Assessment Through a Pet Owner Survey of the Gastrointestinal Tolerance of a New High Protein-Low Carbohydrate Diet Range in Growing Dogs

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ABSTRACT

The digestive tolerance of three commercial diets (Baby Dog Small & Toy, Baby Dog Large & Medium, and Junior Dog Special Large) issued from a new high protein-low carbohydrate diet range, Veterinary HPMTM, was assessed in growing dogs through an online survey administered to 129 pet owners over a 28-day testing period, and was compared to that of the dogs' usual diets. Multiple-choice questionnaires had to be filled out at the beginning of the study, at the end of a 4-day diet transition, and after 7, 14, and 28 days.

About 30% of the enrolled dogs had previously shown a digestive sensitivity with their usual food, mainly manifested as diarrhoea.

In the present study, more than 94% of the pet owners were satisfied with the way the transition to the tested diets had taken place. Volume, consistency, and odour of the stools showed little change when switching diets, and were not significantly different between the different time points for each tested diet. The percentage of dogs with flatulence on days 7, 14, and 28 (except for one diet) significantly decreased compared to day 0.

In conclusion, the three tested Veterinary HPMTM diets enabled a safe diet transition from numerous kinds of canine foods. The tested diets have all shown a high digestive tolerance in various-sized puppies and growing dogs of different breeds.

INTRODUCTION

The usual process of validation of new pet food formulas includes analyses of raw materials and finished products, as well as trials on digestibility, digestive tolerance, and palatability. The Veterinary HPM range (Virbac SA, France) is formulated so that proteins

Table 1 *Recorded parameters for the assessment of dog gastrointestinal tolerance*

	Time of recording				
	D0	**Day 4**	**Day 7**	**Day 14**	**Day 28**
Digestive sensitivity	x				
Previous dietary transition within the last 12 months	x				
Owner's perception about dietary transition between the usual diet and the test diet		x			
Faecal consistency	x	x	x	x	x
Evolution of faecal consistency compared to the usual diet			x	x	x
Stool odour			x	x	x
Evolution of stool odour compared to the usual diet			x	x	x
Stool volume			x	x	x
Evolution of stool volume compared to the usual diet			x	x	x
Flatulence	x		x	x	x

and lipids represent the major sources of energy, with the proportion of carbohydrates kept as limited as possible, in order to match carnivorous needs more closely (Hewson-Hughes et al, 2013). Feeding dogs with High Protein-Low Carbohydrate (HP-LC) diets has been demonstrated to help improve body weight and composition, and glycaemia regulation (Kronfeld et al, 1977; Hill et al, 2001, 2009; Diez et al, 2002; Wakshlag et al, 2003; Blanchard et al, 2004; Prélaud and Harvey, 2006; Roudebush and Schoenherr, 2010; Hewson-Hughes et al, 2011; Chaix et al, 2014).

This new nutritional approach may raise some questions about digestive tolerance (Nery et al, 2010; Goudez et al, 2011) and about the transition from the usual commercial diets to HP-LC diets. Therefore, besides experimental digestibility trials, additional field trials performed at the owners' homes could be a way to better reflect specific sensitivity and allow for adequate testing of diet transition from various qualities of usual diets. Indeed, a higher number of animals from various breeds and ages can be enrolled in such trials. In particular, puppies have higher risks of gastrointestinal problems, due to the immaturity of their digestive system, adoption-related stress, a change in diet, and the higher prevalence of intestinal worm infestations.

The objective of this study was to assess the digestive tolerance of the new Veterinary HPM Baby and Junior Dog diets in client-owned puppies of various breeds, through a questionnaire survey administered to the owners over a 28-day testing period.

MATERIALS AND METHODS

Survey Design

Owners of young dogs selected in a database prepared by an independent company specialised in customer satisfaction research were given the opportunity to participate in an online survey. If they agreed, they had to answer questions at home, using an internet link to a questionnaire, on their animal's digestive sensitivity and gastrointestinal tolerance to its usual diet and to the diet they were asked to test during a 28-day period.

These multiple-choice questionnaires had to be filled out at the beginning of the study (D0), at the end of the 4-day diet transition (D4), and after 7 (D7), 14 (D14), and 28 days (D28). Several parameters were recorded (Table 1) to evaluate the gastrointestinal tolerance of the dog to its usual diet, to the test diet during the transition phase, and to the test diet alone.

