomized; of the 59 males, 46 had been orchiectomized. Their rearing conditions such as locations and foods were not changed for this study. They were the same as those used typically at their guardian household. No veterinary treatment was administered to dogs and cats during the study period.

Table 4 Summary of dogs that did not voluntarily consume the evaluated products, sliced *Katsuobushi* (smoked-dried bonito) and other dried treats

Breed	Sex*1	Age*2	Body weight (kg)	Consumed or not*3 of the evaluated product*4								Unbalanced diet*5
				A	B	C	D	E	F	G	H	
Dachshund (long-haired miniature)	Female (neutered)	3 y	4.1	○	○	○	○	○	×	×	×	+
Chihuahua	Male (neutered)	2 y	3.7	×	×	○	×	×	×	×	×	+
Poodle (toy)	Male (neutered)	9 m	3.5	○	○	○	○	○	○	×	×	+
Dachshund (long-haired miniature)	Female (neutered)	5 y	4.4	○	○	○	○	○	○	×	×	+
Dachshund (long-haired miniature)	Male (neutered)	2 y	4.5	×	×	×	×	×	×	×	×	+
Poodle (toy)	Female (neutered)	3 y	3.6	○	○	○	×	×	×	×	×	+
Poodle (toy)	Male	1 y	3.1	○	○	○	○	○	○	○	×	−
Chihuahua	Male (neutered)	2 y	3.2	○	○	○	○	○	○	○	×	−

*1 Neutered: ovariohysterectomized or ovariectomized females, orchiectomized males

*2 y, years; m, months

*3 ○, consumed; ×, not consumed

*4 A, Sliced *Katsuobushi*; B, Sliced low-salt *Katsuobushi*; C, Sliced *Katsuokarebushi*; D, Sliced *Magurobushi*; E, Sliced low-salt *Magurobushi*; F, Mixture of sliced *Chikin* and sliced *Katsuobushi*; G, Mixture of sliced *Iwashi Niboshi* and sliced *Katsuobushi*; H, Low-salt *Katakuchi Iwashi*; Product names are presented based on their characteristics (see Table 1).

*5 Based on an interview with the guardian; +, with a tendency to an unbalanced diet; −, without a tendency to an unbalanced diet

2-3 Procedures for evaluating voluntary consumption of the products by dogs and cats

Palatability of the products was evaluated by observing the animals' voluntary consumption of them. Feeding of one of the eight kinds of product was done for the respective animals at 3 hr after feeding of their routine diets. The order of the presentation of the products of eight kinds was assigned randomly using a random number table made by the authors using C language. Eight feedings of the products were done every two days or every three days. At the time of examination, 1 g of the product was presented under the nose of a dog. The time (seconds) until the dog voluntarily took the product was measured. For cases in which the animal did not consume the product within 30 s, the product was judged as 'not consumed'. Furthermore, when the entire amount of the presented product was not swallowed or when a part of the product was expelled by the animal, the product was also judged as 'not consumed', even if the animal had voluntarily ingested the product once.

2-4 Survey of guardian satisfaction with palatability of the product for dogs and cats

A guardians' satisfaction survey was administered to assess the palatability of each product during evaluation of voluntary consumption of the products by dogs and cats. Satisfaction was recorded by the respective guardians for each product as one of the following seven grades: very dissatisfied, reasonably dissatisfied, somewhat dissatisfied, either dissatisfied or satisfied (neutral), somewhat satisfied, reasonably satisfied, very satisfied.

