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Incorporation of Cellulose into a Chew Treat for Dogs Increases Elasticity and Chewing Time

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Abstract: Problem statement: We have reported earlier that administration of a treat containing a special cellulose preparation (Arbocel BWW40®), instead of a control treat without cellulose, diminishes the clinical signs of periodontal disease in dogs. Based on the physical characteristics of cellulose preparation, we hypothesized that treats with cellulose have greater elasticity and induce longer chewing time, leading to more mechanical dental cleansing. **Approach:** Treats without or with cellulose were subjected to bending and pulling tests in which the threshold before fragmentation, expressed as required force, was determined. The treats were also used in an experiment with dogs to determine chewing times. **Results:** The addition of cellulose to the treats raised the forced needed for bending and pulling until fragmentation by 12 and 99%. The inclusion of cellulose into the treats raised chewing by dogs of medium-sized and large breeds by 16 and 11%. In small-breed dogs chewing time was not affected by cellulose. **Conclusion:** The inclusion of the cellulose preparation into the treats induces a resistant and elastic texture which promotes chewing. It is suggested that the cellulose-containing treats maintain contact with the tooth surface which provides effective mechanical cleansing, explaining the observed improvement of periodontal disease in dogs.

Key words: Periodontal disease, chew treat, cellulose preparation, chew structure, chewing time, dental cleansing, bending resistance, chew elasticity

INTRODUCTION

The Arbocel BWW40® preparation of cellulose (J. Rettenmaier and Söhne GmbH + Co KG, Rosenberg, Germany) is a natural, highly purified product, forming a completely insoluble fiber network. This cellulose-based fiber is made by a special technique to achieve a very fine and defined particle structure. The so-called fibrillation technique produces fibers with high capillary effect and surface activity. We have tested the application of the cellulose preparation in the management of feline hairball symptoms (Beynen *et al*., 2011) and canine periodontal disease (Beynen *et al*., 2010).

The addition of the cellulose preparation to a complete dry food reduces hairball symptoms in cats (Beynen *et al*., 2011). When compared with the control diet, the feeding of the diet with added cellulose markedly lowered the incidence of vomiting, retching and coughing. Based on literature data we have suggested (Beynen *et al*., 2011) that cellulose ingestion causes delayed gastric emptying, leading to binding of single strands of hair to food particles so that more swallowed hair is transferred into the duodenum. The cellulose-mediated increase in transit rate of digesta may subsequently promote the excretion of hairs with the feces.

Administration of a treat containing the cellulose preparation, instead of a control treat without cellulose, diminishes the clinical signs of periodontal disease in dogs (Beynen *et al*., 2010). The sum of the changes in the severity of the 10 clinical signs of periodontal disease was used as an overall index of improvement of periodontal disease and it was found that the extra improvement caused by the treat containing cellulose was 17%. Given the physical characteristics of the cellulose preparation, we have speculated that its positive effect on periodontal disease may relate to additional mechanical dental cleansing due to resistance against disintegration and increased chewing time.

The present study was carried out to test our speculations on the mechanism of action of treats fortified with the cellulose preparation. Control and test treats with identical composition as those used in the

clinical trial on periodontal disease in dogs (Beynen *et al*., 2010) were subjected to laboratory measurements on the forces needed to break the treats by bending or pulling. Furthermore, the control and test treats were used in a chewing experiment with dogs to determine chewing times. It was reasoned that resistance of a dog treat against bending and pulling in combination with elongated chewing time will contribute to cleansing of teeth and thereby to the management of canine periodontal disease.

MATERIALS AND METHODS

Animals and housing: For the chewing trial, 24 healthy dogs of different breeds were used. The dogs were selected so that they could be divided into three body-weight categories of eight animals each. The dogs of small breeds had an average weight of 7.5 kg with range from 5.5-9.0 kg. The medium-sized and large breeds had mean body weights of 15.8 and 28.5 kg with ranges from 12.4-23.6 and 24.1-30.9 kg. The dogs were housed as various groups in kennels with outdoor fence. During the chewing test, the dogs were housed individually.

Design of chewing test: For one week prior to the test and during the test, all dogs were fed the same complete dry food (Royal Canin, Selection Croc). The daily amount food provided to each dog was in agreement with its maintenance energy requirement. The chewing test had a cross-over design with two administration periods of three days each and a test-free interval of three days. During each administration period, four dogs of each category received either the control or test treat. On each measurement day, one treat per dog was supplied between 14.00 and 14.30 h. Chewing time was measured using a stopwatch and expressed as time (sec) that the dog was actually chewing until the treat was fully swallowed. The observer was blinded to treatment modality.

