Fact or Fiction?

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Saliva: More Than Just Spit

World Series time is perfect for watching a bunch of multimillionaires spit. Many managers and players, seemingly oblivious to the fact that millions of people are watching them, practice this odious activity, often with high frequency. The all-time champion in my book is Terry Francona, manager of the Boston Red Sox who seemed to be constantly letting goo fly. To top it all off, the television cameras delight in focusing on "spitters." What kind of message does this send to youngsters watching the game? Do you allow your little leaguer to spit?

Regardless, what a great lead for this month's topic.

Spitting is an excellent way to spread a number of diseases, notably tuberculosis. Others are meningitis, pharyngitis, pneumonia, measles and influenza.[1] The reason is that saliva has a lot going for it. The mouth is a perfect environment for growing bacteria, viruses and fungi. Theodor Rosebury computes that under healthy conditions, saliva contains some 10^8 to 10^9 bacteria per milliliter.[2] Donna Mager of the Forsyth Institute estimates there are more than 700 species of commensal mouth bacteria, all living in distinct niches in about 33 square inches of the oral cavity, as dentists call it.[3] Yet, she says, "Most of the bacteria in our mouths are our friends." Kathleen McGowan adds, "Despite the bad actors, you will rarely get an infection by biting the inside of your cheek. That's because saliva has a host of unique antibodies and antimicrobial compounds that can cause bacteria to clump together or to explode."[3]

Saliva is powerful and critical to our existence. It heals wounds and disables pathogens. It is the perfect lubricant, permitting us to effortlessly eat, talk, kiss and play a slide trombone.[3] We secrete between half a liter[4] to three liters of saliva a day.[5]

Saliva is 99.5% water, but the dissolved chemicals in the other 0.5% play a crucial role in oral and dental health, as well as their obvious one of providing digestive enzymes.[4] Table 1 presents a formula for "fake saliva," courtesy of Art Kushner.[6]

Table 1- Fake Saliva[6]

Component	Concentration (g/L)
Sodium chloride	0.4
Potassium chloride	0.4
Calcium chloride	0.8
Monosodium phosphate	0.7
Sodium sulfide	0.005
Urea	1.0

John Emsley notes, "The pH of saliva is effectively neutral, being 7.0, and it is designed to promote remineralization of the tooth enamel. It can do this, provided the pH does not fall below 5.5, at which point slight demineralization occurs. Lack of saliva is known as xerostomia, and this is a symptom of many conditions, including being a side effect of some common drugs. Chewing gum is an ideal remedy."[4]

Saliva and medicine

Saliva tests for cancer, diabetes, infections and the tendency to develop cavities are currently in the works. Many researchers say that these tests have the potential to transform much of medical diagnostics into a more convenient, less expensive and less painful exercise, giving spit a long overdue public relations boost.[7]

One malady for which saliva testing is quickly proving worthy is oral cancer. The disease is newly diagnosed in more than 350,000 people worldwide each year and can be disfiguring or deadly if not diagnosed early. Although many dentists give their patients yearly exams for oral cancer, it's often difficult to detect before it progresses to a dangerous stage.[7]

Scientists are reporting that, instead of blood tests and biopsy, saliva can be used to detect primary Sjogren's Syndrome (pSS), an autoimmune disease which affects approximately four million Americans, 90% being women. Patients with pSS are 40 times more likely at risk than healthy people to develop lymphoma, a fatal lymphocytic cancer.[8]

Men's saliva has yielded a painkiller three to six times as powerful as morphine. The French team that isolated the substance, which they named opiorphin, hope that it may spawn a new generation of painkillers without the negative addictive and psychological effects of morphine. Opiorphin is thought to work by stopping the destruction of natural opiates called enkephalins in nerve cells. The French researchers say that opiorphin is such a simple molecule that it can be easily synthesized for further evaluation, rather than having to be isolated from saliva itself. Alternatively, it might be possible to find drugs that trigger the body to produce its own opiorphin.[9]

In recent decades, researchers have discovered that saliva contains a lot of information about the body. For example, the technique of measuring sex hormones in saliva is well established. Newer HIV tests can detect antibodies to the virus in saliva, and there are even salivary tests for illegal drug use.[3]

In 2002, the National Institute of Dental and Craniofacial Research offered $57 million dollars to scientists to build tools to detect the molecular components of saliva. A sample of saliva can have within it DNA, RNA, proteins, germs, viruses, fatty acids and a host of interesting molecules useful in disease detection. This was a sign that the government was putting serious effort behind developing a saliva-based diagnostic test for various diseases.[10] This sponsorship has resulted in a portable, phone-sized test that in minutes measures proteins in saliva that may indicate a developing disease in the mouth or possibly elsewhere in the body. This point-of-care test could become a common sight in dentists' offices. As envisioned by the researchers, a dentist would collect a small saliva sample with a

patient's consent, load it into the diagnostic cartridge, start the assay and have a readout waiting after a cleaning or a dental procedure has been completed.[11]

A team of scientists and engineers led by Daniel Malamud at the University of Pennsylvania has developed a robust means of analyzing oral samples. They believe their work will lead to a kit, not much bigger than a credit card, which could detect exposure to a variety of substances, from narcotics to anthrax to common bacteria and viruses. Their plan would increase ease of detection and accelerate response time whether it was used in the middle of a public health incident or in a busy doctor's office.[12]

Called IMPOD, the device is described in the March 27 issue of the *Proceedings of the National Academy of Sciences*.[13] In the report, the scientists offer the results of proof of principle experiments in which IMPOD reliably measured the concentrations of MMP-8, an enzyme associated with chronic inflammation of the gums called periodontitis.

Saliva has more uses than the average person thinks. Besides the obvious uses such as aiding a human in breaking down the food one masticates in their mouth, saliva can also be very useful in crime. For example, one can find a person's DNA or blood type from saliva. Saliva can also be used to detect drugs in the human body.[14] A saliva sample for narcotics testing can often give a more accurate representation of what's really going in the body than urine. Some drugs, like cocaine, can appear in the saliva long before they show up in urine.[15]

A forensic investigation can involve the analysis of body fluids, including saliva, for evidence of toxins and both prescription and illicit drugs. Obtaining a saliva samples is far less obtrusive and cumbersome than obtaining a blood or urine sample, especially at the scene of an accident or crime.

Animal saliva

How about some new toothpaste and antiseptic creams? James Randerson notes, "Anti-bacterial chemicals formed by the saliva of sucking calves could soon be added to products such as toothpastes and antiseptic creams. The chemicals are part of the antibiotic arsenal in cow's milk that helps protect newborn calves while their immune systems develop. This arsenal includes antibodies to specific microbes. But lipoproteins (proteins bound to fats) are also broken down by enzymes in the calf's saliva to produce free fatty acids along with residual protein. This residual protein can bind to many bacteria and fungi, preventing them from sticking to surfaces such as cells or teeth. When human volunteers used toothpaste containing the compounds, build-up of dental plaque slowed by two-thirds."[16]

Humans are a significant source of phosphorus. Each human being excretes a minimum of 1.5 grams of phosphorus per day, so that the annual input alone is around three billion pounds of phosphate, as $P_2 0_5$.[17] Canadian and Danish scientists have engineered pigs to secrete an enzyme in their saliva that reduces the polluting phosphorus content of their manure by up to 75%.[18] Could the same thing be done with humans? Think of all the phosphorus waste that could be eliminated. **P&SF**

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