For the correct and homogenous assessment of faeces consistency, owners were

Table 2. *Tested diets ingredients and guaranteed analysis*

		BDST
Ingredients		Poultry and pork dehydrated proteins, rice, animal fats, whole pea, potato starch, hydrolysed animal proteins, lignocellulose, beet pulp, fava bean hull, mineral salts, linseed, fish oil, fructo-oligosaccharides, psyllium fibre, yeast beta-glucan, pasteurised *Lactobacillus acidophilus*.
Guaranteed analysis	Moisture*	9
	Proteins*	36
	Animal to vegetable protein ratio	91/09
	Fat*	21
	Minerals*	7.5
	Crude cellulose*	4
	Nitrogen Free Extract*	22.5
	Starch*	19
	Calcium*	1.2
	Phosphorus*	0.9
	Ca/P	1.3
	Measured metabolisable energy (kcal/100g)	396
	Energy from protein (%)	33
	Energy from fat (%)	47
	Energy from NFE (%)	20

** % on a crude matter basis*

asked to use the 1-to-5 scoring standard scale (Fig. 1). Stool odour was assessed by asking the owner to qualify the odour of their dog's stools as very slightly odorous (very acceptable), slightly odorous (acceptable), mildly odorous (slightly acceptable), odorous (slightly bearable), or very odorous (unbearable). It was defined as "globally acceptable" when it was slightly acceptable, acceptable, or very acceptable. Owners were also asked to report if the odour was decreased, unchanged or increased, compared to the odour previously smelled with the usual diet. They had to qualify the volume of the stools as small, normal or large and compare it to the volume previously assessed with the usual diet (ie, decreased, unchanged or increased). When owners declared their dogs had flatulence with the new kibble, they were asked if the frequency of flatulence was higher or lower than with the usual diet.

Test Diets

The test diets were issued from the range of HP-LC Veterinary HPMTM dog foods (Virbac SA, France) dedicated to growing dogs: Baby Dog Small & Toy (BDST), Baby Dog Large & Medium (BDLM), and Junior Dog Special Large (JDL). The tested diets' ingredients and guaranteed analysis are presented in Table 2.

The diets were supplied to the owners in neutral bags with the corresponding feeding table. The daily ration was left at the animal's disposal for one or more meals, according to the pet owner's habits. The transition to the test diet was realised over the first 4 days of the study, by increasing its

Table 2 cont.

BDLM	*JDL*
Poultry and pork dehydrated proteins, rice, animal fats, whole pea, potato starch, hydrolysed animal proteins, lignocellulose, beet pulp, fava bean hull, mineral salts, linseed, fish oil, fructo-oligosaccharides, psyllium fibre, pasteurised *Lactobacillus acidophilus*.	Poultry and pork dehydrated proteins, rice, animal fats, whole pea, potato starch, hydrolysed animal proteins, lignocellulose, beet pulp, fava bean hull, mineral salts, linseed, fish oil, fructo-oligosaccharides, psyllium fibre, chitosan, pasteurised *Lactobacillus acidophilus*, chondroitin sulphate.
9	9
36	36.5
91/09	91/09
21	15
7.5	7.5
4	5.5
22.5	26.5
19	22
1.2	1.1
0.9	0.9
1.3	1.2
396	365
33	37
47	37
20	26

** % on a crude matter basis*

proportion in the usual diet as follows: 25% vs 75% on the first day, 50% vs 50% on the second and third days; 75% vs 25% on the fourth day. From the fifth day of the study onwards, the test diet was the exclusive food.

Animals

The three growth diets tested were exclusively given to weaned puppies and young dogs, from 2 to 14 months old.

All enrolled dogs had to eat a dry diet in the form of kibble on a regular basis. The dogs' usual foods mainly came from specialised distribution channels or mass retailers, more rarely from veterinary practices (Table 3).

The owners of 129 household dogs (32, 36, and 61 thereafter fed with BDST, BDLM, and JDL, respectively) were consulted by way of the questionnaire. Eighty six percent of dogs were pure breed of various sizes. All the characteristics of the tested animals are presented in Table 4.

Analytical Method

Statistical analyses were performed using SAS 9.3. Comparisons of gastrointestinal tolerance parameters between the different time points (D0=usual diet, D7/D14/D28=test diet) for each type of diet (BDST, BDLM and JDL) were performed using likelihood ratio chi-square tests. The mean consistency faecal scores were compared between the different time points for each diet using a linear mixed model with time as fixed effect and subject as random effect. The significant threshold was set at 5%.

