NuPath Complex and Oral Biofilm Modulation
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The common disease states in the oral cavity, caries and gum disease, are both recognized to result from the action of certain groups of bacteria that reside in the mouth. Consequently, a common approach to dealing with these pathologies has been to attempt to kill these germs in situ, in the mouth. Approaches to this effort include using detergents in toothpaste as an aid to washing away the germs and the use of anti-microbial ingredients and/or strong essential oils as an aid to killing the bacteria. These products attack the biofilm, begin to denature it and increase the speed at which it becomes unhealthy. Indicative of this is published research that demonstrates that brushing without any toothpaste results in a healthier condition than when toothpaste is used. Also, we are now seeing for the first time anti-microbial resistant oral bacteria.

Recent research has shown that the populations of bacteria in the oral cavity live in communities or ecological niches known as the oral plaque biofilm, the oral biofilm. It is within this biofilm that all of the organisms that contribute to common oral disease states exist. What has emerged from the latest science is that this biofilm is a very complex structure, made up not only of the bacteria known to contribute to common oral diseases but also to organisms that are beneficial to the teeth and gums. Indeed, as a “community”, this entire complex is required to render a healthy biofilm. It is now also known that the oral biofilm, like other biofilms in the human body, has highly complex nutritional and waste systems, a sophisticated communication system, and a protective system that is highly resistant to attack from topical antibiotics, detergents and other materials.

The oral biofilm is a ecosystem that has evolved along with human life for as long as there has been human life. In fact, oral biofilms have co-evolved with every creature possessing an oral cavity and each of these biofilms is unique to the species. There are oral biofilms unique to dogs, cats, snakes, monkeys, etc. There were, doubtless, oral biofilms that were unique to each species of dinosaur. As creatures evolve, taking on new food sources and developing new biochemistries, their oral biofilm, evolves with them.

If the oral biofilm were only a destructive element, evolution would have, over eons, naturally selected creatures that were resistant to its formation and growth. Instead, as it is ubiquitous, there are, clearly, factors that convey to the host improved survivability. Emerging science only recently has confirmed that the oral biofilm, in its healthy and balanced state, does protect the tissues of the mouth in many ways and is indeed critical to oral health. Some of these protective benefits include abrasion resistance to the soft tissues owing to the lubricating effects of bacterial mucoproteins, protection from enamel demineralization from transient food acids, aiding in the beginnings of food digestion by their contributions of enzymes, a possible role in the synthesis of essential vitamins, and, perhaps most important, their resistance, within certain limits, to the over-colonization of the oral biofilm with bacteria that are harmful to the host.

As emerging science has shown that there are benefits to maintaining the oral biofilm in a healthy and balanced state, three questions then arise: what is a healthy and balanced biofilm relative to an unhealthy one, does the common approach of killing the germs best serve the interests of our oral health, and, if not, then is there an alternative approach that might better aid in oral health in light of this emerging science?
Every ecosystem, such as the oral biofilm, follows a predictable path of succession. A familiar example of ecological succession is that of a forest. Every forest starts as a meadow, with grasses gradually giving way to bushes and small trees, and these finally giving way to the tall trees that form a canopy. The canopy keeps the forest floor shaded and thus the grasses and some of the early ‘colonizers’ die off for lack of available sun. Depending upon environmental circumstances, some meadows will always remain meadows; some will progress to a mixed forest-meadow state, while others will progress to a mature forest. In much the same way, the oral biofilm has three stages of progression, but unlike the meadow-forest example, the nature of that progression is vitally important to the health of the oral cavity.

In its earliest state, the oral biofilm is characterized as being thin, clear, odorless, slippery, and populated by species of bacteria that require oxygen to survive (aerobes). The progression from this low-film thickness (LFT) biofilm to its next stage is dependent upon the biofilm staying in balance relative to the level of nutrients that are present around it. These nutrients come from a combination of carbohydrate food residues, as well as any nutrient rich fluids emerging from the crevices between the teeth and gums (gingival crevicular fluid) or dissolved within the saliva.

Oral biofilm progression is, first and foremost, a progression of thickness, as different bacterial species colonize the LFT biofilm and pile on top of it. If the nutrients available are either overly abundant in carbohydrate, or are rich in simple proteins, the LFT biofilm will be succeeded by medium film thickness (MFT) biofilm which will now contain organisms that can live in the absence of oxygen (facultative aerobes) and that can metabolize protein as a food source. This biofilm is thicker, no longer clear, is sticky, and may possess a faint sour milk or sour cheese odor owing to the lactic acid waste products of these newer bacteria. This state is also familiarly known as “plaque” and it is what the dentist hygienist removes during a cleaning (scale and polish).

Ecological progression from a MFT biofilm to a high film thickness (HFT) biofilm is a matter of continued presence of simple protein as a food source. If it is present, there will be a gradual drop in biofilm pH, favoring acid loving species, and the piling up of the biofilm itself, effectively suffocating the purely aerobic bacteria that are the basis for the LFT. This is akin to the tall trees keeping the sunlight from reaching the grasses, so that the floor of the forest no longer resembles a meadow.

A HFT biofilm is more proactive in gaining access to protein than is an MFT biofilm. Once the predominant metabolism is anaerobic and proteinophilic, as opposed to aerobic and carbohdratophilic, these communal organisms produce free radical oxygen species, mostly in the form of peroxides, which exit the biofilm at its juncture with the oral soft tissues and oxidize the lipids in the adjacent cell membranes. This has the effect of weakening these cell membranes and the result of this is that they become ‘leaky’, releasing some of their protein-rich cytoplasm extracellularly. Additionally, this process creates an inflammatory response in the host, which creates more permeability in the adjacent capillary beds and lymphatic channels, thereby allowing serum and lymph to enter the field.

