

Mixing Poi

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Mixing poi is something I do regularly. I grow dryland taro, so I dig out several taro varieties, wash and trim them, cook them, run them through a grinder, and mix them together in one bowl. Most times, I mix at least three or more varieties together, one that's thick and gummy, another that's on the sweet side, and another with nice purple color, like a Lehua variety. People comment, "This Lehua poi is so ono!" If they only knew it's a mix. I don't know if the Hawaiians did this too, but I can only guess.

Recently, I thought of another way of mixing poi and this is by crossing different taro varieties together. This attempt is not new; it was probably going on in ancient times, although taro also has a habit of mutating so some off-spring or oha look a little different from its parent or makua. It's believed that of the 4 to 5 varieties first introduced by the Polynesians to Hawaii, probably 300-400 varieties were developed by the Hawaiians. This really depends on who you're talking to.

In the plant world, you have two kinds of botanists, splitters and lumpers. The splitters will give a new name to everything that looks even slightly different, while lumpers will call them all one name. This was probably the same in ancient Hawaii. On top of this, different names were used for the same taro on different islands. However, the fact that almost all the Hawaiian varieties are related creates this narrow gene pool that makes it vulnerable to introduced diseases, just like the Hawaiians, and we've seen that played out on both fronts.

I remember in the early '70's, Mr. Arnold Melim of Palolo crossed Hawaiian taro varieties together. In the 80's, Dr. Ramon Dela Pena, CTAHR Agronomist at the Kauai Experiment Station developed new taro selections using Hawaiian and South Pacific varieties. In the early 90's, Dr. Eduardo Trujillo, a CTAHR Plant Pathologist at UH Manoa crossed Hawaiian and Palauan taro varieties. In the early 2000's, Dr. John Cho, CTAHR Plant Pathologist at the Kula Research Station on Maui crossed Hawaiian varieties with selections from throughout the Pacific and even Southeast Asia. More recently, Dr. Susan Miyasaka, a CTAHR Agronomist of the Beaumont Research Station in Hilo is building upon the breeding of her predecessors by making crosses to increase taro leaf blight resistance. I will touch upon the work of some of these taro breeders.



I have to stop here and explain something. Many people in the Hawaiian community, especially those who grow taro and want to preserve the Hawaiian varieties have a real problem accepting the fact that researchers are crossing Hawaiian varieties with non-Hawaiian varieties. There are many things at play here. For one, they believe breeders are contaminating the Hawaiian varieties and are actually decreasing the quality of poi.

Hawaiians have spent almost two thousand years perfecting their taro varieties through the selection of mutations but also by breeding them. They have matched varieties to the different habitats, and nowhere in the Pacific has taro production evolved to this level of sophistication as in Hawaii, probably reaching 40,000 acres of production at its peak. It's hard to fathom the fact that someone was growing the same plant we're growing 1000-1500 years ago in Hawaii, the same exact plant! We're growing the oha from the oha from the oha from from the oha, and then some. These are cultural treasures that connect us to this land, our past, and also the Pacific, and merit our reverence and protection.

There are some who believe they will have a difficult time identifying Hawaiian taro varieties with the onslaught of new taro varieties. This is already happening as farmers are selling taro they're calling Lehua to be made into poi, when it's in fact a hybrid or even a pure Palauan. One of the problems is that many hybrids were released to the community without descriptions, so no one knows what they really are. I have to agree to all of this.

The World According to Me



Eleele makoko, Kona dryland poi variety

I grow hybrids because I believe it's a matter of survival or food security on our little island of Molokai, but I also grow Hawaiian varieties as a barometer or a standard that I can set. I grow over 25 varieties of taro, and I also believe that we need to protect ourselves much like the Hawaiians did in constantly improving their taro. It's better to have some taro to eat than none at all. But that's me, and everyone has their own rationale for what they do. I plan for the storms, and it's not a matter of 'if', but 'when', but I continue to plant more Hawaiian varieties because that's what the markets are asking for.