Table 3 *Origin of usual food*

	BDST	BDLM	JDL
Total number of dogs	32	36	61
Veterinary practice*	1 (3%)	1 (3%)	5 (8%)
Other specialized distribution channel*†	16 (50%)	16 (44%)	36 (59%)
Mass retailer*	15 (47%)	19 (53%)	20 (33%)

** Number of dogs (percentage)*
† Other specialized distribution channels included pet shops, garden centres, hardware stores, agricultural cooperatives, and internet

RESULTS

Usual Diet

Digestive sensitivity

Thirty-four percent, 28%, and 26% of the owners selected for testing BDST, BDLM, and JDL, respectively, reported that their growing dog was known to have a digestive sensitivity. This sensitivity was usually accompanied by diarrhoea in 100%, 70%, and 75% of the dogs, respectively, and/or by flatulence in 9%, 60%, and 50% of the dogs, respectively.

Faecal consistency

The faecal consistency scores assessed when the dogs were fed with their usual diet are presented in Fig. 2. The great majority of the dogs (91%, 97%, and 93%, respectively) had well-formed stools (faecal scores 1 to 3). The mean faecal consistency scores with the usual diet were very similar in the three groups of dogs (2.4, 2.4, and 2.3, respectively); (Fig. 3).

Flatulence

Flatulence with the usual diet was described in 44%, 72%, and 56% of the dogs selected for testing BDST, BDLM, and JDL, respectively.

Test Diets

The number of available owner appreciations during the course of the study from D4 to D28, varied from 32 to 27 for BDST, 36 to 30 for BDLM, and 58 to 50 for JDL.

Faecal Consistency

From D4 to D28, the rate of dogs with well-formed stools remained steady for the three test diets (Fig. 2). The mean faecal consistency scores remained stable in each group (2.2, 2.5, and 2.5 for BDST, BDLM, and JDL, respectively) throughout the study with no significant differences between the different time points (Fig. 3). For 69 to 84% dogs, owners reported unchanged or increased stool consistency compared to the usual diet (Fig. 4).

Stool Odour

Sixty-eight to 90% of the owners considered that stool odour was globally acceptable when the test diets were administered alone between D7 and D28 (Fig. 5). Stool odour was not significantly different between the different time points (D7, D14, D28) for each test diet. Unchanged or decreased faeces odour was described in 66 to 89 % of the dogs, in comparison to their previous diet (Fig. 6).

Stool Volume

Over 69% of the owners described stool volume as small or normal during the course of the study (Fig. 7). Stool volume was not significantly different between the different time points (D7, D14, D28) for each test diet. Between 67 and 96% of the owners found that the volume of faeces did not change or decreased compared to the usual diet (Fig. 8).

Flatulence

No or less flatulence was observed in 80 to 91% of the dogs fed with BDST, in 74 to 80% of the dogs fed with BDLM, and in 74 to 86% of the dogs fed with JDL (Fig.9). Mostly, the few dogs experiencing flatulence

Table 4 *Testing animal characteristics per test diet*

		BDST	*BDLM*	*JDL*
Total number of dogs		32	36	61
Breed				
N* (%)	Australian shepherd		1 (3%)	3 (4%)
	Ariegeois			2 (3%)
	Beauceron		2 (6%)	6 (10%)
	Belgian Shepherd		2 (6%)	4 (7%)
	Bulldog		1 (3%)	2 (3%)
	Cane Corso		1 (3%)	2 (3%)
	Cavalier King Charles	2 (6%)		
	Chihuahua	5 (16%)		
	Cocker spaniel		3 (8%)	
	Dogo canario			2 (3%)
	German Shepherd			4 (7%)
	German Shorthaired Pointer		2 (6%)	
	Golden Retriever		2 (6%)	10 (16%)
	Jack Russell Terrier	4 (13%)		
	Labrador Retriever		5 (14%)	7 (12%)
	Shih Tzu	2 (6%)		
	Siberian Husky		2 (6%)	2 (3%)
	West Highland White Terrier	2 (6%)		
	Yorkshire	6 (19%)		
	Other breeds†	7 (22%)	8 (22%)	10 (16%)
	Crossbred	4 (13%)	7 (19%)	7 (12%)
Sex				
N* (%)	Female	18 (56%)	13 (36%)	27 (44%)
	Male	14 (44%)	23 (64%)	34 (56%)
Age (months old)				
	Mean (+/- SD‡)	4.06 (+/- 0.85)	4.60 (+/- 1.07)	6.90 (+/- 3.85)
	Minimum	2.00	2.50	2.00
	Maximum	6.00	6.00	14.00
Weight (kg)				
	Mean (+/- SD‡)	2.75 (+/- 1.53)	11.99 (+/- 6.14)	20.30 (+/- 12.11)
	Minimum	0.60	4.00	4.00
	Maximum	6.00	29.00	50.00

** Number of dogs*

† Other breeds, each represented by only one dog for each test diet, included Briquet Griffon Vendeen, Coton de Tulear, Dachshund, Lhasa Apso, Shetland Sheepdog, Tibetan Spaniel, Toy Poodle for BDST, Alaskan Malamute, Border Collie, Dalmatian, Dachshund, Pyrenean Mountain Dog, Rottweiler, Staffordshire Terrier, White Swiss Shepherd for BDLM, and Akita Inu, Basset Hound, Bernese Mountain Dog, Chow-Chow, Doberman, Estrala Mountain Dog, Leonberg, Newfoundland, Samoyed and an unspecified breed for JDL.

