The Amazing Oral Microbiome

with Dr. Jocelyn Strand, ND

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Dr. Jocelyn Strand: Hi, I'm Jocelyn Strand, naturopathic doctor and the Director of Clinical Education for Bio-Botanical Research, the makers of Biocidin®. And I'm here today to talk to you about the importance of the oral microbiome for systemic health. It's something I certainly wish I'd been more tuned into, in my own practice. I feel like I did a disservice not paying attention to the oral health of my patients as much as I could have. And so hopefully, by the end of this conversation, you all will understand the importance of evaluating the oral health of your patients and also have some tools that are easy to apply, to support the oral microbiome and its downstream effects.

There are 77% of the American adults in this country over the age of 30, that have some degree of gingival or periodontal disease and that number goes to 75% over the age of 65 with periodontal disease. So periodontal disease, it's a significant risk factor for a number of different systemic illnesses and we're going to go into those in depth.

In the mouth, there are over 700 species of bacteria with a mean of 296. In a single milliliter of saliva, there are 10 to the eighth microorganisms, and we swallow a liter or more of saliva each day. So a couple of important things here, there's a very high density or volume of microorganisms in the mouth. And not only are they there, but

when we swallow them, they do translocate to the gastrointestinal tract. So it does become very important to maintain a healthy microbial balance in the mouth.

I actually had this picture on a different slide with some information, but I didn't want to hover on it too long. But let me just tell you what this is, what you're looking at is the mouth of an elderly person in a long term care facility who is not getting regular dental care. What you see here is plaque or this is also known as a biofilm. And you can also see gingival and periodontal disease in this patient. And this is going to predispose this person towards a whole slew of other systemic inflammatory illnesses.

The mouth is not a single environment, there are actually several micro niche inside the mouth. So we have the tongue. The tongue has rugae and there are microorganisms that live down inside the rugae. Some of those are even active in the production of nitric oxide, and keeping blood pressure stable. So all sorts of different things in the tongue.

Attached gingiva, so that's the gums, the cheek, the lip, the hard and soft palate, these all have different epithelial niches and so they will house different microorganisms, some of them are beneficial and some of them can become pathological. The teeth are unique as a structure because they are a non-shedding surface, which is why you'll see this buildup of plaque or biofilms on the surface of the teeth.

Other non-shedding surfaces in the mouth would be any kind of dental restoration, crowns and bridgework, removable prostheses, dentures, and implants. So those are also non-shedding surfaces and they become an important place to make sure that oral hygiene is directed in order to remove those biofilms.

This is an example of a biofilm on a toothbrush bristle and this is the same biofilm at higher magnification. The main organisms responsible for the production of biofilm or plaque, which is that fuzzy teeth feeling in the mouth, are Candida and

streptococcus mutans. Those are two main players. And here you can see Candida and then it's associated biofilm.

What is a biofilm? A biofilm is an extracellular matrix that's produced by microorganisms. Usually, there's more or almost always, there'll be more than one different microorganism in each biofilm. And they do something called quorum sensing where they communicate with one another. And the way that that happens is that they're always releasing these signaling molecules and the signaling molecules, when they reach a certain density, it's because there are a certain number of organisms that are all gathered near each other.

And when they hit a certain density, it starts to bind the receptors inside of the microorganism, and they start to produce something called EPS, this extracellular polymeric substance. That is a very sticky substance and it becomes like an invisibility cloak that hangs out over the top of the microorganisms, and it has multiple activities that benefit the microorganism.

The first is that it protects them from our immune system. The second thing is that it protects them from any other harsh environmental conditions like antibiotics, antimicrobials, the mechanical activity of brushing your teeth. So to some degree, what they have done then is to produce a little envelope or pocket around themselves that then protects them.

