

# A Breath of Fresh Air

## Oral care support from vitamin action

By Sarah-Jane Godfrey, DSM Nutritional Products



Oral health is one of the top three concerns for companion animal owners. It is reported that approximately 70% of cats and 80% of dogs develop some form of periodontal disease by the time they are 3 years old and that every dog or cat can be affected to some extent during its life. The increased awareness that oral health does not just affect the pet's oral cavity but impacts upon its overall health has meant that owners are seeking effective product solutions from the pet industry to help them maintain their companion's oral health. Further, such measures, in order to be effective must be prolonged and in the form of daily care. Consequently the diet as the source of the support is a logical solution. Vitamin C has been shown to be a highly attractive ingredient, well-known by consumers. It is also known to be important for the maintenance of normal oral health. The patented ingredient STAY-C® 50, a highly specialised form of vitamin C from DSM Nutritional Products, is clinically proven to provide nutritional support to oral health in cats and dogs and is an ingredient that is attractive to pet owners, offering pet food producers multiple points of differentiation for their products.

### Oral disease an on-going concern

During the last century, there has been a world-wide surge of interest in veterinary dentistry. Interstitial gingivitis or so-called pyorrhoea alveolaris" was reported in dogs as far back as 1899. In 1939 the prevalence of dental disease and requirement for surgical intervention in dogs was also reported. Dental disease is certainly not a new "modern" problem in our dogs or our cats.

Infection and inflammation of the gums and supporting tissues of the teeth, seen in periodontal disease, are caused by plaque, a sticky surface deposit comprised of bacteria, sugar and food residue and the formation of calculus or tartar, which is mineralised plaque. The problem starts when yellowish brown plaque and calculus are allowed to build up on an animal's teeth. In the absence of regular cleaning, it is within a few days that plaque attracts calcium salts and becomes mineralised. As plaque matures, gingivitis develops into periodontitis characterized by increased mobility of teeth, concurrent gingivitis and sub-gingival calculus. Untreated this can result in bad breath (halitosis), bleeding and inflammation of the gums, receding gums and the eventual loss of teeth. Halitosis due to periodontal disease is caused by plaque bacteria, which are attracted to the tooth surface within eight hours after teeth cleaning. Without adequate oral care the bacteria change from somewhat irritating strains to bone destroying types that produce hydrogen sulphide causing halitosis and pain. Such bacterial loads

and the damage to the integrity of the surface tissue can lead to the development of more extensive disease conditions.

A pet's diet generally is considered to be a major factor in the development of plaque and tartar. Clinical evidence suggests that soft or sticky foods propagate plaque formation while the abrasive action and increased salivary flow from mechanical devices, such as dog chews, or large, fibrous foods are considered beneficial.

### Increased awareness of the importance of regular oral care

If unchecked, development of periodontal disease does not just impact the health of the oral cavity but can also affect the animal's systemic health. Bacteria causing the infection in the mouth can migrate into the lymphatic system and blood vessels. In healthy animals the transient bacteraemia can be cleared effectively by the immune system, however, if not removed they may colonise other areas of the body impairing immune and organ function. Periodontal disease has been linked to conditions of the heart valves and pulmonary airways and changes in the kidneys, myocardium and liver. In people it has been linked to arthritis, low birth weight, heart disease, stress, anxiety, obesity and stroke.

The importance of dental care for companion animals means that dentistry is an integral part of the veterinarian training curricula with many now specialising and offering complete dental care services for

companion animals worldwide. Routine veterinary oral examinations are an important part of care for all pets. In addition, regular home care is necessary to help support oral health of companion animals. It is generally accepted that the most efficient oral home care method for dog and cat owners to remove plaque from their pet's teeth is by regular brushing with a toothbrush using appropriate pet toothpaste. This is not however a procedure that many companion animal owners can carry out effectively or even comply with. In a DSM pet owner survey only 16% of dog owners cleaned their pet's teeth every day, driving the need for pet products that provide a more complete approach to oral care.