‡ Standard deviation

with the test diets had already experienced it with their usual diet.

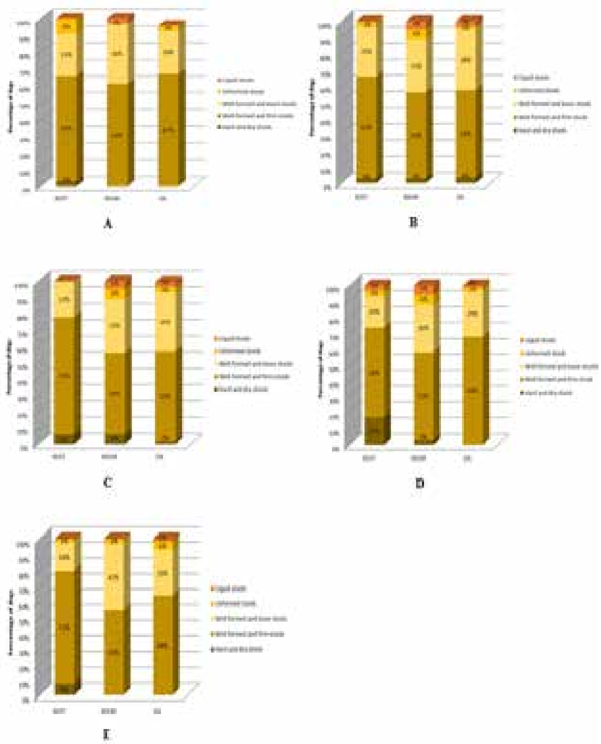
Satisfaction

Ninety-four percent, 97%, and 99% of the pet owners whose dogs were fed with BDST, BDLM, and JDL, respectively, were satisfied with the way the dietary transition had taken place in the present study.

The satisfaction rate and score at the end of the study were 93% (7.5/10), 88% (7.8/10) and 89% (7.6/10) with BDST, BDLM and JDL respectively.

Fig. 1 *1-to-5 scoring standard scale for assessment of faeces quality.*

Fig. 2 *Distribution of fecal consistency scores with the usual diet (A), on day 4 at the end of the dietary transition (B), and on days 7 (C), 14 (D), and 28 (E) with the test diet alone.*



DISCUSSION

The extrusion process has been extensively applied in dry pet food production for several decades. Since this process needs starch in order to obtain the "expanded" texture of kibble, vegetable ingredients rich in starch have assumed increasing importance in pet food formulas. As carnivores, dogs do not produce salivary amylase, but secretion of amylase may be induced to a certain extent in their pancreas and small intestine by adaptation to diets which are rich in starch (Kienzle, 1993). They may experience digestive problems and poor faecal quality when the upper threshold for starch digestion is reached (Goudez et al, 2011). Risks of facilitated weight gain (Rand et al, 2004) and promotion of a pre-diabetic condition (Hewson-Hughes et al, 2011) have been described as other negative consequences of diets with excessively high levels of carbohydrates in carnivores. The FEDIAF Guide (FEDIAF, 2014) includes no reference to carbohydrates, considering that those are non-essential nutrients, and according to the National Research Council's Committee on Animal Nutrition (2006), dogs do not require carbohydrates in their diets, provided they get a sufficient amount of protein. Recent self-selection studies have shown that, when offered the choice,

***Fig. 3** Mean fecal consistency scores with the usual diet (A), on day 4 at the end of the dietary transition (B), and on days 7 (C), 14 (D), and 28 (E) with the test diet alone.*

