CALL OF THE WILD:
TAXIDERMY TANNIC ACID/TANNINS IN EMBALMING.
A DEAD-END ROAD TO FORMALDEHYDE-FREE CHEMICALS.

By James H. Bedino, Chemist/Director of Research
The Champion Company

Tannic acid or tannins are the latest attempt to replace formaldehyde in cavity fluids in the embalming industry. The goal is admirable but, there's only one problem, they just don't work. Tannins have some serious problems and just won't translate to embalming of human remains. What are tannins, why would they be used and what exactly are the problems with this failed strategy of formaldehyde-replacement embalming? These questions and other topics will be discussed and answered in our current article. As always, brutal honesty abounds with no apologies for speaking the truth. With that in mind, I invite you to read on. One more thing, be certain to check out the postscriptum where I discuss this whole notion of humor, truth, and decorum.

As most in the embalming industry know, but would prefer to pretend otherwise, formaldehyde is the most serious exposure/health/disposal/use hazard that exists in embalming. We are basically embalming like we were in the early 1900's, with the same techniques, same simple instruments, and with the same toxic/carcinogenic formaldehyde mixtures with essentially the same results. Any frontiersman undertaker of the late 1800's, early 1900's would be proud, indeed. This situation is unacceptable, untenable and indefensible. Consequently, the path to the future involves drastic reduction/elimination of formaldehyde chemicals and replacement with reduced hazard alternatives with the goal being reduced overall toxic exposure values from the chemicals in embalming while still retaining reasonable embalming results.

Champion has virtually single-handedly explored this toxic reduction road with its reduced exposure glutaraldehyde/formaldehyde blends of the Second Generation and the glutaraldehyde-driven formaldehyde-free formulations of the Third Generation Millenium New Era line of embalming chemicals. These chemicals offer significant to near complete elimination of formaldehyde with drastically reduced overall exposures to embalmers, during their use. But, are there other effective formaldehyde-replacement chemicals out there that have not been investigated or utilized by The Champion Company? Let us delve further into this interesting topic.

At first thought, tannic acid/tannins seem like a real possibility, after all aren't they used to tan and preserve animal hides? You are absolutely right — they are very effective taxidermy tanning agents under the right set of circumstances. Unfortunately, they are mostly a dead-end road to the elimination of formaldehyde in classic, old-style embalming with the results being far from a traditional formaldehyde embalming and

unacceptable to most embalmers. Laughably, this is being touted as some kind of a "breakthrough" and involves "secret ingredients". I think you can figure out the "secret" from just reading the title of this article. Of course, I could be all wrong and there really is some secret, magical chemical compound out there that nobody knows about that is a modern miracle of embalming, but I have a bad feeling that I am probably right about this. The most insipid part of the situation is — if this is truly a breakthrough and a much preferred alternative — then why is what it supposedly replaces, formaldehyde, extolled in the same breath as irreplaceable, safe, effective and the only chemical on the face of the earth that really, truly embalms? If you truly believe there are alternatives to formaldehyde, then what is all the screaming about in Europe and the U.K., mostly orchestrated by the BIE and their U.S. industry buddies, about the death of embalming and the demise of the funeral industry? It appears, at least in the embalming industry, you can have your cake and eat it too. Just don't choke on the icing. That's pretty sad, but I think that's about the way it is. At any rate, let's investigate tannins and their chemistry, their successful history in taxidermy and explore the reasons they will never replace formaldehyde in traditional/old-style dehydration embalming in the funeral industry.

Tannin is a derivation of an old Celtic word for oak. Tannins naturally occur in trees and their barks as a natural defense against wildfires, various infestations and general decomposition action. This is perfectly demonstrated in Redwoods and Sequoias as they have a significant tannin content and are hardy, resistant and long-lived trees. Tannins derived from various trees and plants have long been known to precipitate proteins and have been used for centuries in leather making and taxidermy. In addition to taxidermy, its modern uses include it being a cotton mordant (i.e., a reagent used to fix dyes to textiles) usually in conjunction with alum or iron agents, and a chemical wood stain/fixative for decorative wood and decking. An interesting old use is in permanent inks and dyes. Oak gall ink was used to preserve the writing on important legal and government documents. In addition to being the predominant ink/dye in money. Invisible ink was famously made and used by spies by the combination of oak gall extract and ferrous sulfate in the past. There were numerous medical usages, also, including antidiarrheals, topical treatment for hemorrhoids, burns, cuts and fever blisters and as a general fever tonic. Burn treatment was popular in earlier times but fell into disuse due to liver necrosis concerns from overexposure.