2-5 Procedures for evaluating palatability of a never-fed food on which the products were sprinkled

Each of two kinds of dry-type dog foods (Diets A and B) and cat foods (Diets C and D), none of which had been fed to any of the 100 dogs and the 100 cats, were fed, respectively, at 6 hr after feeding of their routine diets. These foods were so-called therapeutic diets manufactured for control of dogs' and cats' body weight. For the study, 10 g of the newly fed food was placed on a food dish of the animal. Observers noted whether it was consumed voluntarily within 30 s or not. After this preparatory study, one of the evaluated eight products was sprinkled to the new food and was presented to each animal at 6 hr after feeding of their routine diet. The amount of the topping material and the new food were, respectively, 1 g and 10 g. The order of using the new foods was determined randomly using a random number table made by the authors using C language. In the trial with each new food, the order of the eight kinds of the evaluated products was

Table 5 Summary of cats that did not voluntarily consume the evaluated products, sliced *Katsuobushi* (smoked-dried bonito) and other dried treats

Breed	Sex*1	Age*2	Body weight (kg)	Consumed or not*3 of the evaluated product*4								Unbalanced diet*5
				A	B	C	D	E	F	G	H	
Mongrel	Female (neutered)	3 y	4.2	○	○	○	○	○	○	×	○	−
Mongrel	Male	1 y	3.1	×	×	×	×	×	×	×	×	+
Mongrel	Male (neutered)	12 y	5.6	×	×	×	○	×	×	○	○	+
Mongrel	Male (neutered)	8 y	4.8	×	×	×	×	×	×	×	×	+
Mongrel	Female (neutered)	15 y	3.9	×	×	×	×	○	○	○	○	+
Mongrel	Male (neutered)	6 y	5.3	○	○	○	○	○	○	×	×	+
Mongrel	Female	10 m	2.8	×	×	×	×	×	×	○	○	+
Mongrel	Male (neutered)	7 y	3.5	○	○	○	○	○	○	×	○	+
Scottish Fold	Female (neutered)	11 y	4.5	×	×	×	○	○	×	×	×	+
Mongrel	Female (neutered)	6 y	3.9	×	○	×	×	○	×	×	×	+
Mongrel	Male	7 m	3.8	○	○	○	○	○	×	○	○	+
Mongrel	Male (neutered)	15 y	5.6	×	×	○	×	○	×	○	○	+
Munchkin	Male (neutered)	4 y	4.3	○	○	○	○	×	○	○	×	−
Mongrel	Male (neutered)	3 y	4.4	○	○	○	○	○	○	×	×	+
Mongrel	Male (neutered)	2 y	4.7	○	○	○	○	○	×	○	○	−
Mongrel	Female	8 m	2.7	○	×	×	×	×	○	○	×	+
Mongrel	Female (neutered)	3 y	3.1	○	○	○	○	×	×	○	○	+
Mongrel	Male	1 y	3.4	○	×	○	○	○	○	○	○	−
Mongrel	Male (neutered)	8 y	5.2	○	○	○	○	○	○	×	○	−
Mongrel	Female (neutered)	5 y	4.9	○	○	○	○	○	○	○	×	+
Mongrel	Female (neutered)	4 y	5.0	○	○	○	○	×	×	○	○	+
Mongrel	Male (neutered)	3 y	4.5	○	○	○	○	○	○	○	×	−

*1 Neutered: ovariohysterectomized or ovariectomized females, orchiectomized males

*2 y, years; m, months

*3 ○, consumed; ×, not consumed

*4 A, Sliced *Katsuobushi*; B, Sliced low-salt *Katsuobushi*; C, Sliced *Katsuokarebushi*; D, Sliced *Magurobushi*; E, Sliced low-salt *Magurobushi*; F, Mixture of sliced *Chikin* and sliced *Katsuobushi*; G, Mixture of sliced *Iwashi Niboshi* and sliced *Katsuobushi*; H, Low-salt *Katakuchi Iwashi*; Product names are presented based on their characteristics (see Table 1).

*5 Based on an interview with the guardian; ＋, with a tendency to an unbalanced diet; －, without a tendency to an unbalanced diet

the same as in the first study for each animal. The interval of evaluations for eight products was one or two days.

2-6 Observation of adverse events

General findings of the dogs and cats were observed carefully and circumstantially by each guardian during the day of product feeding and the following day to note any adverse event in either of the two studies.