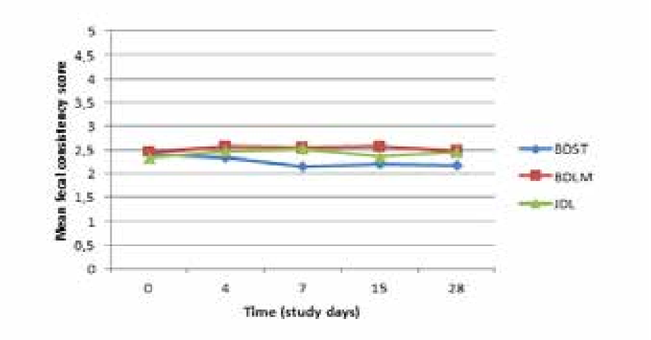
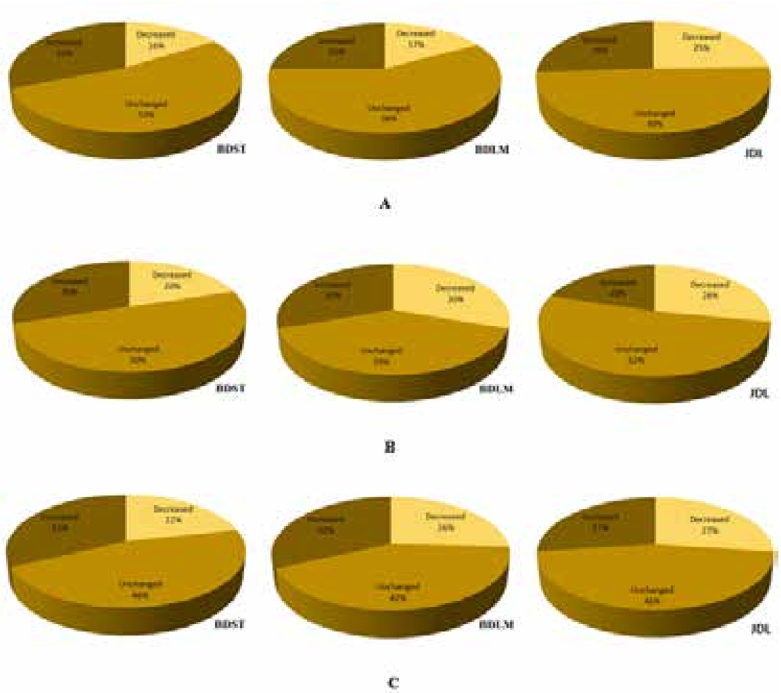


***Fig. 4** Evaluation of fecal consistency on days 7 (A), 14 (B), and 28 (C) with the test diet alone compared to usual diet.*



dogs achieved 30% of their energy from proteins and only 7% from carbohydrates (Hewson-Hughes et al, 2013).

Some studies have shown that digestive tolerance tends to be lower in large-breed puppies: significantly poorer faecal consistency was recorded for large-breed puppies compared to small-breed ones. This could be due to a longer digestive transit time in these breeds. Another explanation would be that the higher colonic bacterial activity in larger puppies may lead to an accumulation of organic acids that could draw water into the lumen of the digestive tract. The higher watery content of the faeces will result in poorer faecal scores (Weber et al, 2002, 2003). One of these studies showed that nutrient utilisation increased up to 21 weeks of age for Medium and Giant Schnauzers as well as for Great Danes and up to 35 weeks for Miniature Poodles.

A number of hypotheses have been advanced to explain this age-related increase in nutrient digestibility, including the larger amounts of food ingested by puppies, changes in small intestine nutrient absorption and in digestive enzyme activities, and/or transit time of food during growth. These results suggest that highly digestible foods are required by puppies in small breeds in order to compensate their relative lower digestive capacity, and in larger breeds in order to reduce the level of carbohydrate and protein colonic fermentation.

Lastly, the simple act of changing dog foods has been associated with gastrointestinal disturbances that can lead to diarrhoea, faecal inconsistency, and/or increased faecal volume, pleading for gradual food adaptations (Goudez et al, 2011; Wakshlag et al,

Fig. 5 *Appreciation of stool odor on days 7 (A), 14 (B), and 28 (C) with the test diet alone.*