Tannins are complex aggregates of many chemicals, but are predominately polyphenols with MW (molecular weights) ranging from 500-3,000 and as high as 20,000. Actually, tannins are divided into hydrolyzable tannins and condensed tannins as general classes. Condensed tannins are really not polyphenols but rather polymeric flavanoids, which are a heterocyclic ring system and referred to as proanthocyanidins. Epicatechin and catechin are the two most well known and are derived from quebracho and acacia trees (See Figure 1). Condensed tannins are prevalent in teas, fruit juices and wines and flower colors. The tannic mouth fullness of red wines is caused by these tannins. The health values of flavanoids are well characterized in the medical literature. Condensed tannins are also, sometimes referred to as catechol tans and are available as a dark reddish/brown astringent powder derived principally from quebracho bark. Catechol tans are not easily decomposed by acids, as are polyphenols. Condensed tannins are not what is being attempted in embalming and we will now focus on HT's (hydrolyzable tannins), particularly tannic acid.

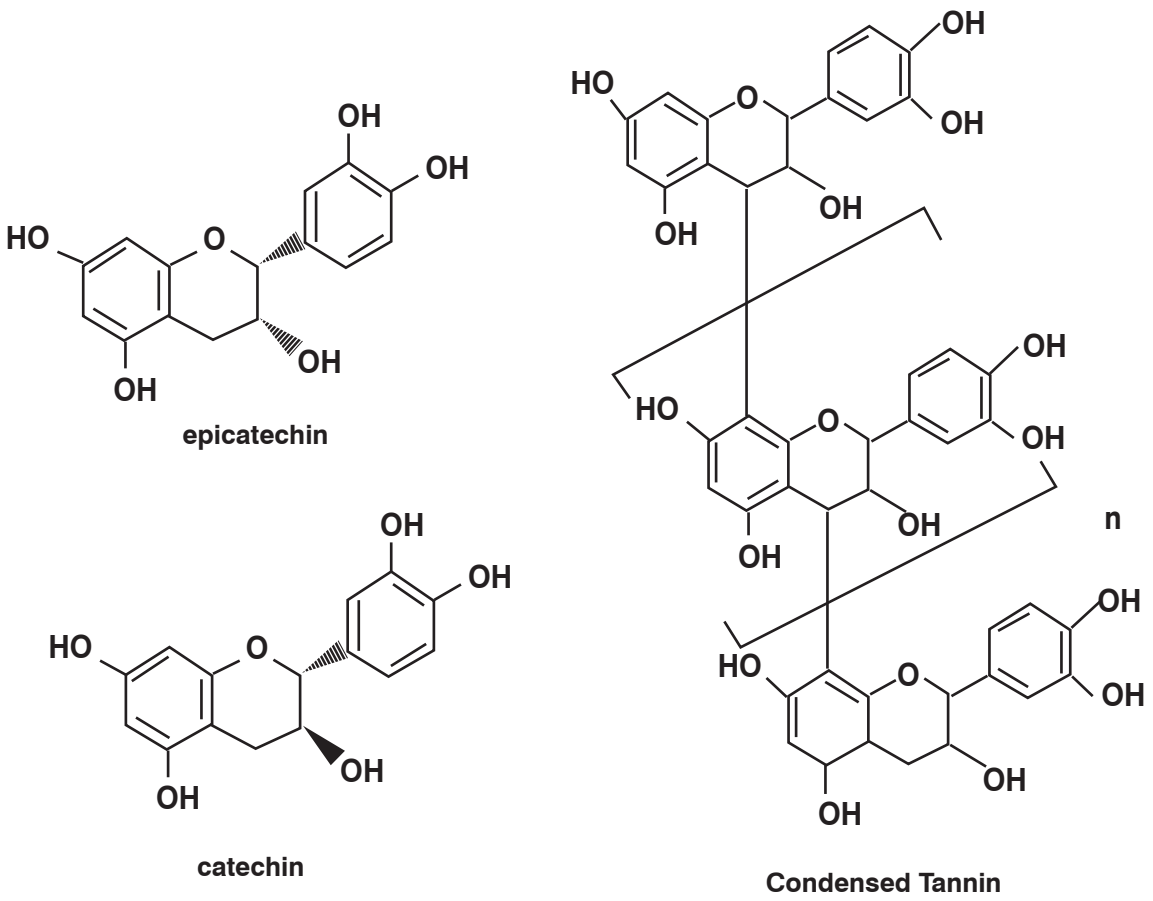
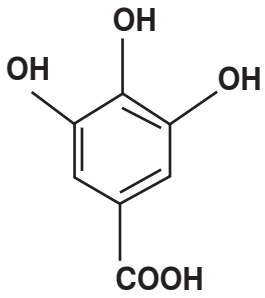
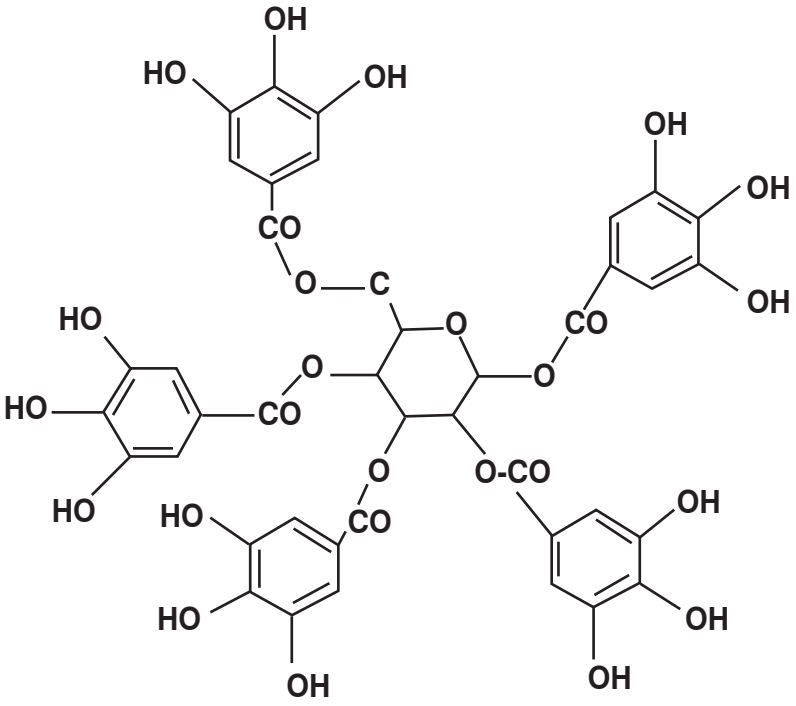


