The Taproot Podcast

Season 5, Episode 2

Guest: Adán Colón-Carmona

Hosted by Liz Haswell and Ivan Baxter

Transcribed by Jo Stormer

[Theme music]

0:32 **Ivan Baxter:** Welcome back to The Taproot podcast, where we dig beneath the surface of a scientific publication to tell the stories behind the science. I'm Ivan Baxter.

0:41 **Liz Haswell:** And I'm Liz Haswell. Especially after this past summer, academic institutions are vocal about the need to diversify both their students and their faculty. But have you thought deeply about the advantages of a diverse faculty?

0:58 **Ivan:** Today's guest Adán Colón-Carmona makes the case that the faculty with multiple identities have unique experiences that help them connect to their students, create empathy for them, and inspire them to find out what makes them happy. One note, before we begin: we recorded these episodes in October, and then life intervened. So any references to recent or upcoming events may not match our current situation. And with that, on to the episode.

[Theme music]

1:25 **Liz:** Today's guest is Adán Colón-Carmona. He did his PhD at UC Irvine and postdoctoral work at the Salk Institute and at UC Davis. He's now a professor in the Department of Biology at UMass Boston, where he teaches, he mentors, and he conducts research on abiotic stress responses, cell cycle, and plant rhizosphere interactions. Adán has won many, many

awards, including faculty appreciation awards. He has trained (get this) 113 undergraduates. He has participated in a range of service positions in ASPB, in NAASC (that's the North American *Arabidopsis* Steering Committee), and SACNAS [Society for the Advancement of Chicanos/Hispanics and Native Americans in Science]; most notably, he was recently elected to the board of directors of SACNAS. Welcome to The Taproot, Adán.

Adán Colón-Carmona: Thank you. Thank you for the invitation to participate.

2:41 **Ivan:** Well, it is our pleasure. So, today's paper is the "Influence of *Arabidopsis thaliana* accessions on rhizobacterial communities and natural variation in root exudates" by Micallef at al in the *Journal of Experimental Botany.* Adán, would you give us a short summary of the paper please?

3:00 **Adán:** Sure. So Shirley Micallef was a graduate student at the time. When she joined my lab, she was interested in the rhizosphere and certainly bacteria that were living in rhizosphere. We didn't know at the time whether it plants from a single species had diverse microbiomes, nor did we know whether slight genetic variations was enough to produce differences in bacterial populations that lived in the rhizosphere of plants. So we hypothesized that there were differences and that diversity matters, and that plants and potentially what they exude is responsible for that diversity. What we did was that we took eight different natural accessions of *Arabidopsis* and (using the same starting inoculum) what we did is that we use soil from Waltham, Massachusetts, a neighboring town here. We grew plants in a mixture of sterile potting soil and Waltham soil, and we monitored the rhizosphere bacterial population profiles over developmental time.

And so what we found was that even though each accession started with

the same bacterial community that was from the Waltham soil, accessions produce unique rhizosphere bacterial communities over that developmental time. Additionally, what we found was that exudates for each of these accessions was different. So we proposed that that could be the reason for the differences in the bacterial communities that we found.

Ivan: Awesome. I think one of the age-old questions when I think about the plant rhizosphere, is what the heck is the plant rhizosphere and how do you actually make sure you're looking at the rhizosphere when you are sampling these things? What did you guys call the rhizosphere and how did you sort of separate that out from the root or the soil?

5:05 **Adán:** So the rhizosphere is that environment immediately outside the the root system. The way that we did the experiments is that after growing the plants in soil, we would pull them out, shake any loose soil from the root system, and (whatever was still attached to the roots) we collected that root sample and we profiled the bacteria that were in that root sample that was physically attached to the roots themselves.

Ivan: And the same for the metabolites?

Adán: Correct. When we did exudate analysis, we actually did those in vitro. So we did that in vitro. We didn't grow them in soil and then sample to the exudates in soil. Rather, we grew the different accessions in vitro and isolated the exudates that way.

