

EFEITO DE BISCOITO EXTRUSADO COM COBERTURA DE PIROFOSFATO DE SÓDIO SOBRE O CÁLCULO E A PLACA DENTÁRIA PRÉ-EXISTENTES EM CÃES

(EVALUATION OF THE EFFECT OF EXTRUDED BISCUIT COATED WITH SODIUM PYROPHOSPHATE ON PRE-EXISTING PLAQUE AND DENTAL CALCULUS IN DOGS)

(EVALUACIÓN DEL EFECTO DE GALLETAS EXTRUSADAS CUBIERTAS CON PIROFOSFATO DE SODIO SOBRE LA PLACA Y EL CÁLCULO DENTARIOS PREEXISTENTES EN PERROS)

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RESUMO

O objetivo deste trabalho foi avaliar o efeito do consumo de biscoito extrusado de alta densidade e dureza, com cobertura de pirofosfato de sódio, sobre a redução da placa e do cálculo dentários pré-existentes de cães. Foram empregados 28 cães, divididos em dois grupos de 14 animais, distribuídos quanto à gravidade da doença periodontal e à massa corporal. Os cães do grupo controle receberam apenas alimento industrializado extrusado para cães e água. Os animais do grupo teste receberam, em adição ao alimento industrializado, o biscoito em teste. O experimento teve duração de quatro semanas. O biscoito em teste foi produzido por extrusão e recoberto com 0,6% de pirofosfato de sódio. O consumo do biscoito promoveu, ao final do experimento, uma redução média de 18,9% no Índice de Cálculo Dentário ($p < 0,01$), enquanto nos animais do grupo controle esse índice permaneceu inalterado. Uma redução de 4,5% do Índice de Placa Bacteriana (IP) foi verificado no grupo teste, enquanto no grupo controle houve um aumento de 10,8% no IP, resultados não significativos. Os dados encontrados permitem concluir que o consumo do biscoito extrusado pode ajudar a reduzir o cálculo dentário supragengival pré-formado de cães.

PALAVRAS-CHAVE: Cálculo dentário. Placa dentária. Cães. Pirofosfato de sódio.

SUMMARY

The aim of this experiment was to evaluate the effect of consuming a sodium pyrophosphate coated extruded biscuit of high density and hardness on the reduction of pre-existing dental plaque and calculus in dogs. The dogs were divided into two groups of 14 dogs each, the test group and control group, divided in relation to the periodontal disease severity and the body weight. Animals in the control group received only dry food and water. The dogs in the test group received the biscuit being tested and the same dry food. The experimental period lasted four weeks. The test biscuit was produced by extrusion and coated with 0.6% sodium pyrophosphate. At the end of the experiment, an average reduction of 18.9% was found in the Dental Calculus Index (CI) in the test group ($p < 0.01$). During the experimental period, the CI value remained the same in the control group. Although there was no statistical difference, a 4.5% reduction in the Bacterial Plaque Index was found in the test group, while a 10.8 % increase occurred in the control group. From the data reported here it could be concluded that consumption of this extruded biscuit can help in reducing preformed supragingival dental calculus.

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KEY WORDS: Dental plaque. Dental calculus. Sodium pyrophosphate. Dog.

RESUMEN

El objetivo de este experimento fue evaluar el efecto del consumo de galletas extrusadas cubiertas con pirofosfato de sodio de alta densidad y dureza sobre la reducción de la placa y el cálculo dentarios preexistentes en caninos. Los perros fueron distribuidos en dos grupos de catorce animales cada uno, el grupo experimental y el grupo control, considerando la severidad de la enfermedad periodontal y el peso corporal. Los perros del grupo control recibieron solamente agua y comida seca. Los perros del grupo experimental, además del agua y la comida seca, recibieron las galletas. El periodo experimental fue de cuatro semanas. La galleta fue producida por la extrusión y cobertura con pirofosfato de sodio al 0,6%. Al final del experimento fue observada una reducción media de 18,9% en el Índice de Cálculo Dentario (ICD) en el grupo experimental ($p < 0,01$). Durante el periodo experimental el valor de ICD permaneció igual en el grupo control. Aunque no hubo diferencias estadísticas, fue observada una reducción de 4,5% en el Índice de Placa Bacteriana en el grupo experimental, mientras en el grupo control hubo un aumento de 10,8%. Con base en estos datos se concluyó que el consumo de las galletas extrusadas puede ayudar a reducir el cálculo dental supragingival preexistente.

PALABRAS-CLAVE: Placa dentaria. Cálculo dentario. Pirofosfato de sodio. Perros.