Figure 1

Hydrolyzable tannins, or pyrogallols, as they are sometimes referred to are essentially gallic acid esterified to a polyol (typically d-glucose, the simple sugar) and further esterified or oxidatively crosslinked to yield large, very complex admixtures of related chemicals The simplest example is gallotannin, which is pentagalloyl glucose (See Figure 2). Ellagitannins, for example, are oxidative couplings of galloyl esters from gallotannins. Gallotannins are typically less astringent than the condensed tannins. Gallotannins are typically found in berries (combined with condensed tannins) and particularly in pomegranates and persimmons, to which the astringent taste is attributable. The chemical of commerce, however, is commercial tannic acid which is a heterogeneous and variable mixture of gallotannins from sumac galls, aleppo oak galls, and sumac leaves (a member of the poison ivy family) along with many other poorly defined higher molecular weight chemicals. Most tannic acid is now derived from quebracho by purification to yield reasonably high percentages of gallotannins. Tannic acid is a yellow/brown amorphous powder with a nominal MW (molecular weight) of 1294g/mol, but this is just an estimation. Typically the formula is listed as C76H52O46 with an approx. MW of 1701. Tannic acid is highly soluble in alcohols and water and is weakly acidic with a pKa of 10. Several of the other chemicals found in tannic acid are various sugars, acids and their salts, hemicelluloses, pectins, lignins and numerous nitrogen and phosphorous compounds. Some of the acids present are characterized as gallic, oxalic, citric, tartaric, and phosphoric, in addition to acetic and lactic acid from sugar fermentation reaction.