2-7 Ethics

Dogs and cats were all treated with due consideration of animal welfare during the study period based on the “Regulations for Animal Experimentation at the General Incorporated Association, Katsuragi Institute of Life Sciences” (the first and second authors’ former affiliation) under approval by the Institutional Animal Care and Use Committee.

3. Results

3-1 Voluntary consumption of the products by dogs and cats

The numbers of dogs and cats that had consumed the eight products voluntarily differed slightly among the products. They were 92–99 in dogs and 89–93 in cats for each product (Tables 2 and 3). All the animals were confirmed to have eaten the entire amount of the presented products completely when they had once taken the product in the mouth. The times until the animals voluntarily took the products were within 1 s in the shortest cases, both of dogs and cats, for either product. Almost all animals took the products in a few seconds. The median time until consumption was 3 s

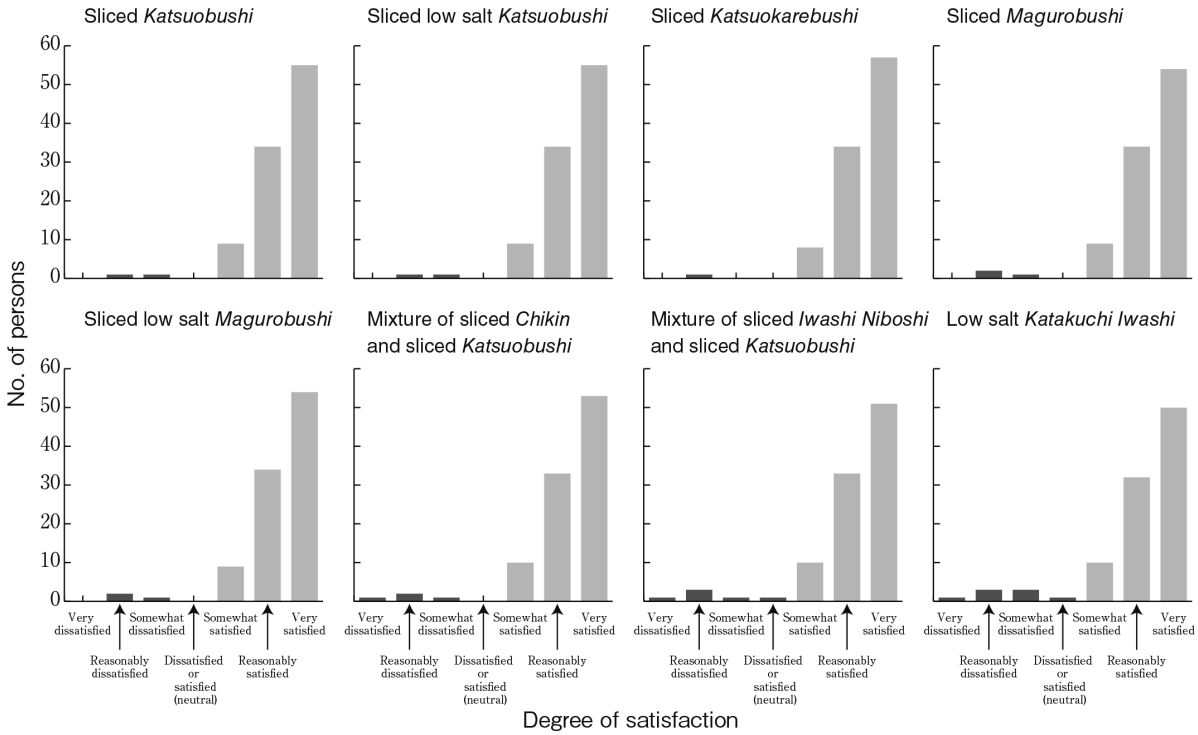

Fig. 3. Distribution of satisfaction of dog guardians for the sliced *Katsuobushi* (smoked-dried bonito) and other dried treats

: Guardians whose dogs voluntarily consumed the evaluated product

: Guardians whose dogs did not voluntarily consume the evaluated product

for all products in dogs and 2.5–3 s in cats. A small minority of the animals, however, required much more time, such as around 20 s (Figs. 1 and 2). Eight dogs and 22 cats did not consume any product voluntarily. Interviews with the guardians of these dogs and cats indicated that 6 of the 8 dogs and 16 of the 22 cats showed an unbalanced diet during ordinary feeding and did not accept foods of many varieties (Tables 4 and 5).