INTRODUCTION

Dental calculus and gingivitis are the disorders most commonly found in dogs that are examined in veterinary practices in the United States (LUND et al., 1999). Regardless of the importance of these affections, no statistical data has been found in the scientific literature concerning their incidence in Brazil.

Dental calculus occurs due to calcification of the bacterial plaque. The dental calculus are also covered by a layer of bacteria (EISNER, 1989). Dental calculus is a secondary effect of bacterial plaque accumulation and contributes for the occurrence and development of periodontal disease, characterized by inflammation, edema and retraction of gingival tissues, formation of pockets, alveolar bone resorption, loss of periodontal ligament, root and furcal exposure, and dental exfoliation. There is also a relationship between periodontal disease and histological alterations in the kidneys, myocardium and liver (DEBOWES et al., 1996).

Plaque accumulation and secondary formation of dental calculus can be reduced or prevented by oral hygiene, such as that done by employing chemical methods, for example, by using chlorhexidine solution, or by physical methods, such as teeth brushing (GORREL e RAWLINGS, 1996). These methods, however, are very time consuming and require the owners' cooperation (MILLER e HARVEY, 1994). Due to these difficulties, alternative methods were sought to reduce the formation of dental calculus by physical methods, like using cereal biscuits, edible rawhide strips, specific dry foods and biscuits and by the combination of physical means and chemicals that inhibit crystal growth, such as the use of hexametaphosphate and sodium pyrophosphate coated bis-

cuits (LAGE et al., 1990, JESEN et al., 1995, STOOKEY et al., 1995, STOOKEY et al., 1996, GOREL e BIERER, 1999, GORREL et al, 1999).

The aim of this experiment was to evaluate the effect of chewing a sodium pyrophosphate coated extruded biscuit of high density and hardness in the reduction of pre-existing dental calculus and plaque in dogs.

MATERIAL AND METHODS

Animals

This study included 28 dogs from the university colony, with ages between 3 and 7 years, of both sexes and of various breeds, weighing between 6 and 25 kg, with periodontal disease and with no other affections. In order to reduce possible variations on results, we used only dogs whit mesocephalic conformation. Dogs with dental occlusion problems or incomplete dentition were not included too. The health status of these dogs was clinically assessed by physical exam and laboratory tests, including blood count, serum creatinine and BUN.

Experimental Protocol

The dogs were initially classified according to the severity of their periodontal disease as grade I (early periodontitis), II (moderate periodontitis) or III (advanced periodontitis), as described below (HARVEY e EMILY, 1993):

I – Early Periodontitis: gingival topography is normal or may show hyperplasia, inflammation of periodontal ligament, and minor loss of attachment with minimal pocket development, lack of tooth mobility.

II – Moderate Periodontitis: there may be mod-

erate loss of attachment with moderate to deep-pocket formation, hyperplasia may mask pocket depth or gingival recession may reduce pocket. Gingival topography no longer is normal, and only slight mobility is seen.

III – Advanced Periodontitis: advanced breakdown of supporting periodontal tissues, severe pocket depth or significant gingival recession, severe loss of attachment, and advanced tooth mobility can occur.

They were then divided into two groups of 14 animals and care was taken to achieve a balance in relation to the periodontal disease severity and the bodyweight of the dogs in each group. In the test group, 7 dogs were classified as grade I, and 7 as grade II. In the control group, 6 dogs were grade I, and 8 were grade II.

All animals received the same dry commercial food^a in amounts needed to meet their daily energy requirements (NRC, 1985). Water was provided *ad libitum*.

Besides the dry food and water, the dogs in the test group received the biscuit being tested at 8.00 am and 6.00 pm. In order to promote the mechanical and chemical action of the tested biscuits, the number of biscuits supplied to dogs was enough to the animals spend between 5 to 15 minutes chewing. This way, dogs with up to 10 kg bodyweight were given one biscuit per day (4 animals), those weighing between 10 to 20 kg were given 2 (8 animals) and those weighing between 20 to 25 kg were given 3 biscuits a day (2 animals). Animals in the control group received only dry food and water (3 animals up to 10kg, 9 weighing between 10 and 20 kg and 2 weighing between 20 and 25 kg of bodyweight). The experimental period lasted four weeks.

Test Biscuit

The test biscuit^b was produced by extrusion and coated with 0.6% sodium pyrophosphate, and its average measurements are 7.0 cm length, 2.5 cm width and 1.5 cm height. In a bending test, with the use of a 6 mm knife, supported at a 17.5 mm distance, the maximum average test load corresponding to the rupture of the specimen was 147 kgf. The tests were conducted at the Laboratory of Mechanical Assay - Technology Center - UNICAMP.