### Products for Maintaining Oral Health

The pet industry has recognised its role in continuing to provide solutions that contribute positively to oral hygiene and a variety of products are available. Sometimes the fact that the product is dry and extruded is the basis of the oral health claim benefit, but their effectiveness to provide mechanical cleaning of the tooth can vary. Other products available include chews, which like some dry foods provide enough abrasive cleaning action to help remove plaque accumulation. Owners are also confronted by a number of products containing functional ingredients to further improve oral health. The three principal modes of action commonly implemented in oral care products for companion animals are: ingredients that reduce the growth of bacteria in the oral cavity; ingredients that are said to limit the formation of calculus, which leads to the development of periodontal disease; and ingredients that supplement the mechanical benefit.



For years, many human dental products have included vitamin C as part of their formulation because of the proven benefit associated with oral care parameters. The special form of vitamin C, STAY-C® 50 is added to toothpaste, mouthwash and teeth whitening products. Consumer awareness of health benefits surrounding vitamin C is very high.

### Micronutrients and Support of Oral Health

The development of dental disease has been linked to oxidative stress and a defect in the total antioxidant activity of saliva. The inflammation associated with periodontal disease is a direct result of the actions of bacteria and their by-products on the tissues and the indirect actions of the animal's immune system. In response to periodontal pathogens, polymorphonuclear cells (PMNs or neutrophils) release

### Did you know .....

- **Vitamin C has 100% awareness among consumers, 40% of consumers recognise vitamins as important to their health**
- **Of adults taking vitamin C, 89% believe it prevents illness and maintains good health**
- **62% of pet owners strongly agree that vitamin C helps maintain a strong and healthy immune system**
- **Of those consuming vitamin C supplements, 17% believe it influences gum disease**

destructive reactive oxygen species (ROS), for example, superoxide, via the respiratory burst, during the processes to destroy the pathogen. Although ROS have important roles to play within the body, these free radicals also detrimentally affect the tissues as they damage DNA, cause lipid peroxidation, protein damage, oxidation of enzymes and cause stimulation of pro-inflammatory cytokine release by monocytes and macrophages. Periodontitis has been described to be similar to other inflammatory disease such as rheumatoid arthritis, in which ROS are implicated to induce tissue damage. Biological fluids such as the saliva and gingival crevicular fluid, found in the gingival crevice, contain antioxidants which could be important in terms of protecting oral tissues from the negative effects of ROS. In dogs, it has been reported that those with gingivitis and minimal periodontitis had significantly higher total antioxidant capacity in the gingival crevicular fluid than dogs with advanced periodontitis.

The role of vitamin C and its importance in oral health remains unchallenged. Vitamin C is needed in the body for formation of collagen. This confirms its importance to the maintenance of oral health, supporting gum structure and the integrity of tooth placement. Vitamin C is also a powerful antioxidant in the body and also supports the immune system, subsequently supporting phagocytic leukocyte function. Vitamin C is also needed for regeneration of vitamin E, another important antioxidant. Vitamin E (tocopherols) is a fat soluble antioxidant that protects polyunsaturated fats in cell membranes from oxidation by lipid peroxyl radicals. Other nutrients that will influence antioxidant status are selenium, zinc, copper and manganese, all required for the function of the enzymatic antioxidant system. It is therefore important that when considering supplementation of foods a complete cocktail of antioxidant nutrients are provided to ensure adequate antioxidant protection at all times.

Deficiencies of vitamins A, B, and D have also been linked to periodontal disease. B complex vitamin (including folic acid, niacin,

pantothenic acid, and riboflavin) deficiencies have been associated with gingival inflammation, epithelial necrosis and resorption of alveolar bone in dogs. The functions of vitamin A most relevant to dental disease are its roles in cellular differentiation and the immune response. Vitamin A deficiency has been reported to cause changes in the gingival and subgingival tissues. B-Carotene, pro-vitamin A, is also an important antioxidant. Vitamin D is required for calcium homeostasis and deficiency has been reported to cause changes in the gingivae, periodontal ligament and alveolar bone. Vitamin D also supports the function of the immune system and in people it is suggested that it may play a role in periodontal disease development.