More than 80% of microbial infections will have developed a biofilm in as little as two weeks. So any chronic infection, basically any chronic infection that you're dealing with is going to have an associated biofilm. Biofilm bacteria can resist antibiotic concentration. This is 5,000 research that I just looked at, said 10 to 1,000 times. So I'm not sure on the 5,000 but at least 1,000 times the antibiotics, they can resist when they are exposed to them if they're housed inside a biofilm.

Why is this important? As a clinician, why is it important to understand biofilms? The first is, biofilms can be a source of refractory illness. So if a person has got microorganisms behind a biofilm, these are the patients that look like they are on

antibiotics, they feel better. They come off the antibiotics, and they get refractory or recurrent illness again, and in two weeks, a month, two months later, they're having the same symptoms and having the same infection that they did before.

It's really important to evaluate the presence of biofilm or to treat it presumptively because there really isn't a way to test for it in most cases, for persistent biofilms. The other reason it's really important to understand biofilms as a clinician is that when you're using therapeutics that will work on biofilms, you're not just exposing your patient to the one microorganism that you're thinking they have. Like, say you're working with a patient and you're thinking, "Oh, this person has Candida overgrowth. I'm going to use an antimicrobial to go after the Candida." Well, also, if you're working with something like Biocidin, not only are you going after the planktonic or single cell of that microorganism, but you will also be working on the biofilms. And that means that exposure to multiple organisms, it means the die off of multiple organisms, and the exposure of their DNA to your immune system.

And it also means, everything that's housed in those biofilms is also going to need to be cleared by your immune system. And what is that? Well, that's lipopolysaccharide, which is a highly inflammatory metabolite released by gram negative bacteria. And it will include oxalates, and it will include heavy metals and solvent toxicity. Any endotoxins or environmental toxins that have floated by and been absorbed by that biofilm will then need to be broken down and processed.

And this is important to understand because once you do, you understand the importance of using a binding agent or something to mop up the damage or the biofilm that can occur when you break open and break down those biofilms, and have the resulting antimicrobial effect, anti-biofilm effect. That's called Herxing. People can react poorly to that, it can feel like the flu to a lot of people or it can be a completely discrete symptom from what they're complaining about when they come into your office.

If someone comes in and they have gas and bloating as their chief complaint or maybe they have oral biofilms, if you start working with anti-biofilm agents, then you

may see... I'll give you an example. So in my practice, I had someone with GI symptoms, SIBO like symptoms and when we started working with Biocidin, she got insomnia and anxiety.

And I thought at the time she was reacting to the Biocidin, and I have since learned and with that patient is where I learned that she was reacting to the breakdown of the biofilms. And when she was adequately supported, then she was comfortable moving through that to higher dosing and then achieving a therapeutic dose at that point.

The plaque biofilm does not shed naturally, as we talked about before and as it accumulates, it can become a key driver for dysbiosis, if you don't have adequate oral hygiene. Think back to that picture of the plaque and the gingival inflammation, and the periodontal inflammation. And you can think that all of those biofilms are like a reservoir for reseeding the mouth with dysbiotic or negative bacteria, and yeast or fungal issues as well.

If it's not removed and worked with, then certain bacteria will be able to emerge and then incipient dysbiosis can occur. Let's talk about the sequence of events that happens. So here we have modest inflammation and you can see right here is a little bitty biofilm. So this biofilm is sort of normal, it's totally normal to have biofilms in the mouth. The problem has been that when carb load is high, it drives the production of plaque that can damage the teeth, and can create this cascade of events. So the standard American diet does a lot to create a dysbiotic environment in the mouth.

[10:00]

Back to this, I'm going to get my laser pointer going here. So here you can see modest inflammation right here and this is sort of normal tissue on this side. But what happens is that we get a little bit of a biofilm here and the inflammation is actually the body's attempt to come in and clear the biofilm and the associated microorganisms.