I started learning about taro from the late Dr. Don Anderson of Lyon Arboretum in 1970, just after graduating from Kamehameha. Born and raised in Manoa, I would jump on my

bike or moped and shoot to the back of the valley. Don had a wealth of information not only about Hawaiian taro, but also about taro of the Pacific. I would help him maintain the arboretum collection which included both South Pacific and Hawaiian varieties. In growing taro, you learn something new all the time.

If someone asks me what I know about taro, I usually reply, “I think I know a little bit about taro.” Although I’ve been doing some serious taro growing for the last 25 years in Hoolehua on Molokai, and over ten years growing hybrids, I’m still learning, but I know that the Hawaiian varieties are still the gold standard for poi. Varieties such as Lehua palaii, Lehua maoli, Piko ulaula, Piko kea, Piko uaua, and Eleele makoko are still hard to beat in terms of taste and poi quality. I must add that hybrids such as 99-4, 99-11, and 2000-44 also make great poi, but they still have to stand the test of time and be thoroughly evaluated. A decade is not enough time to do that. Hawaiians spent over 1000 years, and then some. Poi wasn’t created in a day.

The Perfect Storm



Taro leaf blight, *Phytophthora colocasiae* is a devastating fungal disease that can wipe out an entire taro crop in a week if the weather is ideal for the disease, and it did just that a couple of years ago in West Africa. ‘Phytophthora’ means leaf destroyer. Taro Leaf Blight is believed to have arrived in Hawaii in the 1920’s. Based on the diversity of disease strains found in China, it’s believed to have originated there. I cannot overstate the importance of this disease; it’s really bad stuff.

About 10 years ago, the Hawaiian taro collection at the Molokai CES Demonstration and Research Farm was devastated by Taro Leaf Blight. It was so bad, the whole collection was basically wiped out. Luckily, there were two plantings on East Molokai, at Kainalu and Halawa that were not affected, and the Ho’olehua collection was rebuilt from there.

We’re not the only ones eating taro, and in the bigger scheme of things, we’re ‘small oha’. Taro Leaf Blight is global and is believed to have arrived in Hawaii in the 1920’s. It was first found in Java in 1900. Based on the diversity of strains found in China, it’s believed to have originated there.

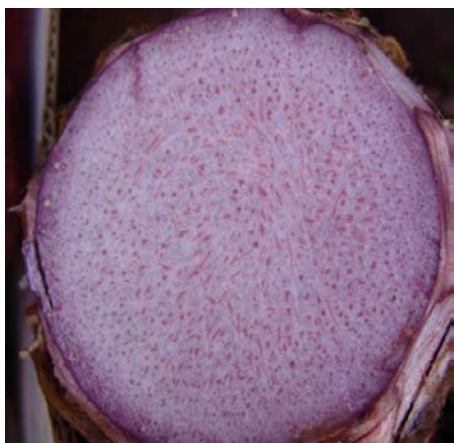
Taro genetics are not normal. Some crosses exhibit a genetic anomaly called ‘transgressive segregation’ where individuals in a cross show characteristics unlike their parents. This characteristic has evolutionary implications leading to the creation of new

racess or species. This characteristic allows plants to occupy new niches or better compete in existing niches. It can also allow us to find resistance to taro leaf blight and root-knot nematode, and also lethal viruses such as bobone and alomae, where none existed in parents and progeny.

I'm digressing a bit, but another important point that needs to be made from my limited perspective is that *'conventional breeding is the alternative to genetic modification'*, which would require a whole newsletter of its own, and then some. Long-term taro breeding could not only help us protect against present threats, but also future ones. I would choose option one over option two any day.

Each UH taro breeder had their own goals, slightly different, but most of them were attempting to improve taro quality, yield, disease resistance, or other characteristics. Dr. Eduardo Trujillo traveled throughout the South Pacific and saw the devastation Taro Leaf Blight caused, not only on the plant, but on the lives of people who grew them and the community as a whole. A seasoned and accomplished plant disease expert with a strong Latin American accent and a temper to match, he was committed to solving this serious disease.