Ivan: Everything gets complicated really quickly once you start looking at these interactions in the soil.

Adán: Correct.

6:06 **Liz:** As I was reading the paper, I kept picturing myself trying to pull a rabbit opposite roots out of the soil and just like having the aerial portion

rip right off the roots every time.

6:18 **Adán:** Yeah, so you would grow them and then you will have to pull them out of the pots. But you can shake off the loose soil and there's still usually plenty of soil leftover that's still attached to roots that you can scrape off and analyze.

6:36 **Liz:** It's interesting. Can you help us, though, think about why different accessions . . . I mean, this is like teleology, but why would a different accessions of *Arabidopsis* want to be associated with different types of microbiota? Like they're all *Arabidopsis.*

6:58 **Adán:** Right. That's a great question; this is a really good question. Frankly, we don't fully know the answer to that, but what we do think is that plants have evolved in different environmental conditions, say the Lansburgh accession population evolved in Germany and we have CVI accession from the Cape Verde Islands. They have enough genetic diversity or differences between them that allows them to recruit a specific bacterial community that might be beneficial to that one Arabidopsis accession. A specific microbial community might assist then the plant to fight off (let's say) pathogens that are within the root system or even in leaf tissue, for example. Similarly, maybe a specific rhizosphere community might assist a plant in (let's say) tolerating stressful abiotic conditions by modifying the plant's physiology. In my lab, for instance, we're interested in studying the interaction between plants, bacteria that are in the rhizosphere, and in environments that are polluted by petroleum.

8:17 **Liz:** Oh, that's interesting. Cuz what you did was to sample how the different accessions can recruit bacteria in the soil in Massachusetts, but presumably the CVI plants didn't evolve to recruit plants from soil in Massachusetts; they evolved to recruit bacteria that were part of a completely different ecosystem and a completely different soil. So

presumably it's possible that the Cape Verde Islands Arabidopsis aren't even exposed to the same bacterial species during evolution. They weren't even exposed to the same species that Lansburgh were. So then when they're given a range of bacteria to choose from, they actually only have the ability to recruit certain sets of bacteria. Does that seem like a reasonable theory, too?

9:09 **Adán:** Yes, yes! And yet at the same time that there's differences in what CVI and Landsburgh are able to recruit, and we could identify what those differences are.

9:21 **Liz:** Yeah. I guess we're saying the same thing, which is that there's potentially differences in the plant's ability to recruit but that may have been also affected by what bacteria were even there to be recruited.

Adán: Correct.

Liz: It's a small point, but I thought it was really interesting to think about. I always think about these accessions as being, you know, minimally different; but the differences you saw in rhizosphere was really big between accessions.

9:49 **Adán:** Yeah. There's differences not only in the communities that we saw, but there's also differences in the exudate profiles that we saw from the different accessions. That was something that we hypothesized, but we didn't know that that would be true.

10:12 **Liz:** Those exudates that was that small molecules you were looking at or proteins?

10:18 **Adán:** Initially we sampled everything and we weren't necessarily identifying the specific chemicals, per se. We were doing just HPLC analyses and looking at the whole profile and using the profiles as our

ability to detect those differences. However, that work has continued and we have focused our attention on:

- trying to identify the genes that are responsible for developing the different communities;
- characterizing seeing those exudate differences between the genotypes;
- focusing our attention also on also determining some secondary metabolism biosynthetic pathways that might change the exudate profiles;
- and also on whether these metabolic and biochemical changes can alter the rhizosphere microbiome - particularly during an abiotic stress response.

But in terms of the differences in exudate composition, what we did find was that there were phenolic differences; there were amino acid differences (specifically glutamic and tryptophan were different between different genotypes); sugars - there were differences in the sugar composition; and we have focused our attention, specifically glucosinolates. We find that altering the glucosinolates pathway can produce differences in microbial communities as well.