Observations on the Biscuit Consumption and Occurrence of Adverse Effects

During the experimental period, dogs were observed four times a day to determine the biscuit consumption and occurrence of diarrhea, vomiting, lack of appetite or any other alteration.

Examination of the Oral Cavity

The oral cavity was examined with the dogs under general anesthesia. Levomepromazine (0,5mg/kg) was used in the pre-anesthesia stage, followed by induction with propofol (5mg/kg). The anesthesia plane was maintained with isoflurane and oxygen via a cuffed

endotracheal tube.

All dogs were submitted to two exams, the first one (T0) being performed immediately before the experiment and the second (T4) four weeks after the experimental treatment was started. The dog's preformed dental calculus wasn't removed in the experiment. All oral cavity exams were carried out by the same veterinarian, with experience in veterinary dentistry, using a lip retractor, a exploratory probe, a periodontal probe marked at 1 mm intervals. In order to ensure a better evaluation of the periodontal condition and to confirm the pocket depth, an intraoral periapical radiography was taken at T0 in teeth with severe periodontitis. Dogs with severe breakdown of supporting periodontal tissues on C, P2, P3, P4 and M1 maxillary teeth were not included in the experiment. To prevent the influence of the examiner on the test results, the veterinarian did not have any information about the experimental group the animals belonged to. The results of oral cavity exams were recorded in specific forms and used for comparisons before and after the treatment.

To illustrate the results, photographic documentation of the labial aspect of the maxillary teeth were obtained during the procedures, assuring that the position of the head of the animals, the flash adjustment and the distance between the camera and the animals were the same.

Measuring the Bacterial Plaque Index and Dental Calculus Index

The Bacterial Plaque Index (PI) and the Dental Calculus Index (CI) were calculated by using the system described by Loe, as shown below (LOE, 1967):

Criteria for the Plaque Index System (PI): 0 – no plaque in the gingival area; 1 – a film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may only be recognized by running a probe across the tooth surface; 2 - moderate accumulation of soft deposits within the gingival pockets, on the gingival margin and/or adjacent tooth surface, which can be seen by the naked eye; 3 – abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface.

Criteria for the Calculus Index (CI): 0 – no caries, no calculus, no imperfect margin of dental restoration in a gingival location; 1 – supragingival cavity, calculus or imperfect margin of dental restoration; 2 – subgingival cavity, calculus or imperfect margin of dental restoration; 3 – large cavity, abundance of calculus or grossly insufficient marginal fit of dental restoration in a supra- and/or sub-gingival location.

It should be noted that only the labial aspects of C, P2, P3, P4 and M1 maxillary teeth were considered in this study. The results of each dog refer to the average of all evaluated teeth, according to the formula below described. The indices were calculated at T0 and T4 for

all experimental animals.

Dog PI or CI = the sum of PI or CI of each one of the evaluated teeth ÷ number of evaluated teeth

Statistical Analysis

Using the paired t-test, the dogs' PI and CI were compared at T0 and T4 within each experimental group, running the SAS® – System for Elementary Statistical Analysis version 6.12 software (SCHOLOTZHAUER e LITTELL, 1997). Another comparison of CI and PI was carried out in a multivariate analysis of variance (MANOVA), using the repeat command of SAS®. The analysis was performed with the data as it was or transformed in logarithm.

The percentage differences between CI and PI obtained at T0 and T4 in both the test and control groups were also determined. Negative values refer to the average reduction of the index and positive values to the average increase.

RESULTS

The biscuit was well accepted by all the animals of the test group. The amount being offered was totally consumed within the maximum period allowed, usually lower than 30 minutes. Food was offered in the amounts needed to meet the daily energy requirements of the animals, and was totally consumed during the experiment, with no differences between groups. There was no vomiting, diarrhea, lack of appetite or any other clinical sign indicating any alteration in the health of the dogs during the experiment.

PI and CI, as well their statistical analysis, are shown on table 1. The percentual variation of CI and PI between T0 and T4 in both groups is shown on figure 1 and 2, respectively. To illustrate the reduction in supragingival dental calculus, pictures of the teeth of two dogs of the test group taken at T0 and T4 are shown on figures 3 and 4. The statistical probabilities found by using paired t-test or a repeated measure analysis of variance (MANOVA) showed the same results. The non-paired comparison between the test and the control group did not demonstrate any statistical difference at any experimental time. The paired comparison between T0 and T4 for the same group revealed that the CI and PI values were the same for the control group. In the test group, the PI values were the same but the CI values were statistically lower at T4 ($p < 0.01$). An interaction between the groups and time was found ($p < 0.01$); the differences between the test and the control group are similar at both points in time but with opposite signs, at T0 the test group value is higher and at T4 is lower, showing the biscuit's effect.