### Patented Vitamin C Oral Care Technology

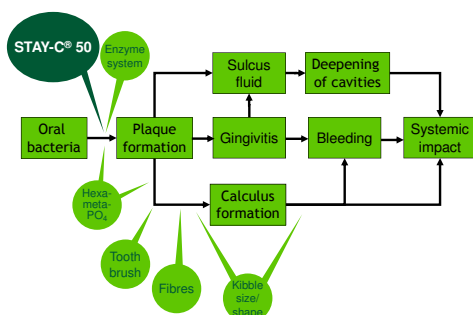
The active ingredient in STAY-C® 50 is a purified, highly bioavailable and stabilized form of vitamin C. Although, initially developed for the human dental care market, the action of STAY-C® 50 is clinically proven in dry pet foods, treats and edible chews. The solubility of this specialist form of vitamin C is vital for its effectiveness in pet oral care products as it rapidly dissolves in water (Figure 1). This is an important feature of STAY-C® 50 when considering the short period of time the food or treat remains in the oral cavity and the time available for it to dissolve in saliva.

**Figure 1: Comparison of vitamin C forms based on solubility and dissolution rate**

	Stability	Solubility in water
STAY-C® 35	Stable form; industry standard	~ 10 %
Ascorbic acid	Crystalline; not stable in pet food	~ 35-40 %
Stay-C®50	Stable form for oral care products	~ up to 50 % plus fast dissolution

When applied to dry pet foods, treats, and edible chews, STAY-C® 50 addresses the three main areas of oral care: plaque and calculus, collagen formation and immune function support. It is an ingredient that acts at the earliest opportunity in the oral cavity, compared with other oral care products or techniques to address areas that impact on the development of periodontal disease (Figure 2).

**Figure 2: Stay-C®50 acts within the oral cavity at the earliest opportunity**

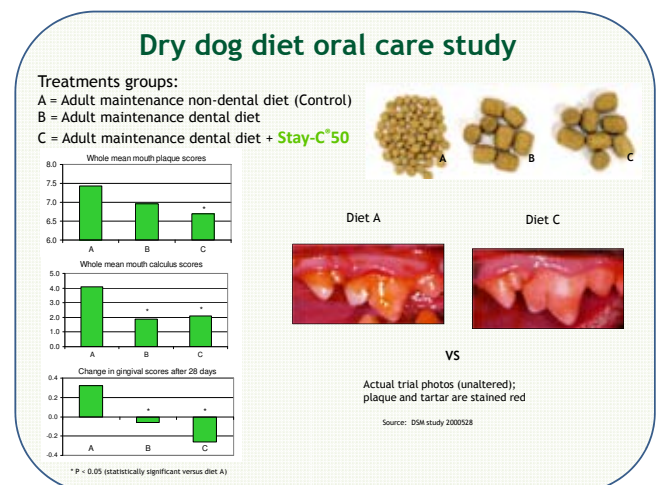


### Clinical Trials Support DSM Patented Oral Care Technology

All DSM clinical protocols to assess the efficacy of STAY-C® 50 in cat and dog products were designed to comply with the trial protocol requirements of the Veterinary Oral Health Council (see [www.VOHC.org](http://www.VOHC.org)).

### Stay-C® 50 Study in Dogs

Several clinical trials have addressed the efficacy of STAY-C® 50 (sometimes referred to as STAY-Clean) in dry dog products demonstrating its benefit to improving the measured oral care parameters plaque, tartar, and gingival scores. The most challenging trial evaluated the added benefit of STAY-C® 50 on an enhanced, extruded dry dog food with a much larger kibble size contributing to greater tooth penetration and abrasion specially formulated to maximize mechanical action.