Our body does that by sending neutrophils in. The problem is that the neutrophils are not active or effective against the biofilms and so then you end up with sort of a collateral damage created by the firing of the neutrophils. So you end up with inflammatory damage here and then it can develop deeper, create problems in the tooth itself, a periodontal pocket, inflammation of the gingiva itself, and eventually resorbed bone. So it actually can create and damage the periodontal ligament and cause tooth loss.

In addition to that is the production of the dysbiotic microbiota. So what you're looking at here looks really similar, right? This epithelial cell looks very similar to the gut. And what will happen is that not only the dysbiotic microbiota can then damage this area, causing what's called microbial shift disease, and then the release of those toxins that come with it. So gram negative bacteria can also exist in the periodontal pocket.

They produce something called lipopolysaccharide. And the lipopolysaccharide is a metabolite, it's so toxic to us that even nanograms injected into a human will generate physiological symptoms of septic shock. And so this is a highly inflammatory and mediated release of mediators from the gram negative bacteria here. That then circulates, causing damage to a number of different barriers.

We're talking about increasing inflammation contributing to autoimmunity here, promotion of atherosclerotic plaque. So you can imagine with inflammation circulating in the bloodstream, that you're going to increase the damage to the endothelial tissue and the promotion of plaque, and then neural autoimmunity as well. So, damage to the blood brain barrier and the crossing of both bacteria and its associated metabolites into the brain.

Let's go into each of those in a little bit more depth. Periodontal disease, among the most common oral infectious diseases, associated with the establishment of a highly pathogenic biofilm that triggers an immune inflammatory host response. So again, it's the host response that's creating the issue here and that leads to the destruction of supporting periodontal tissues and eventual tooth loss.

Due to the anatomical proximity... this is one of my favorite things to talk about, the anatomical proximity of the periodontal biofilm to gingival bloodstream, periodontal pockets may act as reservoirs of microbial pathogens and their products, as well as inflammatory mediators and immunocomplexes that can disseminate to other sites in the body. So very succinctly put, you're going to get exposure not only to the pathogens, which is transient septicemia, but also to their metabolites.

Here's progression again, gingivitis. Starting out, you can see how inflamed the tissue is here, progressing to periodontitis, and you can see destruction of the surrounding gingival tissue and eventually, to dental caries or cavities. And periapical abscess as a possibility as well, which means all of that adjacent blood flow and again, translocation of the microorganism directly from an abscess into the systemic circulation.

The response, again, bacteremia immune response, endocarditis, pericarditis, and heart failure, all associated with that. Here you can see that the immune metabolites, so LPS binds toll-like receptor 4, and then that will initiate through NF kappa Beta, the release of all of these inflammatory cytokines. You can see the whole list here, so all of the bad guys, right? IL-1, IL-6, TNF-alpha, are increased. And then they have to be processed by the liver where they can also cause damage as well. This particular article associates oral dysbiosis to atrial fibrillation.

How big a role does this play? Well, the research published in the Journal of Dental Research showed that people with untreated tooth infections are 2.7 times more likely to have cardiovascular problems like coronary artery disease than patients who have had treatment of dental infection. That is highly motivating to me, right? So, especially right now, I think in the current climate, we need as much support as we can have for systemic infection, and I think it's a really easy and modifiable risk factor to work with treatment in the mouth.

And I mean, speaking of what's going on in the world now, let's talk a little bit about the pulmonary link to oral health as well. So the microbiota of the lung more closely resemble those of the mouth than any other body site. That seems like it makes

sense, right? It's logical, the mouth and the lungs are closely associated with each other anatomically. But also, when we're sleeping at night, we have a depression of our respiratory reflexes, and we'll have some micro inhalation of saliva.

And so we're basically inoculating directly from our mouth into our lungs. And just as a point of awareness, without any kind of claim by the company, but a piece that maybe could be very helpful to a large section of the population right now is that people who have COVID complications are much more likely to have an altered pulmonary microbiome. So if that's the case, then we would assume that working with the oral microbiome could potentially set that person up for improved outcomes for any kind of inflammatory disease.

