




Relación entre el tipo de alimentación y la formación de barro biliar en caninos

Relationship between the type of diet and the formation of biliary sludge in canines

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Palabras claves:

barro biliar,
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Resumen

Introducción. Existe una amplia gama de alimentos equilibrados disponibles en el mercado, caracterizados por diversas marcas, presentaciones, precios y calidades. Estos alimentos pueden cumplir o no con los requisitos mínimos de nutrición, ejerciendo una notable influencia en el funcionamiento de los órganos, en particular en el sistema digestivo. Entre estos órganos, la vesícula biliar desempeña un papel crucial al llevar a cabo de manera silenciosa funciones como la acumulación, concentración y transporte de la bilis. La alteración en su funcionamiento puede desencadenar la formación de arenillas, las cuales pueden evolucionar hacia la aparición de cálculos o provocar enfermedades como la colecistitis aguda o crónica (hemorrágica), así como la colangiohepatitis, entre otras. **Objetivo.** El objetivo de esta investigación fue analizar la posible relación entre el tipo de alimentación y la formación de barro biliar. Se llevaron a cabo estudios utilizando datos obtenidos a través de exámenes ecográficos realizados en 100 caninos seleccionados de aquellos que asistieron a la clínica veterinaria Pet Wash entre los meses de junio y agosto de 2023. **Metodología.** Utilizando un enfoque cualitativo de naturaleza observacional, transversal y correlacional, se procedió a recopilar información relevante a través de encuestas. Posteriormente, se completaron las hojas de trabajo que contemplaron las variables de interés, tales como la edad, raza, sexo, contextura física, y el tipo de alimentación suministrada a los caninos (ya sea balanceada, casera, mixta o basada en la dieta Barf). Asimismo, se registró el nivel de presencia de barro biliar, clasificándolo en categorías que abarcan desde normal hasta severo o grave. **Resultado.** Los resultados de nuestro estudio revelan que, entre las variables examinadas, el tipo de alimentación presenta un índice de significancia de 0.002. Este hallazgo confirma la hipótesis inicial de que la alimentación guarda una relación directa con la formación de barro biliar. Además, al aplicar el coeficiente V2 de Cramer, se obtuvo un valor de 0.451, indicando una relación moderada entre estas dos variables. Estos resultados respaldan la relevancia de considerar el tipo de alimentación como un factor determinante en la predisposición a la formación de barro biliar en los caninos. **Conclusión.** En conclusión, se determina que, entre los diferentes tipos de alimentación proporcionados a los ejemplares caninos, la

dieta casera, ya sea suministrada de forma individual o en combinación con alimento balanceado y comida preparada, es mayoritariamente responsable (en el 60% de los casos) de la presencia de barro biliar. **Área de la ciencia:** Medicina Veterinaria.

Keywords:

biliary mud,
feeding, canine,
ultrasound,
gallbladder.

Abstract

There is a wide variety of balanced foods, of different brands, presentation, price, quality, which meet or do not meet the minimum nutritional requirements and influence in one way or another the functioning of the organs, specifically the digestive system, including the gallbladder whose silent job is to accumulate, concentrate and transport bile. The alternation of its functioning can generate the formation of grit that leads to stones or diseases such as acute or chronic cholecystitis (hemorrhagic), cholangiohepatitis, etc., therefore, this research aimed to determine whether there is a relationship between the type of diet and the formation of biliary mud, taking the data resulting from the echographic examination of 100 canines selected from among those who attended the Pet Wash veterinary during June and August 2023. Through a qualitative, observational, cross-sectional, correlational, and non-experimental approach, Pertinent information was collected through a survey and then the worksheet was filled with the variables under study: age, race, sex, physical build, type of diet (balanced, homemade, mixed, barf), level of bile sludge (normal, mild, moderate, severe or severe). As a result, it was obtained that, of the variables analyzed, the type of diet has a significance index of 0.002, which confirms the assumption that feeding has a direct relationship in the formation of the bile sludge, in addition, when applying Cramer's coefficient V_2 , a coefficient of 0.451 is obtained, which is equivalent to a moderate relationship between these two variables. It is concluded that, of the types of food of the canine specimens, homemade food, individual or combined (with balanced or prepared food), generates in the majority (60%) the cases of the presence of bile sludge. Science Area: Veterinary Medicine.