3-2 Satisfaction of guardians with palatability of the evaluated product for dogs and cats

All guardians whose animals had consumed the products voluntarily responded that they were “somewhat satisfied”, “reasonably satisfied”, or “very satisfied”. Guardians whose animals did not voluntarily consume the products responded that they were “very dissatisfied”, “reasonably dissatisfied”, “somewhat dissatisfied”, or “either dissatisfied or satisfied (neutral)” (Figs. 3 and 4).

3-3 T Palatability of a never-fed food on which the products were sprinkled for dogs and cats

When new foods which had never been fed to any of the dogs were presented to each of 100 dogs, 94 and 88 dogs voluntarily consumed the two foods (Diet A and Diet B), respectively. Subsequently, when each of the evaluated products was sprinkled on the foods, 94 and 88 dogs that had respectively taken the new foods (Diet A and Diet B) at the preliminary confirmation voluntarily consumed again the entire amount of the presented food. Of the 6 dogs and 12 dogs that had not taken the new foods (Diet A and Diet B), some voluntarily consumed the new food after the evaluated products had been sprinkled (Table 6). Regarding study with cats, the results were almost identical to those obtained from the study with dogs, although the incidences of cats that had voluntarily consumed the newly fed foods were lower than those in dogs, as described hereinafter. When new foods which had never been fed to any of the cats were presented to each of 100 cats, 87 and 81 cats voluntarily consumed