In every lung disease studied to date, the lung microbiome is altered. I thought that was stunning. When I was in medical school, we didn't talk at all about the pulmonary microbiome. In fact, we thought that it was a sterile environment, unless there was an infection like pneumonia or something like that, that had overcome or infected the lung tissue. We didn't talk at all about the pulmonary microbiome. We now understand through research that there is a pulmonary microbiome and that healthy people have a different pulmonary microbiome from people with lung diseases.

Oral health is also associated with autoimmune disease. So 1,676 subjects aged 30 to 40 years old were randomly selected and followed for 30 years. So, a very long term study. And the results showed that subjects with higher plaque index, so again, those biofilms, a marker of poor oral hygiene, were more likely to develop autoimmune diseases in 30 years. So again, that contribution, most likely the mechanism there again, is that constant release of pro inflammatory mediators.

There are certain microorganisms that are sort of bad players or dysbiotic organisms that we acknowledge in the mouth. One of those is porphyromonas gingivalis. This is a really cool slide because there's just a lot going on here. So let's dive into it a bit. The keystone periodontal pathogen, pseudomonas gingivalis, enters

the bloodstream during episodes of transient bacteremia and it will gain access to the brain, so we talked about that, because of damage to the blood brain barrier.

Periodontitis can exert its influence indirectly, by sustaining peripheral inflammation and this can affect the glial cells then by priming them into a pro inflammatory phenotype. So we're looking at neuro inflammation. In addition, this could also overload an overwhelming clearing of toxic neuro peptides from the central nervous system. And the potential causal relationship of periodontitis and Alzheimer's disease is further supported by shared risk factors then.

You can see here the comorbidities, environmental factors, so smoking, low level of education attainment, poor nutrition, and lack of physical activity. So here you can see keeping active, eating healthily, and exercising. I think all of us as practitioners know that modifying lifestyle is one of our most powerful therapeutics for our patient and that's certainly borne out in the research as well. And just realizing that the microorganism can enter the central nervous system and remembering that this is a modifiable risk factor, meaning that we can work with this; we can work with oral health and with the pathogens that are there.

More information and connection to systemic diseases directly related to porphyromonas gingivalis. We have cardiovascular disease, in the form of atherosclerotic and myocardial infarction, abdominal aortic aneurysm and hypertension. Oncology, squamous cell carcinoma, esophageal cancer, and pancreatic cancer. Diabetes, non-alcoholic fatty liver disease, pneumonia, COPD, Alzheimer's, we have talked about. Depression, rheumatoid arthritis, and poor pregnancy outcomes. So imagine what a difference you can make for your patients, being aware of and then working with the oral microbiome.

Less than one minute after an oral procedure, organisms from the infected site may have reached the heart, lungs, and peripheral blood capillary system, and this is why the founder of the company, Bio-Botanical Research, Dr. Fresco, likes to use botanicals before and after a dental procedure to help support the body's ability to

fight off these microorganisms and to address in other ways, too. So we'll talk about the activities of botanicals specifically for this purpose.

[20:10]

Look at this long list, all of these are associated with dysbiotic oral pathogens, erectile dysfunction, cardiovascular disease, kind of, we talked about that ad nauseum, driving that point home. Atherosclerosis, Alzheimer's, pancreatic cancer, breast cancer, kidney disease, respiratory infections, esophageal cancer. So, a long list.

Stillbirth, preterm and low birth weights, colorectal cancer, oral cancer, ulcers, stomach cancer, lung cancer, and a few more. Adverse pregnancy outcomes. We talked about inflammatory bowel disease, meningitis or brain abscess, lung liver, or splenic, abscess, appendicitis and diabetes, all of these associated with a dysbiotic, or pathogens in the mouth.

We talked a little bit about Candida as one of the main players in the production of plaque in the oral microbiome. And what I thought was interesting is that we have talked about translocation of microorganisms directly from the mouth into the bloodstream; they also translocate from the mouth into the gut.