Introduction

The dog is a living being that must receive specific care both in its diet and protein intake, as well as in medications, treatments, veterinary check-ups, affection, etc. (Ortiz et al., 2018). As for food, it is worth mentioning that there is a wide variety of balanced foods, of different brands, presentation, price, quality, adjusted to the age of the dogs or to some type of physiological condition, which meet or do not meet the minimum nutritional requirements. (Koscinczuk, 2017), and that could well affect in one way or another the functioning of the organs, specifically the digestive system, including the gallbladder, which, although not very representative in size, is in its contribution to the pet's health.

Since the gallbladder is a small organ that works silently, accumulating, concentrating and transporting bile, it generates some concern regarding some type of problem in its functioning and contribution to the formation of biliary sludge; however, this deficiency is not precisely caused by the bile itself but by the type of food, nutrients and care of the dog's digestive system: when the bile, which is generated by the liver, passes into the gallbladder and if it does not function properly, it causes the bile to back up, generating the formation of grit, also called biliary sludge or lumps at the level of the biliary tree and which, in larger quantities, become stones or diseases such as acute or chronic cholecystitis (hemorrhagic), cholangiohepatitis. Not only does the bile become dense, but it also retains cholesterol, calcium and other solid elements., among others (Binder, 2019; Bohórquez, 2021; Zárate, 2008).

Although, if detected in time, it could be addressed with changes and/or improvements in diet, late detection would lead to the need for surgical intervention or to the death of the canine specimen; Therefore, it is important to analyze the contents of canine food to prevent pathologies that lead to a direct impact on the health of dogs. (Bust, 2016), since 90% of the calories in pet food in the United States, Japan, Australia, New Zealand and northern Europe come from balanced foods. In contrast, in Latin America, the Pacific region and the rest of Europe, the percentage is 30 to 50%. (Koscinczuk, 2017, p. 82).

Regarding the type and components of canine nutrition, it is worth mentioning a study carried out in Chile by the National Consumer Service (SERNAC, 2021), which highlights five basic elements that canine food should contain:

- Proteins, which are groups of essential amino acids, there are 10 types that are essential for the diet of a dog and cat, these are: arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.
- Carbohydrates, which are not essential macronutrients but are used in pet foods as sources of energy and dietary fiber: sugars, starch and fiber, which in food are metabolized and absorbed as glucose, a source of energy used by most of the body's cells.

- Fiber, which is beneficial for intestinal transit; some are known as prebiotics, which can also promote colonization by beneficial intestinal bacteria.
- Fats are necessary for caloric energy, food palatability, formation and maintenance of fluidity and function of cell membranes and for the formation of prostaglandins, leukotrienes and others; the essential fatty acids are linoleic, linolenic and arachidonic.
- Minerals, each with its own function and need will depend on the stage of the specimen: essential macrominerals include calcium (bone ossification), phosphorus (energy transfer), potassium and sodium (balance of cellular ions), magnesium (sensory impulses), chlorine (balance between acids and bases); essential microminerals are iron (synthesis of haemoglobin in red blood cells), manganese (formation of cartilage and skin), copper (synthesis of skin pigments), iodine (functioning of the thyroid gland), selenium (antioxidant).
- Vitamins, their variety should depend on the stage of life or specific requirement: essential fat-soluble such as A (vision, skin), D (metabolism or calcium and phosphorus), E (antioxidant), K (blood clotting); essential water-soluble: B1-thiamine (nervous system), B2-riboflavin (skin), B3-niacin (skin, cellular energy), B5-pantothenic acid (growth, skin), B6-pyridoxine (cellular energy), B7-biotin (skin, hair), B9-folic acid (blood cell formation), B12-cobalamin (blood cell formation), B12-choline (phospholipid synthesis).