DISCUSSION

It is well known that the maintenance of oral health and improved quality of life of companion animals are assured by preventing the accumulation and by removing the bacterial plaque and the dental calculus (STOOKEY, et al., 1995). Daily or at least every other day oral hygiene can reduce or even prevent the occurrence of periodontal disease (HENNET, 1995). However, many dog owners are not able to adequately perform these hygiene procedures (MILLER e HARVEY, 1994). Therefore, studies to develop alternative methods, such as the use of cereal biscuits (LAGE, et al., 1990), edible rawhide (JENSEN, et al., 1995), bones and specific dry foods (GORREL, et al., 1999) have been performed.

In the present study the test biscuit was effective in reducing the dental calculus. An average reduction of 0.4 points, that is 19.8%, was found in the CI of the dogs in the test group after four weeks of consumption ($p < 0.01$), reaching a maximum reduction rate of 70%. The CI value remained the same along the experimental period in the control group. The absence of statistical difference between the CI of the test and the control group at T4 can be explained by the difference of only 0.18 points between them, below the least statistical significant difference of 0.26 points. This difference was, however, 0.2 points higher for the test group at T0 and 0.18 points lower for the test group at T4, showing the biscuit's effect in reducing the dental calculus. Although there was no statistical difference for PI, a 4.5% reduction was found for this index in the test group, while a 10.8 % increase occurred in the control group. As the bacterial plaque and the dental calculus are being continuously formed along time (HENNET, 1999), the results obtained can be considered of interest, since the biscuits avoided the increase of the bacterial plaque.

The biscuit used in this experiment has the characteristic of a higher degree of hardness. In the bending test, baked cereal biscuits for dogs had a maximum load for rupture of 14kgf (CARCIOFI, 2003), ten times less than that of the extruded tested biscuit in evaluation. Bending tests determine the load or strength that is necessary to rupture the material under study. This test was chosen because it is able to mimic the dog's chewing, when food is under the pressure exerted by the sharp tooth surface. This higher biting strength generates more pressure and friction between the biscuit and the tooth surface, and can explain the partial removal of supragingival dental calculus of dogs that received the biscuit. In spite of this higher hardness degree, the odontological evaluation at the end of the study did not find any dental alteration in the dogs that could indicate excessive hardness or abrasiveness of the test biscuit. However, long-term studies are necessary to evaluate abrasiveness on the teeth.

Chemical methods used to inhibit the formation

of dental calculus have been described. Stookey et al (1995) conducted a study in which several levels of sodium pyrophosphate and sodium hexametaphosphate was incorporated in extruded dog foods. These chemicals were incorporated inside and outside the dog's foods. They found reductions between 10% and 89% in the formation of dental calculus, according to chemical product and level used, with better results applying the chemicals by coating the foods. In other study, coating dog biscuit's with 0,6% of sodium hexametaphosphate reduced calculus formation by 46% (STOOKEY et al., 1996).

The experimental model used here, however, assessed the effect of consuming an extruded biscuit on the reduction of preformed dental plaque and calculus in dogs with several stages of periodontal disease. On the other hand, scientific studies that have been published evaluated the efficacy of products in inhibiting the formation of dental calculus in dogs. Thus, the preformed dental calculus was removed when the experiment was

started. This difference in the experimental methods makes it very difficult to compare the data described here with those found in the literature. The model used in this experiment is able to better mimic the situation in which owners try to improve the periodontal situation of their pets by using snacks, not necessarily having done a previous dental treatment.

The results found in the present study, show that the association of a physical method, chewing a hard extruded biscuit that reduces preformed supragingival dental calculus, with a chemical method, sodium pyrophosphate, could possibly improve the biscuit's effectiveness on periodontal health. However, further studies are necessary to quantify the efficacy of this association.

From the data reported here it can be concluded that the extruded biscuit was efficient in reducing preformed supragingival dental calculus.

Table 1 - Average values \pm standard error of the means and percentual difference of Dental Calculus Index (CI) and Bacterial Plaque Index (PI) before (T0) and after 4 weeks (T4) of consumption of test biscuit.

Group		T 0	T 4	% difference
CI	Test	2.02 \pm 0.2	1.62 \pm 0.2*	-19.8%
	Control	1.82 \pm 0.2	1.80 \pm 0.2	-1.1%
PI	Test	1.57 \pm 0.2	1.50 \pm 0.1	- 4.5%
	Control	1.48 \pm 0.2	1.64 \pm 0.2	+ 10.8%

*difference between T0 and T4 is statistically significant ($p < 0,01$).