Remember that 10 to the eighth microorganisms in a milliliter of saliva and we swallow a liter a day, and this study showed that people who brush their teeth after every meal had a significantly lower level of Candida in their stool. So another reason to pay attention to what's in the mouth is the effect that it will have on the ecology of the microbiome in the gastrointestinal tract.

This is an image of the gastrointestinal tract here and the epithelial lining of the gastrointestinal tract. And as anything comes down the lumen of the gut as part of the beginning, at the beginning of the stool, or it will... what happens is pathogens or any kind of antigen... so a pathogen, it can be a toxin, it can be a food antigen, will come bumping along here. And the dendritic cell here is constantly sampling what's in the gut.

What happens when we get dysbiosis is this increase, again, in cellular metabolites, including lipopolysaccharides, which is here, LPS. That increases permeability, so very similar to what we were talking about in the oral mucosa as well. So these metabolites go directly across the intestinal lining, into the bloodstream. What's interesting is that the first stop then is the liver, which will clear and take the hit on most of the LPS. But when our LPS rises to a certain level, that will escape and cause systemic inflammation.

Here we have TMA that will be converted to TMAO, which is a high risk factor for cardiovascular disease. And actually, it's so closely linked to intestinal permeability that it's now being developed as a way to test for intestinal permeability. We also have the LPS stimulating NF kappa Beta, again, inflammation, and then the platelet aggregation, the formation of foam cells. And ultimately, we have occlusion of the endothelial lining or endothelium, causing occlusion of the blood vessel itself.

So, LPS, let's talk a little bit more about it. Metabolic endotoxemia is defined as a two to three fold increase in LPS and it's commonly found in cardiovascular disease patients. But even modest increases in LPS can increase fat deposition, insulin resistance, chronic inflammation, damage to the mitochondria, pro atherogenic endothelial adhesion, so then we're talking about a pro thrombotic state, and the accumulation of plaque in the arteries. As sort of the end point, and obviously an increasing risk factor then for cardiovascular disease.

Remember, when we're talking about cardiovascular disease, that it is the leading cause of death in the United States. It affects 48% of our adult population. Coronary artery disease is the most prevalent, stroke is the second most prevalent, and 90% of stroke risk is due to modifiable factors.

If we as clinicians have the ability to affect change in those modifiable factors, then we can support our patients and reduce their total risk. Hypertension is the most common form of cardiovascular disease, and it is a major modifiable risk factor as well. And that's an area where we can work as clinicians, and we can support our patients.

This is a picture of a biofilm on a heart valve. So in addition to the metabolic effects of dysbiosis, intestinal permeability allows the translocation of microorganisms from the GI tract into systemic circulation. Studies have detected the presence of microbial DNA in atherosclerotic plaque and in the fat around the heart. Research shows that these bacteria can be oral or GI. So that's really important to remember, either translocation from the mouth or from the gut can hole up and create biofilms in the endothelial cells of the cardiovascular system. Biofilms are a source of constant and spontaneous inoculation of pathogens, and are resistant to immune activity and to medications as well.

Okay, what you're looking at, I love this slide, I just think it's so fascinating. If you look closely, you can see that there are a few tiny little green spots. This is a confocal microscope image of activated microglial cells and there are only a few activated microglia scattered throughout the brain. That's a normal level and this is rat brain. After infusion with LPS, this is what happens to the neural glial cells, this highly activated brain. And this is the same brain tissue at a higher magnification. So LPS, causing activated microglia and a central nervous system inflammation.

Biofilms can be good under a healthy state, but they can be pathogenic or be an ongoing source of many inflammatory metabolites and pathogens. So LPS and other metabolites inside the biofilm will be produced continually. Our immune system is ineffective against them. This is just a little bit of a review before we move into therapeutics. So our immune system is ineffective against biofilms and instead of being able to kill it, it creates inflammation in the adjacent tissue and a lot of collateral damage.