Although recommendations are given to keep a dog well fed, periodic check-ups should be carried out to detect any unforeseen changes or effects on the health of the canine specimen, considering that not all organisms are the same and that, in some, correct feeding will not cause health problems, in others it can simply contribute to the formation of pathologies such as biliary sludge.

It is necessary to review the different types of levels according to the amount of biliary sludge present in the gallbladder: it is identified as normal when there is no biliary sludge visible inside the gallbladder; mild level or Type I occurs when little biliary sludge or sludge is observed inside, without being considered cholecystitis; moderate level or Type II shows, inside the gallbladder, a large amount of biliary sludge that can later contact and become cholecystitis and obstruction in the cystic duct, the wall of the gallbladder is maximum 2-3 mm); severe level or Type III is already the previous step to the presence of mucocele, constituting a medical emergency, in this case "the common bile duct appears as a hypoechoic tubular structure in the ventral part of the portal vein, with a diameter less than 3 mm in the dog"(Guendulain et al., 2010, p. 109); the severe level or Type IV corresponds to a presence of immobile content in the internal part of the gallbladder or accumulation of mucus "that distends the walls of the gallbladder"(Rodelo, 2017, p. 12)and, according to its ultrasound characteristics, the mucocele has been classified as "echogenic

bile, stellate pattern, kiwi stellate, kiwi with residual center and kiwi model”(Reyes et al., 2016, p. 265).

Moving on to the diagnostic mechanism of this pathology, it is necessary to perform a physical, blood and ultrasound examination; the first two are complemented and confirmed by the third, which is the ultrasound, which has become a basic and essential tool for identifying all types of anomalies, specifically those related to problems of the digestive tract and specifically those of the gallbladder.(Larrañaga, 2021).

Thus, the physical examination allows to identify spaces sensitive to pressure, which generate pain in the pet, sometimes the enlargement of areas; blood testsThey facilitate the detection of high levels of enzymes, cholesterol, bilirubin, bile acids; while X-ray and ultrasound give a real image of the presence of gallstones, their location, the formation of mucoceles or any malformation that could be mistaken for a cyst or tumor.(Binder, 2019).

The above is confirmed by an article published by the American College of Veterinary Surgeons (ACVS, 2023), in the sense that a diagnosis begins with a physical examination, then a blood test, combined with the imaging technique; therefore, it is argued that abdominal ultrasound is very useful in the early stages of the presence of these abnormalities in the gallbladder, since ultrasound is a non-invasive technique that effectively allows the gallbladder and the biliary tree to be observed and “is indicated to rule out extrahepatic obstruction in jaundiced animals, detect biliary stones or masses, and visualize thickening of the gallbladder wall.”(Guendulain et al., 2010, p. 108)It also allows us to establish a difference between what may be cholecystitis (acute or hemorrhagic) and cholangiohepatitis (inflammation of the bile duct that extends to the adjacent periportal region (cholangiohepatitis)(Bolívar-Rodríguez et al., 2019; Reyes et al., 2016; Tejeira, 2022).

In short, the findings obtained through a physical examination, clinical-pathological data and laboratory data must always be complemented with a rigorous analysis of the results obtained through ultrasound.(Bohórquez, 2021).

For all the above, it is important to insist on the early detection of the possible presence of biliary sludge, with the help of an ultrasound, and determine if it is a consequence of the intake of foods high in fat or cholesterol that lead to saturation of the bile generated by the liver and the obstruction of the bile ducts, as well as foods low in protein and fat that cause nutritional deficiencies.

This study refers specifically to the digestive system of dogs, specifically in relation to the effects on the gallbladder, since it was determined as an object of analysis whether there is a statistically significant relationship between the type of food and the formation

of biliary sludge in canines, taking the data resulting from the ultrasound examination of the canines subject to this study.