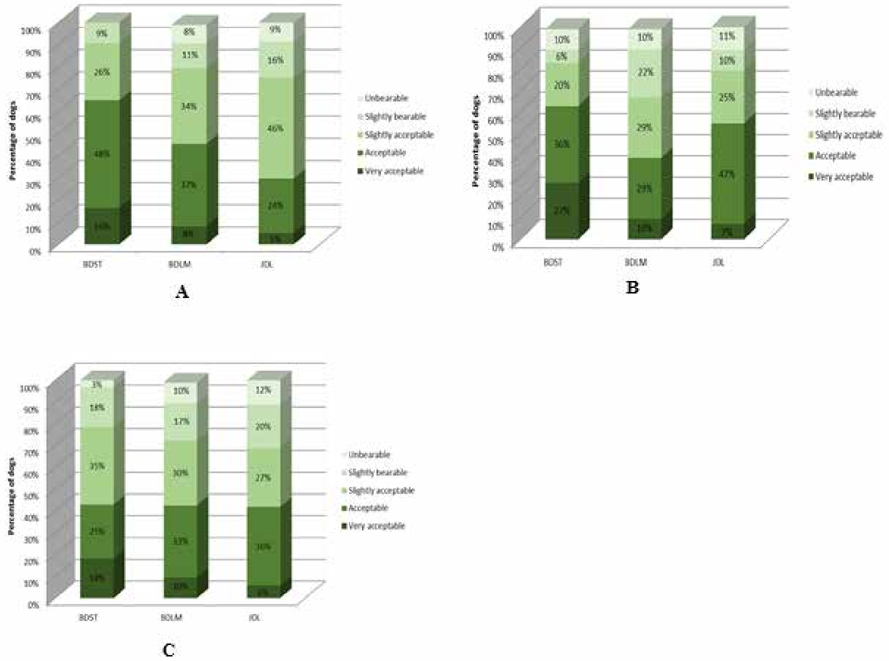


Fig. 6 *Evaluation of stool odor on days 7 (A), 14 (B), and 28 (C) with the test diet alone compared to the usual diet.*

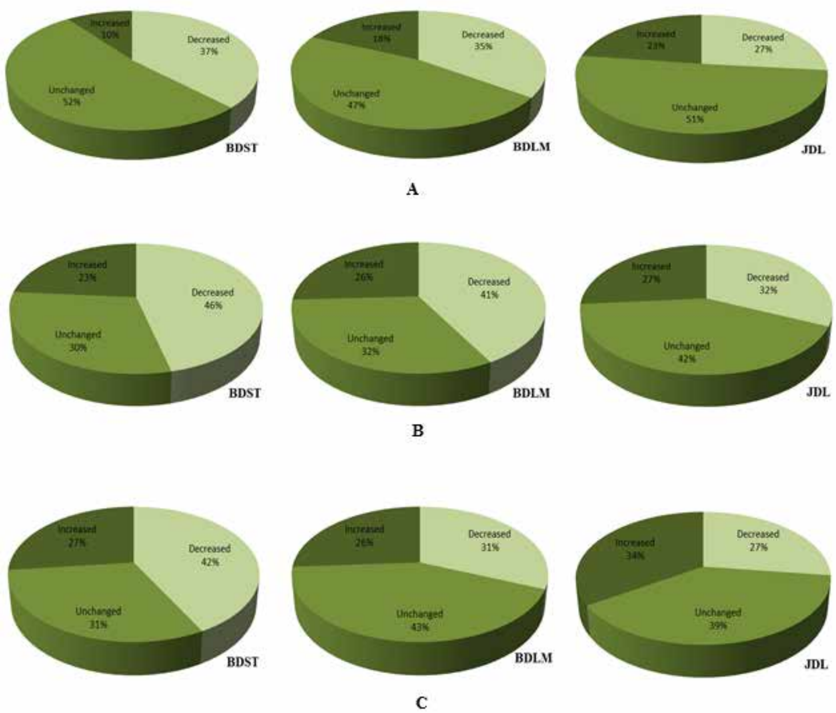


Fig. 7 *Evaluation of stool volume on days 7 (A), on 14 (B), and 28 (C) with the test diet alone.*