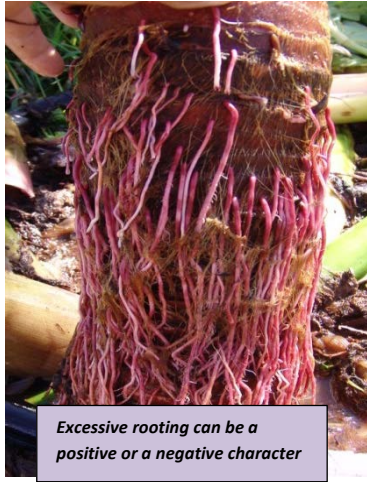
Screening varieties and collecting data from taro trials found elsewhere, he determined that the Palauan varieties were 80-90% resistant to this disease. He brought around 15 Palauan varieties to Hawaii, and after screening them, selected one of them, P10 or Ngeruuch as the parent to cross with the main commercial poi taro in Hawaii, Maui Lehua.



Maui Lehua is believed to be a hybrid itself. Some say it's a cross between Lehua maoli and Pi'i ali'i, while others say it's a seedling of Lehua maoli. Whatever the case, Maui Lehua's attributes include a large mother corm or makua, purple poi color, and early maturity. It's believed to be more tolerant to Leaf Blight than Lehua maoli, the main poi variety before the 1980's, but its biggest improvement over Lehua maoli is the relative lack of sideshoots or oha. Lehua maoli, especially in dryland conditions, may have over 20 oha per plant, while Maui Lehua may have 4-5 oha.

Depending on how you look at it, many oha can be a benefit if you're just starting to grow taro and are in need of a lot of planting material, or a shortcoming if you already have a lot of planting material. Twenty oha on each plant makes a lot of opala or rubbish after harvesting, and it needs to be dealt with. Some look at it as organic matter to add to the lo'i after harvesting, while it could be a magnet for disease added back to

the lo'i. There are also labor costs involved in dealing with all this plant material. But many taro growers and taro eaters will agree you cannot beat the taste of poi made from Lehua maoli.



Excessive rooting can be a positive or a negative character

The gene-for-gene theory says, “for every new gene you pick up, you lose a gene” and the gene you lose may be an important one. This was to be played out in Dr. Trujillo’s work and also others. Dr. Trujillo crossed Maui Lehua and Ngeruuch and produced a couple hundred seedlings. He multiplied and meticulously evaluated each seedling in an area known for ideal Taro Leaf Blight conditions, Hakalau Valley on the Hamakua Coast of the Big Island.

He set goals for selection of superior seedlings, including less than 6 oha, no runners, and oha attached close to the makua or mother plant. However, one of the most important goals was to find a selection with a purple corm having high tolerance to Taro Leaf Blight combined with good poi characteristics. Crossing a light pink corm of Ngeruuch with a beautiful purple corm of Maui Lehua, you would expect 50% pink corms and 50% purple corms at best or maybe every shade from pink to purple. Instead, only 7% of the 200 seedlings or 14 seedlings exhibited purple corms. Taro doesn’t appear to follow Mendelian genetics, and is one of the challenges in breeding taro.

Out of the 200+ seedlings, Dr. Trujillo selected three plants, one each with a white, a pink, and a purple corm. Each one had Pa in their name identifying it as a Palauan, and with a Hawaii descriptor attached. The white was named Pa’uakea, ‘white rain’, while the pink was named Pa’akala after the pink akala berry. The purple was named Palehua after the red lehua flower. All three are high yielding, but Pa’uakea and Pa’akala, in my experience can get huge, like 24 pounds each! In higher elevations, Pauakea produced more, while at lower elevations, Paakala produced more.