Methodology

This qualitative, observational, cross-sectional, correlational and non-experimental research sought to collect information, at a given point in time, to establish whether or not there is a correlation between the type of diet and the formation of biliary sludge in canines.(Cvetkovic-Vega et al., 2021); A survey was used to record the specific data of the canine specimen under study and then a worksheet was filled out with the variables under study: type of food(balanced, homemade, mixed, barf), subject of analysis(age, race, sex, physical build), formation of the biliary sludge (detected by ultrasound) due to the type of diet (normal, mild, moderate, severe or serious).

The study universe corresponded to 100 canine specimens selected from among those who attended the Pet Wash veterinary clinic during June and August 2023. The processed data allowed for their corresponding analysis and establishment of results based on confirming or rejecting whether the type of food has an impact on the formation of biliary sludge in canines.

In order to simplify the analysis, although there is a detailed list of the breeds of dogs treated, it was decided to group them according to the following fundamental variables:

- Age: ranges 3 to 5 years = considered young adult; > 5 to 7, older adult; > 7 years, geriatric;
- Sex: female and male; and,
- Physical build: normal, thin, fat, obese.

Regarding the variables associated with nutrition, the following parameters were defined:

- Type of feed: balanced (premium, super premium), barf, homemade, prepared and mixed (homemade + prepared, premium + barf, premium + homemade, premium + prepared, super premium + barf, super premium + homemade, super premium + prepared); and,
- Feeding frequency: one, two or three times a day.

Regarding the presence of biliary sludge, the following levels were considered:

- Normal: no biliary sludge is seen inside the gallbladder;
- Mild or Type I: Little biliary sludge or mud is seen inside;
- Moderate or Type II: large amount of biliary sludge;
- Severe or Type III: previous step to the formation of mucocele; and,
- Severe or Type IV: presence of mucocele.

Results

To enrich this research, each of the 100 selected specimens was subjected to an examination using two ultrasound equipment from Jiangsu, China, of the Chison Ultrasound Diagnostic System brand, model ECO 3, manufactured in June 2018 and the other of the Chison Digital Color Doppler Ultrasound System brand, model Ebit 60, manufactured in September 2021, with the aim of identifying the presence of different levels of biliary sludge, including categories such as normal, mild, moderate, severe and serious. It is worth mentioning that in all the cases treated at the veterinary clinic, no specimen was detected with a serious or Type IV condition.

Figure 1 shows an image of a canine specimen diagnosed as being in normal condition. In this image, the wall of the gallbladder appears thin and smooth, with no evidence of biliary sludge or focal lesions. In addition, the capsule appears smooth and thin, in accordance with normal characteristics, with a measurement usually less than 2 mm.

Figure 1

Biliary sludge: normal level



Figure 2 shows an example of the presence of a mild level (Type I) of biliary sludge in the gallbladder, a thin and smooth capsule, a normal cystic duct without obstructions, and does not represent a risk factor for cholecystitis.

Figure 2

Biliary sludge: mild level (Type I)



Moderate sludge level (Type II) can be visualized in Figure 3; it highlights a moderate amount of biliary sludge, normal gallbladder volume (maximum volume is 1 ml/kg of weight), but there may be an increase in the gallbladder walls and compacted biliary sludge formations.

Figure 3

Biliary sludge: moderate level (Type II)



Severe level (Type III) of biliary sludge is shown in Figure 4. According to the results obtained by ultrasound and technical analysis, the wall of the gallbladder is 2 mm thick, which means that biliary sludge occupies 60% of the area; this is the previous step to the

severe level (Type IV), which is already considered mucocele and becomes a veterinary emergency because it generally causes cholecystitis.

Figure 4

Biliary sludge: severe level (Type III)



Having presented the images of the different levels of biliary sludge obtained by ultrasound, it is now necessary to review the characteristics of the canines one by one: breed, sex, age range, physical build.

The dogs participating in this study belonged to different breeds, so the study universe was covered by specimens of different sizes and specific characteristics; Table 1 shows the level of biliary sludge detected in the dogs, grouped by breed, from which it can be inferred, in the first instance, that there is no relationship between the states of two variables. From the data in Table 1, 20 dogs without biliary sludge (normal level), 57 with mild level, 15 with moderate level, 8 with severe level and none in serious condition stand out.