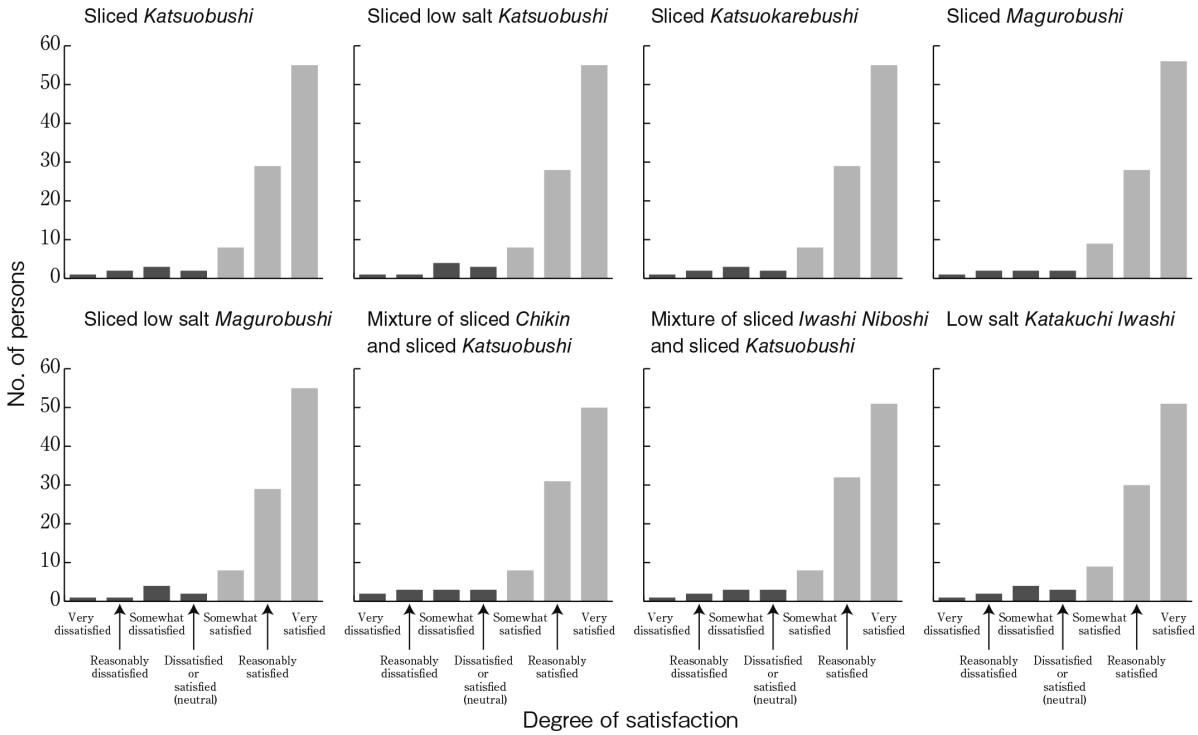

Fig. 4 Distribution of satisfaction of cat guardians for the sliced *Katsuobushi* (smoked-dried bonito) and other dried treats

: Guardians whose cats voluntarily consumed the evaluated product

: Guardians whose cats did not voluntarily consume the evaluated product

the two foods (Diet C and Diet D), respectively. Subsequently, when each of the evaluated products was sprinkled to the foods, 87 and 81 cats that had respectively taken the new foods (Diet C and Diet D) at the preliminary confirmation voluntarily consumed again the entire amounts of the presented food. Of the 13 cats and 19 cats that had not respectively taken the new foods (Diet C and Diet D), some consumed the new food voluntarily after sprinkling of the evaluated products (Table 7).

3-4 Adverse events

Neither dogs nor cats showed any change in activity, appetite, or other general findings. They developed no symptom such as tremor, sialorrhea, vomition, or diarrhea after taking any of the products. The dogs and cats developed no abnormality such as roughening of the hair coat, alopecia, or skin redness.

4. Discussion

Sliced Katsuobushi has been commonly given to dogs and cats, especially to cats, as a part of their staple food or treats in past years in Japan (Hayashidani et al., 1987; Ohshima, 2019). However, in recent years, a concept of complete and balanced diet, which can maintain the health of animals of respective developmental stages as a staple food, has been introduced to companion animal foods. Many guardians have come to purchase the foods commercially, not as home-made, for their dogs and cats. Following this, the frequency of giving Katsuobushi to the animals has decreased as a part of the staple food diet. However, its serviceability as a treat probably persists.

The evaluated dried products are all regarded as showing high palatability for dogs and cats because they were consumed voluntarily by the animals. The short time, around a few seconds, necessary for consumption also supports this inference. Therefore, these products are expected to satisfy an animal's guardian in terms of palatability. In fact, the guardians whose animals voluntarily consumed the products

Table 6 Voluntary consumption of never-fed dog foods for dogs after sprinkling the evaluated products, sliced *Katsuobushi* (smoked-dried bonito) and other dried treats

Products*1 sprinkled to never-fed diets	No. of dogs voluntarily consuming never-fed diets after sprinkled with dried treats			
	Diet A		Diet B	
	Of 94 dogs which voluntarily consumed the diet itself	Of 6 dogs which did not voluntarily consume the diet	Of 88 dogs which voluntarily consumed the diet itself	Of 12 dogs which did not voluntarily consume the diet
Sliced *Katsuobushi*	94	5	88	8
Sliced low-salt *Katsuobushi*	94	5	88	8
Sliced *Katsuokarebushi*	94	5	88	8
Sliced *Magurobushi*	94	4	88	7
Sliced low-salt *Magurobushi*	94	4	88	7
Mixture of sliced *Chikin* and sliced *Katsuobushi*	94	4	88	8
Mixture of sliced *Iwashi Niboshi* and sliced *Katsuobushi*	94	4	88	7
Low-salt *Katakuchi Iwashi*	94	4	88	6