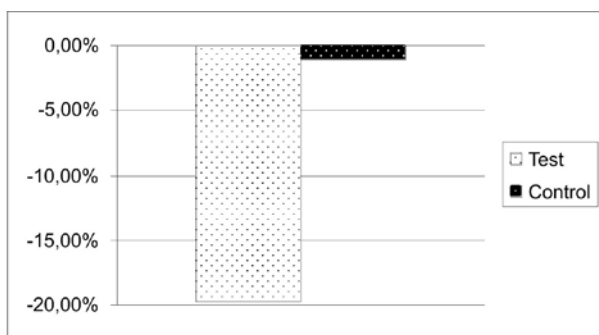


Figure 1 - Percentual variation of Dental Calculus Index before (T0) and after 4 weeks (T4) of consumption of test biscuit.

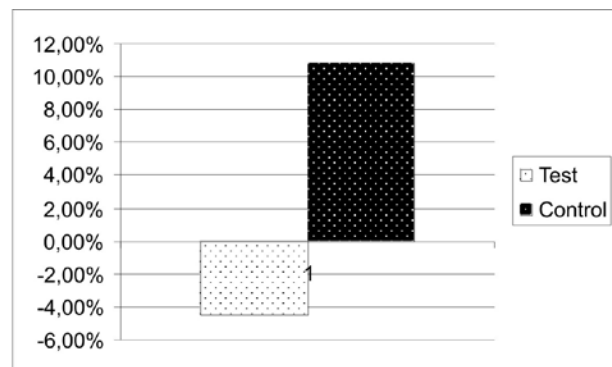


Figure 2 - Percentual variation of Bacterial Plaque Index before (T0) and after 4 weeks (T4) of consumption of test biscuit.



Figure 3 - A same dog in the test group before (T0) and after 4 weeks (T4) of consumption of test biscuit. Note the reduction on supragingival calculus.

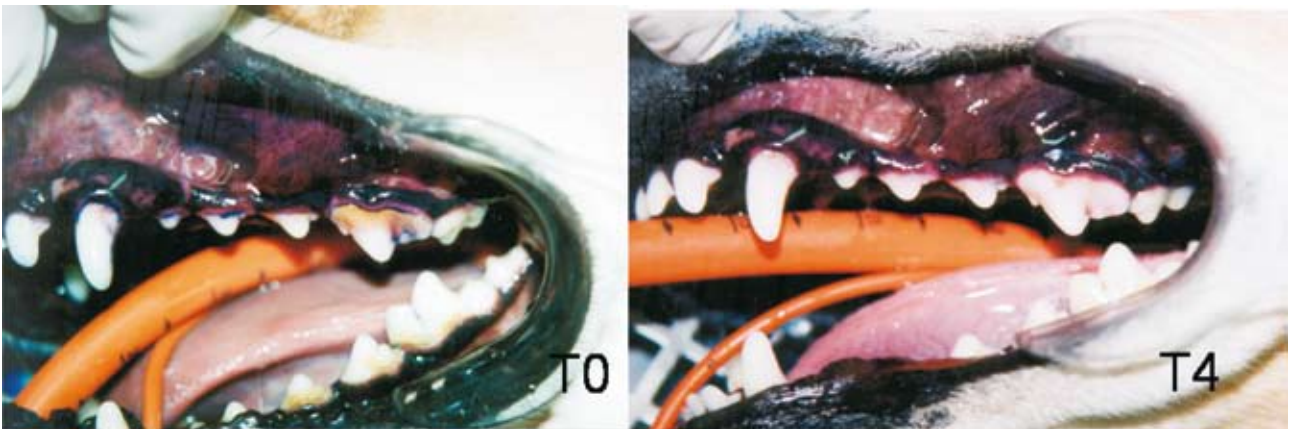


Figure 4 - A same dog in the test group before (T0) and after 4 weeks (T4) of consumption of test biscuit. Note the reduction on supragingival calculus.

FOOTNOTES

a Sabor & Vida (Flavor & Health) Adult Dog Food (Guabi, Mogiana Alimentos S.A., Campinas, SP, Brazil)

b Faro Creck (Guabi, Mogiana Alimentos S.A., Campinas, SP, Brazil)

c Neozine (Aventis Pharma Ltda, São Paulo, SP, Brazil)

d Propofol (Abbot Laboratório do Brasil Ltda, Rio de Janeiro, RJ, Brazil)

e Forane (Abbot Laboratório do Brasil Ltda, Rio de Janeiro, RJ, Brazil)

f Replak, (Dentsply Industria e Comércio LTDA, Petrópolis, RJ, Brazil)

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