Table 1

Biliary sludge level detected in a group of 100 canines, grouped by breed

Race	Normal	Mild	Moderate	Severe	Serious	Total
American Bully		1				1
Beagle		1		1		2
French Bulldog		1				1
English Bulldog		1				1
Chihuahua	1		1	1		3

Cocker Spaniel	1	2				3
French Poodle	5	13	5	2		25
Golden Retriever		2	1			3
Jack Russell Terrier		1				1
Labrador Retriever			1			1
Maltese		1		1		2
Mestizo	2	11	4	1		18
German Shepherd		1				1
Pug		1				1
Schnauzer	5	10	3	1		19
Shih Tzu	4	9		1		14
Yorkshire Terrier	2	2				4
Total	20	57	15	8	0	100

Table 2 presents the data grouped according to the other basic variables (sex, age range, physical build) of the specimens subject to this study, taken into account to establish their relationship with the presence of biliary sludge, so as to confirm or not whether these variables intervene in the formation of biliary sludge.

Table 2

Level of biliary sludge detected in a group of 100 canines, grouped by sex, age ranges and physical build

Variable	Description	Normal	Mild	Moderate	Severe	Serious
Sex	Female	20	26	8	4	
	Male	10	31	7	4	
	Total	20	57	15	8	0
Age ranges	Young adult	16	20	7	2	
	Senior citizen	2	19	1	2	
	Geriatric	2	18	7	4	
	Total	20	57	15	8	0
Physical build	Normal	19	38	12	6	
	Slim		5	1		
	Fat	1	13	2	2	
	Obese		1			
	Total	20	57	15	8	0

Now, after breaking down the sample under study according to the basic variables of sex, age ranges and physical build and their relation to biliary sludge, excluding the 20 specimens that did not present this pathology, it is found that 40 females and 40 males

have some level of biliary sludge, according to age ranges 29 are young adults, 22 older adults and 29 geriatric; finally, regarding physical build and those who have some level of biliary sludge are: 56 considered to be of normal build, 6 thin, 17 fat and 1 obese.

As regards nutrition, different types were considered, such as: balanced (premium, super premium), barf, homemade, prepared and mixed (homemade + prepared, premium + barf, premium + homemade, premium + prepared, super premium + barf, super premium + homemade, super premium + prepared).

Another element considered was the frequency of feeding.that, according to what was mentioned by the canine guardians, in general, the daily portion was always the same, regardless of how many portions the specimen consumed it; from the data in Table 3, it can be highlighted that only three of the canines ate homemade food, once a day, while 67 canines ate twice a day, regardless of the type of food, and 30 were fed three times a day.

Table 3

Type and frequency of feeding specific variables

Description	1 time	2 times	3 times	Total
Barf		1		1
Homemade	3	9	5	17
Homemade + prepared		5	3	8
Premium		13	2	15
Premium + barf		2		2
Premium + homemade		9	5	14
Premium + prepared		2	2	4
Prepared		3		3
Super premium		15	5	20
Super premium + barf			1	1
Super premium + homemade		6	5	11
Super premium + prepared		2	2	4
Total	3	67	30	100

In relation to the type of food, it is worth mentioning that, according to Mena-Perez et al.(2021) There are a large number of dog food brands worldwide, classified as economical, premium or super premium based on its composition, which, according to its characteristics and purposes offer to meet the different needs of age, race, physiological condition, since the quality of life and longevity of dogs depends on proper nutrition., establishing the importance of maintaining certain minimum and maximum ranges of dietary components for canines, such as:

- Proteins (between 22.22 and 32.20%);
- Fat (between 9.21 and 16.70%);
- Humidity (between 5.50 and 9.54%);

- Fiber (between 1.70 and 4.00%);
- Starch (between 23.40 and 43.50%); and,
- Ash (between 4.70 and 9.90%).