These data confirmed that the enhanced diet formulated with STAY-C® 50 not only significantly reduced plaque and calculus indexes versus the control but there was also a significant improvement in gum quality after the dogs were fed the diet for the typical 28 days. The reduction in gingival scores was more pronounced after exposure to the enhanced diet with STAY-C® 50 compared to the enhanced diet without STAY-C® 50. This would imply that gum irritation caused by plaque bacteria, as well as the abrasive action of dry extruded pet food, can be counteracted by the addition of STAY-C® 50.

### Stay-C® 50 Study in Cats

The efficacy of STAY-C® 50 in improving oral care parameters related to a dry extruded cat food application was demonstrated in multiple controlled clinical trials. The data indicated that reductions in plaque and calculus scores were possible after the cats were fed the test diet formulated with STAY-C® 50 for 28 days, compared to the same diet without this ingredient. Studying the gingival status, it became obvious that only the group of cats exposed to the diet with STAY-C® 50 showed improved gum quality. In one study, the gums

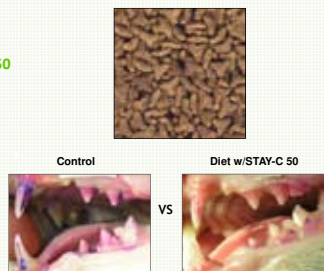
## Dry cat diet oral care study

### Treatments groups:

Control = Standard dry extruded cat food  
 Test = Standard dry extruded cat food + **Stay-C<sup>®</sup>50**



\*P < 0.05



Actual trial photos (unaltered):  
 plaque (blue) and tartar (red)

Source: DSM study 2000007

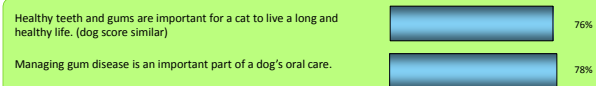
surrounding the molars and premolars of these animals showed up to a 20% improvement in gingival scores.

## Positive Consumer Reaction

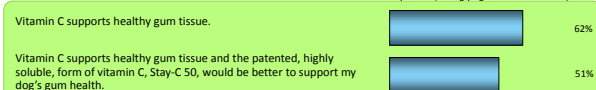
Two DSM consumer studies investigated the concepts “Stay-Clean” and “Freshening the Breath” which utilised the features of STAY-C<sup>®</sup> 50 to support the understanding that dental health is a concern for pet owners. Vitamin C, compared with other functional additives available on the market to support oral care, was found to be highly attractive to pet owners. For the Freshening Breath concept, the key measures liking, uniqueness, believability and purchase intent, pet owners stated they would definitely or probably would buy a premium dog or cat oral care food or dog oral care treat made with STAY-C<sup>®</sup> 50.

### Consumer perceptions related to the concept “Freshening Breath”

#### Pet owner's see the importance of gum disease



#### Pet owner's believe in (Stay-C<sup>®</sup>50) vitamin C



#### Pet owners are very interested in an oral care product with Stay-C<sup>®</sup>50

Based on the key measures liking, uniqueness, believability and purchase intent, pet owners stated they would definitely/probably would buy a premium dog/cat oral care food or dog oral care treat made with DSM's Stay-C 50

From DSM custom 2011 US consumer study  
 MarketTools report DSMN50417

## STAY-C<sup>®</sup> 50 - The marketing advantage

Vitamin C is a highly attractive health ingredient that combines significant public awareness with a positive health message. Combining the consumer perception of vitamin C with the proven functionality of STAY-C<sup>®</sup> 50 is extremely powerful when marketing oral care products for pets.

For more information on STAY-C<sup>®</sup> 50 applications, antioxidants or other nutritional solutions please email [sarah-jane.godfrey@dsm.com](mailto:sarah-jane.godfrey@dsm.com) or contact your local DSM representative.

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