Pa’akala at 20 pounds each grown in Hoolehua, Molokai

In Dr. Trujillo’s trials, taro planted at around 6000 plants per acre produced 100,000 pounds per acre! These yields are phenomenal and probably never achieved before. Palehua yields were less, at 40,000 pounds per acre but still more than Maui Lehua. Of these varieties, only Palehua made good poi, but the other two made great kulolo. Pa’lehua is faster maturing than Maui Lehua, and I believe the taste is very similar.

Dr. Trujillo was responding to a crisis in American Samoa in 1993 where severe Taro Leaf Blight brought about by storms and extreme wet weather caused taro production to plummet from 786,000 pounds to just 11,000 pounds. He first introduced Palauan taro varieties as the interim solution, and then shifted to breeding new varieties utilizing Palauan varieties.



Hawaiian taro (front 2) and hybrids

At the same time, taro breeders from other Pacific islands, such as Fiji and Vanuatu, were evaluating wild and cultivated taro varieties for resistance to Taro Leaf Blight. Dr. Vincent LeBot, a former student at UH, was also working on taro diseases in Vanuatu, and shared resistant varieties with other breeders in the Pacific.

Universities and academia impose conditions on researchers to ‘publish or perish’, but a new condition was being imposed on many. Claiming and owning intellectual property was looked at as a way to provide reliable, long-term funding to the university and also researchers. The problem was not everyone agreed that you could own these things, especially those who were the ancestors of the original caretakers of these plants, and the plants themselves. The question surfaced, “Who said you can use our ancestor and our ancestor’s plants?” In Hawaii creation legends, the taro was considered the elder brother of man.

Dr. Trujillo was caught in a cross-fire and became the scapegoat for this new paradigm of generating money. The three new taro varieties would be sold to growers for \$2 per huli and if propagated by the farmers, they would also have to pay. About five years before this whole issue blew up, I asked Dr. Trujillo that same question, but I don’t think he understood what I was saying, or the ramifications of my statements. After protests and rallies by members of the Hawaiian community and others, and a big blowout at the UH Board of Regents meeting, it was decided that the patents would be voided. Many UH faculty members were crying out ‘foul’ because their academic freedoms were being trampled upon. There will be an ongoing conversation on this issue that won’t end with this one incident.



A Mix of UH Hybrids

I understand both sides of this issue, and it’s a thorny one at best. And this is only the beginning, because more GM tropical crops are coming down the pike. Just add a foreign gene or a gene you’ve ‘created’, insert it in a plant, and call it your own. Patent it and sell it to everyone who wants it. However, I was intrigued by Dr. Trujillo’s work that you could improve taro plants through

conventional breeding techniques, and improve not only disease resistance, but also yields.

Palehua is grown by both dryland and wetland taro growers. Palauan taro also has a very different taste than Lehua or other Hawaiian varieties, and some poi eaters may be able to detect taste differences. Some farmers have also commented that Palehua rots easily, but I think many farmers don't realize it matures in eight months, and if you harvest it at nine months, it might be rotten.



The poor field-holding ability characteristic could come from one of its parents, Maui Lehua, and is a common characteristic to many of the Lehua family. You cannot hold them in the field when they're mature. Compare this to Piko and especially Moi, which probably has a longer holding life after maturity than most. The old taro buyers would watch for mature Lehua fields and buy them for pennies when they knew the farmers would be stuck with them. This was much harder to do that with Moi, and also Piko varieties.

Dr. John Cho took Dr. Trujillo's work to the next level by utilizing a larger gene pool of taro plants from throughout the Pacific to Southeast Asia, and as far as west as Nepal. Conducting many stages of breeding and creating hundreds of seedlings, he was able to identify selections to replace Maui Lehua. His strategies were evolving and involved many levels and sources of resistance. However, some appear to have a higher Raphide content than the Maui Lehua.

Rhaphides are needle-shaped Calcium oxalate crystals that cause itchiness in taro, and cannot be eaten without thoroughly cooking them. In this case, you have to cook them longer than the Hawaiian variety. Rhaphides are also found in 200 families of plants and is probably a defense mechanism to protect plants from being eaten by herbivores. Hawaiians selected away from this characteristic.