Gallic Acid



Gallotannin

Figure 2

Tanning chemistry is poorly understood, not well defined and highly dependent on pH, temperature, solvent, and tannin/protein ratios. Best results are obtained when the tannins used are higher molecular weight with high conformational mobility, as this results in more net complexing reaction. Proteins that respond best to tannin action are ones with high molecular weights, relatively high percentages of prolines and have open and flexible structure (i.e., minimal secondary and tertiary structuring). The best tannins are small enough to penetrate the interfibrillary regions of proteins but large enough to crosslink peptide chains at more than one point. The resulting protein precipitation is mostly of a hydrophobic nature along with H-H (hydrogen bonding) and VanDerWaals attractions. Ionic or covalent bonds occur much less or are rare and probably only result from quinones and aldehydes through oxidation. Tanning action is from the tannin phenolic group reacting with the protein carboxyl groups. These hydrophobic bonds are stronger at high ionic strengths (high tannin/protein ratios) and high temperatures. High tannin/protein ratios (at least 2:1) are necessary for effective precipitation action. Compare this to chrome tanning, for example, where barely 3% concentration is required for effective tanning action and glutaraldehyde-based tanning where single digit concentrations are the norm and you can easily see the problems with tannic acid. Protein precipitation is favored at a pH near the protein isoelectric point and very unfavored at high pH's when the phenol/hydroxyls are ionized and the protein possesses a net negative charge with resulting protein repulsion and minimal precipitation occurring.

Tanning is generally always done at acidic pH's as oxidation of polyphenols spoils the tanning action. To its detriment, however, most tanning is reversible by acid hydrolysis. Particularly, hydrolyzable tannins disassociate from bound proteins in acidic aqueous media and resolubilize with the result being a reverse tanning effect. This can even occur in just hot or boiling water immersion. Another problem with hydrolyzable tannins is, that due to their complex heterogeneous mixture, yeasts, molds and fungi readily grow in the tanning liquors with acid fermentation occurring. Due to this breakdown of the sugars present in the tannin by microorganisms, a sand-colored sludge can occur called "bloom" when immersion tanning is being done. Despite these drawbacks, tanning, if carefully applied and controlled, is highly effective in taxidermy situations, where animal skins are the protein target. Properly prepared, defatted and demeated animal skins, where skin collagens are the target protein to be tanned are very effectively precipitated and bound because the linearity of the collagen protein responds very favorably to the tannin action with pH controlled long immersion times. The result is excellent taxidermy specimens with good shelf life.

So, what's the problem in embalming? Well, there's a lot of problems. Gross anatomical embalming is not taxidermy animal skin preservation/presentation and never will be. What works in one discipline does not necessarily always translate to another and the step from immersion taxidermy to whole body embalming, in this case, is enormous and insurmountable. The use of tannins in embalming will only deliver a mild tissue reaction, it will be only temporary and it will be reversible under almost all circumstances. The results will be totally unacceptable for a traditionalist formaldehyde embalmer. Lab testing, I personally have conducted over the years, bears these facts out. 20-25% tannic acid in 85% methanol shows little penetration coupled with minimal tissue reaction on gross organ and muscle tissues when looked at on the lab bench. In fact, the results appear little different than if the specimens were immersed in methanol or isopropyl alcohol and nothing else. You might as well just use a couple of bottles of drugstore isopropyl rubbing alcohol for cavity treatment. The results won't appear to be much different. The aldehyde function, so critical to semi-permanent preservation is essentially missing for all intents and purpose. Phenolic-like, polyol action is present but in far too small titres to deliver anything resembling classic embalming results. Tannic acid is too complexed with other chemical compounds, such as sugars and celluloses and susceptible to acid fermentation by yeasts, molds and fungi innoculation to be acceptable for traditional embalming operations. Gross pH swings to the high end of the scale in abdominal and gut tissues and their unavoidable exudates will bring most tanning-type tissue reaction to a standstill in most situations. It is nearly impossible even to deliver enough tannins to the protein targets, if only a couple of ounces is present in each bottle. That's barely enough to complex an ounce or so of protein with the rest of the delivery system being just methanol or other alcohol. The methanol does, at least, minimize the possibility of microbial acid fermentation action by the natural biocidal ability of alcohols in general. So, at least, that's a good thing. But, that's about it. It's still a volatile, toxic and flammable alcohol solution and forget about it ever being an acceptable substitute for natural/green burial — it's not. Also, don't ever expect an arterial fluid utilizing this chemical admixture to ever see the light of day. Slow reaction times with minimal tissue preservation action in the first place will render arterial-style embalming totally ineffective and completely unacceptable to a traditionalist formaldehyde embalmer. The Champion Company, under my direction, decided long ago not to go down this road, a road that we determined early on, to be a road to nowhere. Eliminating formaldehyde is a laudable goal, the problem is — the replacement has to reasonably duplicate the action and results of traditionalist dehydration,