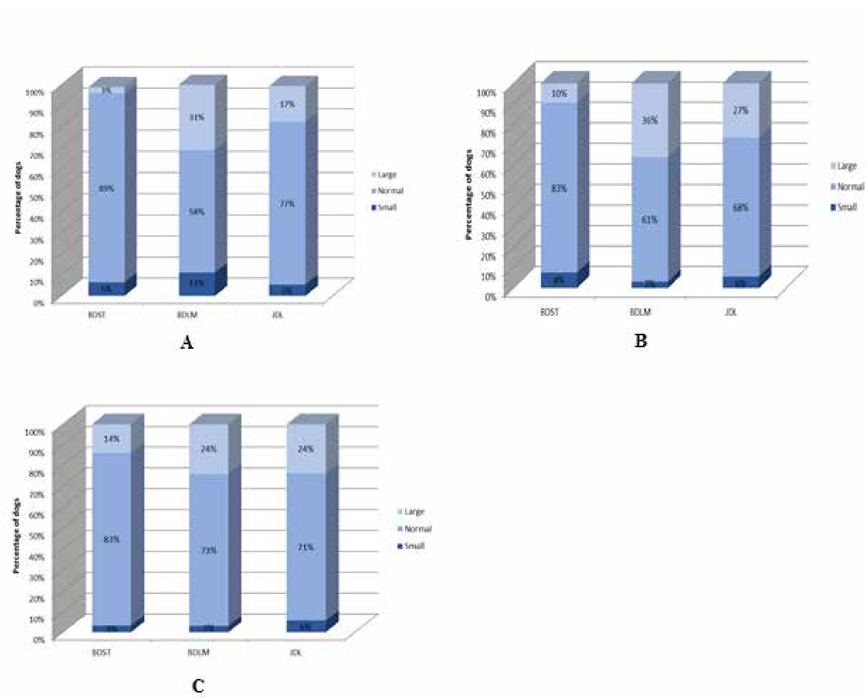


Fig. 8 *Evaluation of stool volume on days 7 (A), 14 (B), and 28 (C) with the test diet alone compared to the usual diet.*

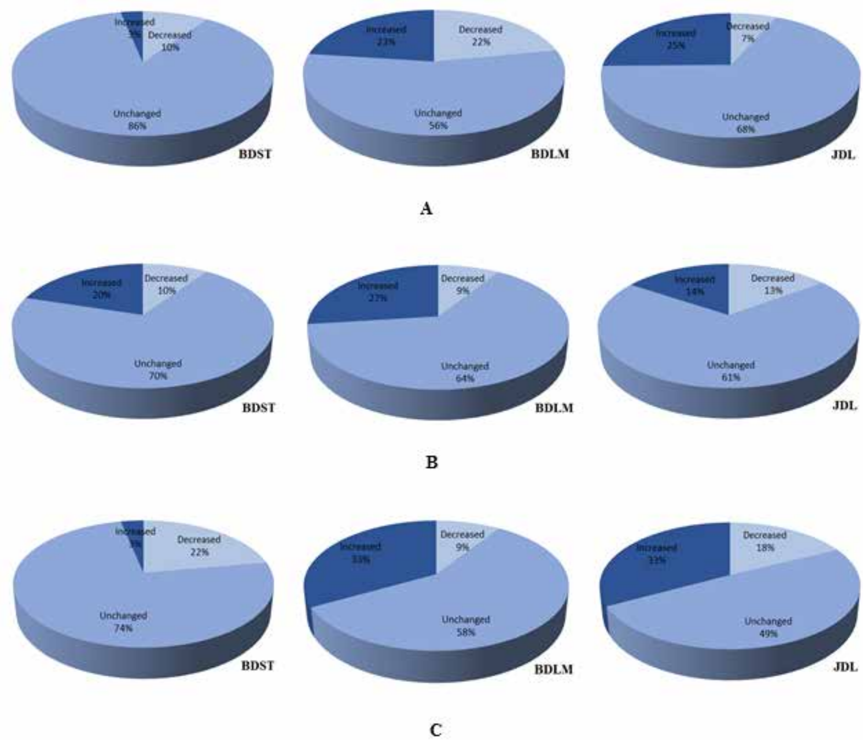
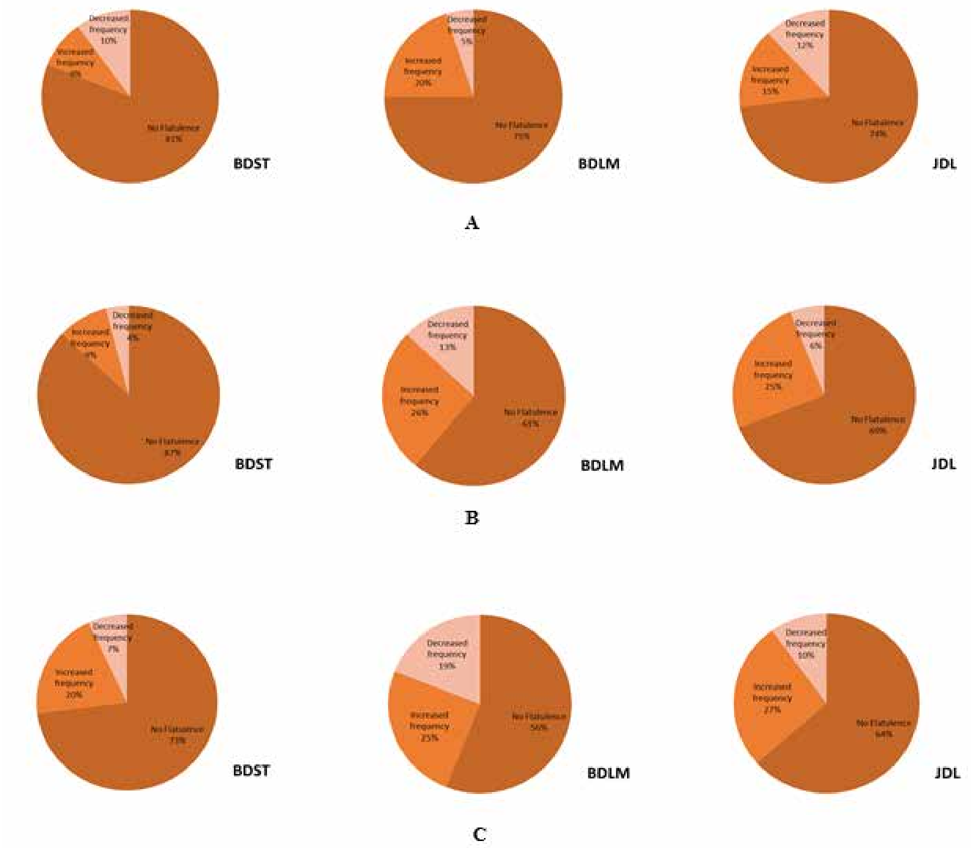