We get inflammatory damage to hepatocytes and to the Kupffer cells, which are the immune cells in the liver. We have retention of toxins in the extracellular matrix of the biofilm. Those are so toxic, the biofilms are so toxic, because they actually hold on to heavy metals and organophosphates. And they're so good at that they're actually used at toxic waste sites to bioremediate areas that have high toxic load.

That should tell you the importance of making sure that you help a patient clear those bio toxins and maintain a healthy microbiome. Retention of endogenously produced toxins as well. And then it's also again, an ongoing source of dysbiotic organisms, preventing balance not only in the GI tract, but also in the mouth. And we have microbiota everywhere. We have it in the genital urinary tract as well, in the ears, in the sinuses, and on the skin, there's a microbiome everywhere. So this is an area that could apply to any body system.

What do we do? Now that we know the importance, how do we manage that? Well, gratefully, there are botanicals that have been around for centuries, that can assist us in managing to create and support a healthy microbiome, both in the mouth and the gastrointestinal tract. I'm going to read this out loud because to me, it's so perfectly put.

Historically, combinations of herbs, usually referred to as formula, in some cases, combining as many as 20 to 30 herbs, were commonly employed. This exponentially increases the range of possible interactions between the constituents in the various herbs themselves as well as in the human body. We have empirical knowledge of plants based on millennia of use. Plants often have a positive synergistic effect on medicines such as antibiotics and chemotherapeutic agents. The complexity of botanical medicine is ultimately a delight.

This is what I think is really interesting. I think it's easy to get apologetic or to feel sort of sheepish that we don't have a double blind placebo controlled clinical trial on everything that we try for our patients' sake in functional medicine. And there is research out there, but also, we have this millennia of use of these products, showing their safety, showing their efficacy. And really, it's such a useful... and I say low intervention. I think as a naturopathic doctor, what that means to me is that it's gentle.

It means we're working with the body in the gentlest, most effective way. It's a way for us to support our patients. And I want to break down a little bit more of what he said here, which is that you have a synergistic effect, oftentimes when you use formulas.

[30:00]

A really key example and one that applies to this conversation is if you have an antimicrobial herb, it's going to have better efficacy if you include a biofilm busting herb or a biofilm breaking down, or a herb that breaks down biofilms.

That's really intuitive, right? If you break down the biofilms, the antimicrobials will have better access to the microorganism. Not only that, but a lot of those botanicals, not only will they be anti-microbial, but they may also have an effect on the immune system, supporting host immune defense. They also may have an anti-inflammatory effect. They may have an antioxidant effect. They may have an analgesic effect.

And so we get these multiple levels of therapeutics, you don't have just one activity of the product. So it's so beautiful and graceful the way that botanicals can be used to support health, and I really feel as though they're a gift to us, these botanicals, in supporting health in our bodies.

There is research showing that essential oils. So in this particular one, what they found was that here we show that selected antimicrobial essential oils can eradicate bacteria within biofilms with higher efficiency than certain important antibiotics, making them interesting candidates for the treatment of biofilms.

Biocidin is a combination of 17 herbs and essential oils and we do have research showing the breakdown of a number of different biofilms. So that included beryllium; that includes klebsiella, E. coli, and pseudomonas. We've actually had pilot research and published research on some of those microorganisms.

The other synergistic piece that I wanted to mention before I move on and forget was that in the research that we did with borrelia, we were able to see that synergy with conventional therapeutics when the killing dose... this was in vitro, the killing dose of ceftriaxone went down to one eighth its normal killing dose when it was used alongside the Biocidin. There are multiple reasons for that but the one that we really

think caused that was the breakdown of the efflux pump, which I will talk about here shortly.

Essential oils for anti-microbial activity. Look at how long they've been used, used for mummification in ancient Egypt, used to disinfect hospitals during World War One, galbanum was mentioned in the Old Testament and one of the oldest recorded histories of beneficial use. Both of these are essential oils that are in Biocidin. In addition to the essential oils, we also have the activity of proanthocyanidins and tannins that will also help with the disabling or dismantling of biofilm communities.