I visited a taro farmer in Hanalei and he made an interesting discovery. Hawaiian birds such as Hawaiian coot and mudhen migrate from Ni'ihau to Hanalei each year to roost, feed, and nest in the wetlands of Hanalei. They also eat taro plants. The taro farmer noticed that the birds could distinguish between the hybrids and Maui Lehua, and would prefer to feed on Maui Lehua! Probably the birds were looking for the least itchy and more tasty taro.

I believe this research is a starting point, and there are many 'diamonds in the rough' in these crosses, some having resistance to aphids, nematodes, and even corm rots. Dr. Cho recently retired and many of the selections were lost, but some of these are being

used as the base for another stage of taro breeding to create Taro Leaf Blight resistant varieties.



Dr. Susan Miyasaka is a meticulous researcher known for her thorough work. With a Bachelors of Entomology from UC Berkeley, a Masters in Agronomy from UH Manoa, and a PhD from Cornell University, Susan is well equipped with the knowledge to perform great research. Native to the Big Island, she was able to see the devastation first-hand brought about by taro leaf blight on the Hamakua coast, even when she grew taro on her land in Laupahoehoe. She even witnessed ‘Taro Leaf Blight resistant varieties’ melting away from the disease in Hamakua. I think she truly believed there were no conventional breeding solutions to this problem.

Seeing what genetic modification (GM) could do for the corn earworm, a major pest of sweet corn in Hawaii and the world, she embarked on a different path to attack this problem. Taro production was declining in Hawaii, and she was familiar with the taro devastation in the Solomon Islands and more recently, in Samoa. I believe her intentions were noble; stop the onslaught of Taro Leaf Blight in Hawaii and the Pacific through genetic modification. Susan took a sabbatical at University of California-Davis and worked on genetic modification of taro, in this case the Chinese cultivar, Bun long, the most important leaf variety in Hawaii, and also the main taro variety in Hamakua.

With other researchers, she was successful in splicing a rice gene into Bun long taro, giving it resistance to some taro diseases, but this was just the beginning of this work. I’m not sure how far this work went, but it created a fire storm, another perfect storm in genetically modifying taro. Although it wasn’t a Hawaiian variety that was genetically modified, could this genetic modification reach Hawaiian taro? It would be an easy answer in conventional research, but genetic modification is not conventional. There are many unanswered questions, even in GM work conducted in Hawaii, but there’s also fear of the unknown and unintended results.

Return to Kalo Roots

There’s a whole resurgence of taro in Hawaii, and has been brought upon by many factors. One of them was the uproar over the genetic modification of taro, but there were other factors as well. There are community-based initiatives to make poi available for the Hawaiian community, especially kupuna or elders. Another is in learning the art of making poi pounders and poi boards. With this comes the need to have taro to pound

into poi. These activities help bring to light other Hawaiian cultural, health, and socio-political issues, and these activities enhance communication and networking within pockets where Hawaiians live throughout the state.



Waimanalo Field Day, Photo: Ted Radovich

The recent Waimanalo Field Day on June 21, 2013 was a great example of interest in taro. Over 250 people attended and they were very interested in all aspects of taro. Information about this event flowed to attendees mostly through community-based organizations, such as Onipa'a Na Hui Kalo, the State Taro Security and Purity Task, and also through the extension

network of taro growers on Oahu. I had a lot of fun giving a presentation on Sustainable Dryland Taro Production (above) at the organic taro plots, and observed that the community is hungry for knowledge about taro. This event could have attracted thousands of if it was fully promoted, but I don't think the carrying capacity of the Waimanalo Experiment State could have handled it.

I look forward to next year's event because I know that if done right, we can create opportunities for more networking between taro growing communities and taro eating communities, and also share all the knowledge related to taro through this partnership between the community and UH CTAHR, including the Hawaiian community, the taro growing community, and the greater island community. A hui hou kakou...