Although these fluids contain cellular and humoral elements designed to fight infection and heal tissue, a HFT biofilm tends to be structurally sophisticated enough to assure its survival even in the face of such a response. Of course, without any immune response, as is the case post mortum, it is exactly this HFT biofilm that begins the process of reducing our proteins back to a state of ‘dust’.
Yet, if we are to resist decomposition of our bodies while we are still alive, we can either eliminate the HFT biofilm or drive it back from the ‘deep forest’ stage toe stability of the ‘green meadow’, and then maintain that healthy state.

As the biofilm progresses to the MFT and then the HFT stages, it becomes thicker, stickier and harder to remove during brushing or even a dental hygiene appointment. Often the dental hygienists is required to undertake more severe treatment including scaling and deep root planing. At the terminal stage of the oral biofilm, it has become a more calcified state known as calculus or tartar.

The common approach to dealing with this issue is to consider the entire bacterial ecosystem of the mouth as homogenous and bad, and to try to eliminate it completely through efforts to kill the germs and wash them away with detergents – very much like clear cutting and bulldozing down the entire forest, trees, brush, and grasses—just to rebalance the ecosystem. This approach also disrupts the healthy, symbiotic organisms that populate the beneficial LFT biofilm. Consequently, it is easier for non-traditional organisms, that is, those that through their own evolution have developed resistance to the various agents used in these common products (weeds in the forest analogy), to gain footholds in the early forming LFT biofilms and, unlike the synergistic organisms that have naturally evolved to aid and protect their host, these species have not evolved to possess these host-beneficial characteristics.

The result of the common approach is to create an oral environment that lacks the stability or homeostasis of a natively populated LFT biofilm, and the associated constant need to continually strip the biofilm away as a strategy for maintaining oral health. This approach lacks the enlightenment gained through the emerging science, that stabilizing the biofilm in its LFT state and driving the MFT and HFT biofilms back towards the LFT create a more healthful environment that is more resistant to all common oral disease processes.

A product engineered to make use of this emerging science and to stabilize LFT biofilms and drive back MFT and HFT biofilms is Revitin™, with NuPath® Complex. The formula is composed of four sub-units: the base, antioxidants, plant based extracts, and micronized minerals.

The base has been engineered for ideal consistency, detergent-free cleaning, low abrasivity, flavor, and natural preservation of the bio-active antioxidants. These ingredients are:

- Calcium Carbonate: a mild abrasive
- Water: a carrier of the other ingredients
- Glycerine: a moisturizer
- Hydrated Silica: an agent used to control consistency and, secondarily, as another abrasive
- Stevioside: a plant based, non caloric, not cariogenic sweetener
- Natural flavors: for taste and appeal
- Sodium Benzoate and Tetrasodium EDTA: vitamin preservatives

The antioxidants are ingredients intended to disrupt an important MFT and HFT food source, namely free-radical, cell damaged host protein. The anerobic organisms that overgrow the LFT biofilm encourage the host substrate to extravasate protein through the liberation of free radical oxygen species. By mixing potent antioxidants into the oral plaque biofilm, these free radicals are absorbed, preventing them from reaching the host soft tissue. This has the effect of starving the
proteinoophilic organisms and, secondarily, preserving the integrity of the host. These ingredients are:

- Vitamin E: a potent antioxidant
- Coenzyme Q-10: a potent antioxidant
- Vitamin C: a potent antioxidant

The plant based extracts are ingredients used to condition the biofilm to more readily interact with the various active ingredients, and to do so using only natural substances. These ingredients are:

- Quillaja Saponaria extract: a plant saponin that helps to increase the surface area of the biofilm during its exposure to the active ingredients
- Cranberry Oil: reduces the adherence of the HFT biofilm
- Xanthan Gum: a naturally derived vegetable gum that helps to hold the active ingredients together

The micronized minerals are ingredients intended impede certain biochemical pathways of the anaerobic constituents of the MFT and HFT biofilms. Some of these are prepared according to the Homeopathic Pharmacopoeia of the United States, a preparation method that results in extremely fine mineral powders, capable of penetrating and acting within the biofilm. Three of these ingredients:

- Calcium Phosphate HPUS
- Calcium Fluoride HPUS
- Silica Dioxide HPUS

are used as sacrificial minerals, owing to the fact that HFT biofilms extract these minerals from oral hard tissues and take them up into the biofilm. By increasing the concentration of these elements in the biofilm itself, the biochemical cascade for extracting these minerals from hard tissue is attenuated. Two additional micronized minerals are present in the formula, these are:

- Calcium Sulfate HPUS
- Dimethyl Sulfone (MSM)

These are used to create a surplus of sulfur in a non-amino acid form. Certain constituents of the MFT and HFT biofilms require sulfur attached to an amino acid (i.e. L-cysteine) as an essential nutrient. Metabolizing this entity results in inorganic sulfur compounds that are a waste product of the metabolism and also contribute to mouth odor (halitosis). By supplying non-metabolic and odorless sulfur compounds to the environment of the biofilm, a non-expellable waste product is introduced that acts to attenuate this metabolic cascade.

The result of using Revitin with NuPath Complex is an oral plaque biofilm that maintains the characteristics of a LFT biofilm and, if the ecological progression towards MFT and HFT biofilms begin, the product quickly brings the biofilm back into LFT homeostasis. All this, without harsh chemicals or detergents; without trying to kill the germs, but, rather, respecting the oral ecology and supporting friendly organisms that have been symbiotic inhabitants of our oral cavities for millennia.