The extruded control and test treats were produced by Rondo Food GmbH and Co. KG, Krefeld, Germany. The control treat was grain based, contained no added cellulose and had the following composition according to the manufacturer: crude protein, 16%; crude fat, 3%; crude fiber, 2%; crude ash, 9%, moisture, 17%. The test treat was made by adding 4% of Arbocel BWW40® to the control formula. The transversal cut of the treats had a star form. The weight of a single treat was about 26 g and the length and diameter were 15 and 1.9 cm.

Physical measurements: The tensile strength and elongation were measured with a Zwick material tester (T1-FRxxMOD.A1K, model 2005) that allows quantification of the force Needed (N) to either bend or pull a treat until fragmentation. For the bending test, the treat was placed horizontally on two supporting blocks on each side of the treat. From above, onto the middle of the treat, a pin was pushed downward until breaking of the treat. The force needed for breaking was recorded. To assess resistance against pulling, the treat was placed vertically between two clamps on each side. The top clamp was lifted until disintegration of the treat and the force needed was recorded. All tests were done at a standard room temperature of 23°C and at a relative humidity of 50%.

Data analysis: Chewing times for each dog were calculated as mean of the three-day administration period per treat. To identify significant differences between the physical and chewing values between the control and test treat, the data were subjected to Student's t test. One-tailed $p<0.05$ was preset as criterion of statistical significance.

RESULTS

Table 1 shows that the addition of cellulose to the treats raised the forced needed for bending until fragmentation by 12%. For pulling until disintegration, 99% more force was required when the treats contained the cellulose preparation.

Both the control and test treats were well accepted and the dogs started chewing immediately after administration. Only once there was a dog that did not fully consume the treat. On four occasions there was a dog that stopped chewing for an interval ranging from 16-55 sec. Table 2 documents that dogs of the small breeds chewed on average 42 sec longer than did the medium-sized and large breeds.

The inclusion of cellulose into the treats did not influence chewing time in the dogs of small breeds (Table 2). However, in the medium-sized and large breeds there was a 16 and 11% increase in chewing time when the cellulose-containing treat was supplied. These effects were statistically significant.

Table 1: Force needed to either bend or pull the treats until fragmentation

	Force, N (means ± SD)		
Characteristic	Control treat	Cellulose treat	P value
Bending resistance (n = 4)	12.6±0.44	14.1±4.33	0.013
Pulling resistance (n = 4)	20.8±0.46	41.3±3.29	0.001

Table 2: Chewing times needed to fully swallow the treats by three categories of dogs

	Chewing time, sec (means ± SD)		
Dog size	Control treat	Cellulose treat	P value
Small (n = 8)	101±50.7	102±51.0	0.441
Medium (n = 8)	55±17.4	64±22.0	0.026
Large (n = 8)	56±18.9	62±17.6	0.016

DISCUSSION

The test dog treats were fortified with a cellulose preparation forming a completely insoluble fiber network. This study shows that the cellulose preparation significantly raised the threshold before fragmentation after either bending or pulling of the test treats. Thus, the cellulose preparation contributes to a more resistant and elastic texture of the treats. The greater resistance and elasticity of the cellulose-containing treats corroborates the increase in chewing time that was observed in the medium-sized and large dogs.

Through the increased elasticity and chewing time, the test treats may maintain enhanced contact with the tooth surface, providing effective mechanical dental cleansing and thereby reducing or preventing dental plaque accumulation. It is likely that plaque formation is the initial stage in periodontal disease. Thus, the treats enriched with cellulose may reduce the clinical signs of canine periodontal disease. For the cellulose-containing treats, Fig. 1 illustrates the association between increased resistance against bending, longer chewing time and more improvement of periodontal disease.

The concept that mechanical dental cleansing promotes oral health in dogs is supported by studies comparing different types of food kibbles. It would be anticipated that food kibbles with an elastic texture stimulate chewing and penetration of the teeth into the kibble without breaking readily. Indeed, the feeding to dogs of kibbles with enhanced resistance against crumbling has been shown to reduce existing dental plaque and calculus (Logan *et al*., 2002) and also to prevent plaque and calculus accumulation (Jensen *et al*., 1995). The concept is also supported by studies in which a dry food was supplemented with chews, thus providing additional dental cleansing. The administration of supplemental chews has been shown to reduce dental deposits in dogs (Goorel and Bierer, 1999; Brown and McGenity, 2005; Hennet *et al*., 2006; Stookey, 2009).