Fig.9 *Frequency of flatulence on days 7 (A), 14 (B), and 28 (C) with the test diet alone compared to the usual diet*



2011). Many variables can affect faecal consistency including the source, amount, and quality of starches and proteins, as well as insoluble and soluble fibre content (Wakshlag et al, 2011).

The Veterinary HPMTM Virbac range has been formulated to maximise digestive safety in all dogs, whatever their breed and age. It was important to test BDST, BDLM, and JDL foods in "real life conditions" in order to collect data on their digestive tolerance in a representative population of puppies and young dogs of various breeds and fed with a great variety of usual foods. The results of the present study showed that at the end of the transition period between the dogs' usual food and the tested foods issued from the Veterinary HPMTM Virbac range, faecal scores remained stable compared to before the start of the study. Thus, the dietary transition from numerous kinds of canine foods to BDST, BDLM, and JDL was demonstrated to be safe. This was confirmed by the high level of owner satisfaction, with more than 94% of them declaring they were pleased with the way the dietary transition had taken place. Afterwards, over the course of the study the dog faecal scores remained stable or were even improved with the tested diets compared to the usual diets, with 69 to 84% of dogs showing unchanged or increased stool consistency. The average stool consistency scores (about 2.5) observed when the dogs were fed exclusively with the tested diets remained very close to the ideal score (i.e. between 2 and 3). Low variations were also observed in stool odour and volume on D7, D14 and D28. As digestive tolerance can be assessed by determining faecal quality (consistency, volume, and odour), it can be concluded that the three tested diets in the present survey have a high digestive tolerance in growing dogs (Nery et al, 2010). The lower incidence of flatulence with the tested diets (in about 20 to 40% of the dogs) than with the usual diets (in about 45 to 70% of the dogs) throughout the course of the study confirms the good digestive tolerance of the tested diets.

One of the limitations of this study is that all the parameters were assessed by the owners, and thus a variability in the assessment of subjective parameters (eg, stool odour) was still possible. Nevertheless, this variability was limited for all the semi-quantitative parameters (eg, increased or decreased stool volume) or when a clear score chart was given (eg, stool chart). All the questions were closed ended questions with a limited number of possible answers, which reduced the subjectivity bias as much as possible.

In summary, over the 24-day period when the test diets were administered alone, the mean consistency scores remained stable at the optimal value of 2.5, faeces odour and volume were unchanged or even improved in the great majority of dogs, and the percentage of dogs having flatulence significantly decreased compared to the usual diet. The three tested commercial diets were demonstrated to have a digestive tolerance in growing dogs equivalent to, or better than, that of the animals' usual diets.

In conclusion, the efficiency of the new formulations of the Veterinary HPMTM Virbac diets in obtaining good digestive tolerance in growing dogs was proven by the results of the present survey.

CONCLUSIONS

HP-LC diets have been shown to be closer to the natural diet of carnivores and to help prevent some health issues (Kronfeld et al, 1977; Reynolds et al, 1999; Hill et al, 2001, 2009; Wakshlag et al, 2003; Hewson-Hughes et al, 2011; Chaix et al, 2014). But these diets have raised the question of faecal quality, and it is well known that growing dogs are prone to digestive issues including loose stools. Diarrhoea or loose stools are very common during diet transitions, and occasionally afterwards as well. In the present study, the Veterinary HPMTM Virbac products were proven to enable a safe diet transition from various kinds of canine foods and to have a high digestive tolerance in various-sized puppies and growing dogs of different breeds.

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