rockhardening formaldehyde embalming — and that's not achievable with commercially available tannic acid or tannins in general.

There are far better, proven and effective ways to eliminate formaldehyde and still achieve typical classic embalming results and you know what they are. Reduction/elimination of formaldehyde and replacement with glutaraldehyde and other higher molecular weight mono/dialdehydes and polyphenolics in a synergistic mixture that drastically reduces toxic exposure parameters during the entire embalming and achieves near-classic embalming results that embalmers are all familiar with. Freedom from the toxic exposure of formaldehyde has been around in embalming for over a decade now, and it's called Millenium New Era Third Generation Champion embalming fluids. Easily 90+% of all formaldehyde used in embalming could disappear tomorrow and nobody would notice. And, if you are capable of looking to the future, past the tired and absurdist definitions of century-old toxic formaldehyde embalming — on the horizon is Enigma, Champion's Fourth Generation of non-toxic Ecobalming chemicals which completely redefines what embalming really is.

There's no need for a summary, I think you get it. Finally, as always, embalm smart, embalm safe. There is a wealth of information available on tannins and taxidermy, you just have to peruse it. Wikipedia has some good general articles on tannins and an immense amount of information regarding tannin chemistry is available from Hagerman, et.al., in various articles available on the web and in J. Agric Food Chem journal. Oh, yeah, I almost forgot, remember, it's all a secret.

POST SCRIPTUM: Wherein we discuss the appropriateness of sarcastic humor, cut-to-the-quick commentary, sardonic song lyrics and generally telling it the way it is.

Most have found my humorous intromissions in The Modern Embalmer articles stimulating for thought and discussions, and long overdue in an industry otherwise sacrosanct and decidedly archaic, secretive and defensive in nature. Others have been nothing short of enraged or appalled that anyone darst make light of anything related to our industry and refuse to worship at the altar of decorum and traditionalism.

First things first — the humor and sarcastic commentary is mine and mine alone. It is not the opinions or belief of The Champion Company, or anyone else, for that matter, and you may feel free to condemn me personally for it. The Modern Embalmer is me and solely me and all the facts, science, opinions, sarcasm and humor are all mine, researched by me and are used to stimulate the debate by shining a bright light into dark corners that some would wish never to be illuminated. In fact, I encourage you to enter the debate and research and investigate any and all the points, accusations and opinions that I freely express in my articles and correct me if I am wrong. I think you will find however, that my harsh opinions and sarcastic humor are literally immersed in truth and sadly and accurately portray the current state of the situation in the funeral industry.

My intention is to awaken the profession from its self-induced slumber and face head-on the unmitigated propagation of false information, unfounded worship of archaic attitudes and methods and generalized denial of modernistic change on a myriad of fronts. If this is somewhat disturbing to you — then I have succeeded in my mission. All of the humor and sarcasm in my articles brings to light deep-seated non-truths, misconceptions and downright wrong-headed thinking in our industry. Are we the better for not bringing it to light or for making light of it and invoking discussion, thought, argumentation and resultant progressive change? The decision must be yours, but choose wisely, for our very future depends on it.

On a final note, the most cleverest and poignant of humor is that which penetrates and severs a deep-seated vein of underlying truth that some wish would remain hidden and unspoken of — it is to that end, that I quest.

"Difficile est satarum non scribere"

- Juvenal

Poet, Roman, 1st Century AD