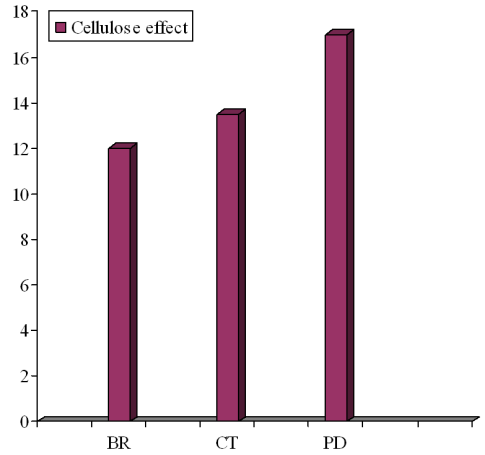

Fig. 1: Percentage effects of cellulose (Arbocel BWW40®) inclusion into a dog treat on its bending resistance and on chewing time and the improvement of clinical signs of periodontal disease in dogs. The effects are expressed as percentage difference versus the values for the control treat without added cellulose. The percentage effects in the figure are based on Table 1 and 2 and on Beynen *et al*. (2010). BR = bending resistance; CT = chewing time averaged for the medium-sized and large dogs; PD = overall index of improvement of periodontal disease

The small dogs weighing less than 10 kg displayed a markedly longer average chewing time than did the medium-sized and the large dogs. The treats with or without cellulose had no differential impact on chewing time. It is likely that the longer chewing time in the small dogs had nullified the impact of the difference in elasticity between the two treats. Possibly, the fortification of treats with cellulose may not induce further improvement of periodontal disease in small dog breeds. This could be relevant because it is generally accepted that dogs of smaller breeds are more prone to periodontal disease than medium-sized dogs. It has been shown that the administration of a supplemental chew to small-breed dogs diminishes dental plaque and calculus formation (Hennet *et al*., 2006). This observation may be a basis for research attempting to enhance the efficacy of treats for controlling dental health in dogs of small breeds.

CONCLUSION

The inclusion of the cellulose preparation into a dog treat significantly raised the force needed for bending until disintegration. It is reasonable to suggest

that the enhanced elasticity of the cellulose-containing treats led to the observed increase in chewing time displayed by medium-sized and large dogs. The stimulation of chewing activity may result in more mechanical cleansing of teeth. This would explain the improvement of periodontal disease seen in dogs after the administration of the cellulose-containing treats (Beynen *et al*., 2010).

REFERENCES

Beynen, A.C., F.V. Altena and E.A. Visser, 2010. Beneficial effect of a cellulose-containing chew treat on canine periodontal disease in a double-blind, placebo-controlled trial. Am. J. Anim. Vet. Sci., 5: 192-195. DOI: 10.3844/ajavsp.2010.192.195

Beynen, A.C., J. Middelkoop and D.H.J. Saris, 2011. Clinical signs of hairballs in cats fed a diet enriched with cellulose. Am. J. Anim. Vet. Sci., 6: 69-72. DOI: 10.3844/ajavsp.2011.69.72

Brown, W.Y. and P. McGenity, 2005. Effective periodontal disease control using dental hygiene chews. J. Vet. Dent. 22: 16-19. PMID: 15909452

Goorel, C. and T.L. Bierer, 1999. Long-term effects of a dental hygiene chew on the periodontal health of dogs. J. Vet. Dent. 16: 109-13. PMID: 10863520

Hennet, P., E. Servet and C. Venet, 2006. Effectiveness of an oral hygiene chew to reduce dental deposits in small breed dogs. J. Vet. Dent., 23: 6-12. PMID: 12593097

Jensen, L., E. Logan, O. Finney, S. Lowry and M. Smith, *et al*., 1995. Reduction in accumulation of plaque, stain and calculus in dogs by dietary means. J. Vet. Dent. 12: 161-163. PMID: 9693645

Logan, E.I., O. Finney and J.J. Hefferren, 2002. Effects of a dental food on plaque accumulation and gingival health in dogs. J. Vet. Dent. 19: 15-18. PMID: 11985120

Stookey, G.K., 2009. Soft rawhide reduces calculus formation in dogs. J. Vet. Dent. 26: 82-85. PMID: 19718971