These are all the different stages of the production and maintenance of biofilms. Here you can see quorum sensing. We talked a little bit about that already. It's when they're communicating with each other and deciding when the right time is to develop a biofilm. And then we have attachment, we have swarming motility, and then the efflux pump inhibition also plays a huge role or efflux pump plays a huge role in the production of a biofilm as well. So when you look at the ingredients in Biocidin, it becomes clear why it has the effect that it does in the body and in vitro in our pilot research. Each of these ingredients act in all of these different ways to support the breakdown of biofilms.

This is a look at our pilot research. This is a graph showing the breakdown of pseudomonas. Here's the control here. You're looking at two different lines because one is what's called planktonic microorganisms, which means free floating, it's not yet produced a biofilm, and the other is a biofilm community. And here you can see the immediate breakdown. And this is pseudomonas, a notorious biofilm producer. Most biofilms are most often studied with pseudomonas because it's so notorious for biofilm production.

And then we have E. coli here, which again, an immediate drop, and then over the course of 24 hours, a total eradication of the biofilms. This is klebsiella pneumoniae, another well-known microorganism for the triggering of autoimmune conditions. And you can see here an immediate drop in the planktonic, so those are free floating.

And then the biofilm, when you look at it, it looks like it sort of mounted a little response and then it couldn't exist after that. And here is a picture of it through microscopy. This is a Candida biofilm. After one hour, a total dismantling of that Candida biofilm and then, 24 hours later, further dismantling and totally unable to reestablish a biofilm in the presence of Biocidin.

Efflux pump, I did talk a little bit about that already. The efflux pump takes an antibiotic, so, this is a mechanism for antibiotic resistance or antimicrobial resistance. If a cell recognizes a pathogen or any cell recognizes that it is dangerous, it can take that and pump it right back out into the environment so that it cannot cause damage to the cell. So, Biocidin was able to break down this efflux pump, in addition to it generating antibiotic resistance.

Another role of the efflux pump is to help with the production of biofilms. So, it actually also creates efflux of the metabolites that are necessary for the production of the extracellular matrix. So an important piece for the breakdown of biofilms as well. And efflux pumps are much higher in volume or density in a biofilm community than they are in a planktonic cell.

The question that we get the most often about Biocidin is, "Well, okay, so it breaks down biofilms and kills pathogens. What about the good guys?" So doing our due diligence, we had this pilot research done with Sun Genomics, which is a full genome sequencing. What we looked at was a stool test and then eight weeks of the Biocidin, and GI detox. And then retesting, no other changes were made. And then we were evaluating, what we were looking at is whether or not the beneficial microorganisms weren't negatively affected.

This is just one person and I selected some of the probiotics of note on this person. You can see here, faecalibacterium prausnitzii, that's an important microorganism for the production of short chain fatty acids, which helps with reduction of systemic inflammation. And then we have lactobacillus and bifido, obviously, well known probiotics. Akkermansia muciniphila, here is an obligate anaerobe that's a keystone

species for beneficial microorganisms; it helps with the reproduction of other beneficial microorganisms.

The way to read this is this is before, and this is after, so we're able to see time point one, time point two, the volume of these microorganisms in the stool. So we didn't see it wipe out and in fact, what we were able to identify was, you can see here, akkermansia muciniphila, was that there was actually an increase in akkermansia in all but one of these participants, and the one that didn't have an increase didn't have any to begin with.

This is total probiotic abundance here and again, all that one person had an increase in their total probiotic abundance. Not only that, but no one had a wipe out of all of their beneficial microorganisms. So, what these botanicals offer is a solution that promotes the health and wellbeing of the beneficial microorganisms. Thanks very much for having us and for tuning in. I hope you have a great day and that you all stay healthy.