*1 Product names are presented based on their characteristics (see Table 1).
*2 Diet A: Royal Canin Veterinary Diet, 'Canine Satiety Support Dry Dog Food' (Royal Canin Japon, Inc., Tokyo, Japan)
*3 Diet B: Hill's Prescription Diet, 'Metabolic Canine (Dry)' (Hill's-Colgate (Japan) Ltd., Tokyo, Japan)

Table 7 Voluntary consumption of never-fed cat foods for cats after sprinkling the evaluated products, sliced Katsuobushi (smoked-dried bonito) and other dried treats

Products*1 sprinkled on never-fed diets	No. of cats voluntarily consuming never-fed diets after sprinkled with dried treats			
	Diet C*2		Diet D*3	
	Of 87 cats which voluntarily consumed the diet itself	Of 13 cats which did not voluntarily consume the diet	Of 81cats which voluntarily consumed the diet itself	Of 19 cats which did not voluntarily consume the diet
Sliced *Katsuobushi*	87	5	81	7
Sliced low-salt *Katsuobushi*	87	5	81	7
Sliced *Katsuokarebushi*	87	5	81	7
Sliced *Magurobushi*	87	4	81	6
Sliced low-salt *Magurobushi*	87	4	81	6
Mixture of sliced *Chikin* and sliced *Katsuobushi*	87	3	81	5
Mixture of sliced *Iwashi Niboshi* and sliced *Katsuobushi*	87	3	81	5
Low-salt *Katakuchi Iwashi*	87	3	81	3

*1 Product names are presented based on their characteristics (see Table 1).
*2 Diet C: Royal Canin Veterinary Diet, 'Feline Satiety Support Dry Cat Food' (Royal Canin Japon, Inc., Tokyo, Japan)
*3 Diet D: Hill's Prescription Diet, 'Metabolic Feline (Dry)' (Hill's-Colgate (Japan) Ltd., Tokyo, Japan)

responded that they were "satisfied" through the satisfaction survey. It can be reasonably inferred that the products will be useful to enrich the guardians' life and satisfaction through feeding of the animals.

When a never-supplied food was presented to dogs and cats, some of them did not consume the new foods. This is a matter of common occurrence. When the evaluated treat products were sprinkled to the new food, however, some animals that did not consume the new foods came to consume them. Some events have changed the foods for dog or cat for several reasons. Some examples are related to disease therapeutics

(Fujii, 2014, 2016). In these cases, the dried product evaluated here might be the impetus for consuming the new foods.

We propose another use for these products for dogs and cats. These animals normally do not consume orally medicated drugs of their own accord because they cannot understand the meaning of medication for disease treatment. Accordingly, animal drugs are usually administered forcibly or are included in their foods. However, those methods are stressful for both the animals and guardians and are also tiresome. For these reasons, some veterinary drugs have been formulated as so-called chewable drugs, which use excipients of animal or plant-origin and which are intended to be consumed voluntarily by dogs and cats. As the excipient for the chewable formulations, such as beef, chicken and soybean-based materials have been used for several drugs with active ingredients of ivermectin (Fukase and Nakamura, 2017; Nakamura and Fukase, 2017, 2020), milbemycin oxime (Fukase, 2011), moxidectin (Nakamura et al., 2013), afoxolaner (Nakamura and Fukase, 2018), fluralaner (Nakamura and Fukase, 2020), and cefalexin monohydrate (Fukase and Nakamura, 2015). However, fish-based materials have not been used for the excipients. Bonito and other dried materials might be applicable for formulating chewable drugs for animals.

From the present research, we conclude that the sliced Katsuobushi and other related dried treats can be expected to give gratification to dog or cat guardians and to enrich the guardians' dietary life with the animals, in addition to offering possibilities of veterinary medical applications.

Conflict of Interest

Tohru Fukase has received a research grant from Marutomo Co., Ltd. Mikiharu Doi and Jun-ichi Matsumoto are an executive and an employee, respectively, of Marutomo Co., Ltd.

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