Through this research, the importance of providing dogs with sufficient nutrients and supplements in adequate percentages is highlighted in order to avoid health problems and, specifically, the high or low presence of biliary sludge.

Although in Ecuador there are several brands and a variety of characteristics associated with breed, size, age, etc., of canine specimens, so-called homemade or home-prepared food is not established as an option, since it may not provide the nutrients and nutritional components that the canine requires for its development and good health; that is why research in this regard does not include this variety of food, since there is no specific standard for its preparation.

Entering into the intervening variable in the hypothesis of this study, Table 4 shows the level of biliary sludge detected and the type of food consumed by the canines, from which it can be determined that homemade food (individual or combined) represents a greater incidence in the formation of biliary sludge.

Table 4

Presence of biliary sludge, depending on the type of diet

Type of power supply	Normal	Mild	Moderate	Severe	Total
Barf		1			1
Homemade	1	10	6		17
Homemade + Prepared		2	5	1	8
Premium	6	7	2		15
Premium + Barf	1	1			2
Premium + Homemade		9	1	4	14
Premium + Prepared		4			4
Prepared	1	2			3
Super Premium	8	12			20
Super Premium + Barf		1			1
Super Premium + Homemade	1	7	1	2	11
Super Premium + Prepared	2	1		1	4
Total	20	57	15	8	100

After reviewing the images obtained by ultrasound and issuing the respective diagnoses, it is now necessary to establish the incidence of diet in the formation of biliary sludge in the canines subject to study, in order to confirm the main assumption of this research.

The data obtained were compiled in an Excel sheet and analyzed using the SPSS 23 statistical tool, using a classification of the variables race, sex, age ranges, physical build, and type of diet; then the Pearson Chi-square test was applied, which allows establishing

the level of significance (with a p-value ≤ 0.05 in case there is a statistically significant association between the variables involved, and if a p-value > 0.05 is obtained, it implies that there is no significant association between the variables under study); as a complement, to identify the effect measure of the Chi-square test, the Cramer V2 coefficient was used, which reveals the degree of intensity of the relationship between the variables under study (considering the value 1 as a complete relationship and the value 0 when there is no relationship between the variables).

As a result of the application of these tests, as can be seen in Table 5, it is established that the feeding variable has a significance index of 0.002, which confirms the assumption that feeding has a direct relationship in the formation of biliary sludge. In addition, when applying Cramer's V2 coefficient, a coefficient of 0.451 is obtained, which is equivalent to a moderate relationship between these two variables.

Additionally, taking the age range variable, it is observed that its significance index reaches 0.006, which would also imply its incidence in the formation of biliary sludge, but Cramer's V2 coefficient of 0.300 establishes that there is a minimal relationship between the variables.

Table 5

Incidence of the type of diet in the formation of biliary sludge

Variable	Chi square significance	Cramer's V2
Race	0.893	
Sex	0.951	
Age ranges	0.006	0.300
Physical build	0.552	
Type of power supply	0.002	0.451
Feeding frequency	0.525	

Regarding the other variables such as race, sex and physical build, all their indices were higher than the p value, meaning that none of these variables affect the formation of biliary sludge.

Conclusion

According to the analysis of the data corresponding to the 100 specimens subject to this study, it can be concluded that the consumption of balanced feed as a canine food option does not generate the formation of biliary sludge, but this is not the case when it is combined with home-cooked food (consumed by people). This can be deduced from the large percentage of canines that presented gallbladder damage:

- Homemade, individual or combined with balanced, there are 64 specimens with a mild level, eight with a moderate level and six with a severe level (total 40 canine specimens)
- Prepared, individually or combined with balanced, there are seven specimens with a mild level, none with a moderate level and one with a severe level (total of eight canine specimens)
- Homemade combined with prepared food, with a total of eight, their biliary sludge levels were two mild, five moderate, one severe.

Therefore, it is highlighted that home-cooked food, understood as the same food consumed by people, is the one that most induces the formation of biliary sludge in dogs.

Conflict of interest

The authors declare that there is no conflict of interest in relation to the submitted article.

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