11:59 **Liz:** That's fascinating. I know you focused on the chemical pathways that lead to differences in exudates, but I was thinking about other ways that different accessions might attract different communities. Am I using the right words to say, like "attract a community"?

12:19 **Adán:** [Tentatively] You know, I guess *attract* is a strong word, but you're *selecting* different communities over time.

12:27 **Liz:** Right. I had been thinking if different accessions have different root

structures (like different density of lateral roots or the root hair length is different or they're thicker or whatever), they could lead to different levels of soil aeration or pH changes in the soil. Could there be all these other differences that are not exudates, exactly?

12:53 **Adán:** You're totally right; you're totally correct on this. Even the eight accessions that we use, they have different root architecture. You could also think about acidification in soils - comes to mind as potential other factors that might impact and would be important in this developing a particular community that lives in the rhizosphere. Our lab did not specifically test those factors per se. We focused primarily on understanding exudate composition, primarily because we wanted to identify the genes that might be responsible for driving some of those changes.

13:34 **Liz:** Adán, I love that you've been understanding the intersection between the diversity of Arabidopsis and the diversity of the bacteria that they interact with in the rhizosphere. I couldn't help but notice that your research on this topic has a really beautiful parallel in the work you do on diversity and in your own personal background. I was wondering if you could just talk a little bit about your training, your background, and how that sort of led you to focus on diversity of training and improving STEM diversity.

14:15 **Adán:** Sure. So I'm an immigrant; my family immigrated to the U.S. from Mexico when I was five years old. I grew up speaking Spanish at home and learned English in school. I am the first in my family to attend college. I was the first to graduate from college and then obtain an advanced degree. In many ways, because no one in my family was a scientist or gotten a college degree, I had to navigate the scientific culture that I was growing up as a college student. I relied on the collection of diverse mentors - those that were scientists and who I was interacting with. I was welcomed

into scientific societies, such as Society for the Advancement of Chicanos and Native Americans in Science (or SACNAS) and ASPB. Those mentors really served as my social networks. Also as an undergrad, I participated in a research training program that was funded by NIH, but it was instrumental in sort of shaping my identity as a scientist.

Just as important, I was fortunate to meet scientists of color through SACNAS. Those individuals that I met through SACNAS became my future colleagues and mentors. Individuals such as Maria Elena Zavala from Cal State Northridge and David Bridges from Boston College. These personal experiences are really motivating factors for me in choosing to work at a place that has a diverse student body (UMass Boston) and really it has allowed me to be active in promoting diversity in STEM fields. To me, this is just as important in the science that I do - this other work that relates to diversity in STEM.

16:21 **Liz:** One thing that I know you care about a lot is the concept of multiculturalism. Can you talk more about what you mean by that?

16:21 **Adán:** Yes. As I mentioned earlier, I am an immigrant to the U.S. when I was very young, and growing up here (first in California, now living in Massachusetts) in many ways my life includes at least two different cultures, right? The Mexican culture, the American culture, and really the blending of these two cultures, such as my Chicano identity; and then there's the scientific culture in which I work in. These multiple cultures that an individual grows up in - when they argue, an individual that sort of grows up develops these multiple identities. As a result, I do consider myself an individual with multiple cultures. In other words, my identity is made up by at least two or more of these cultures, the so-called multiculturalism.

17:29 **Liz:** I think we have a tendency to use a deficit model where we think of

people coming into scientific culture from a different culture. But I wonder if in some ways your multiple identities haven't ended up being assets to you.

17:50 **Adán:** Excellent observation. I think it has, absolutely! At a place like UMass Boston, for example,where approximately 60% of the students are students of color (60% are first in their families to go to college; they are Pell Grant eligible; many of them speak more than one language), my multiculturalism is an asset. It has allowed me to easily relate to the experiences of my students, and certainly during COVID times where you amplify the injustices in society I'm able to empathize with other experiences that my students bring to the classroom. These students then are not only the students that I interact with, are not only having to adapt and persist in sort of the university environment and this academic culture, but also (if I'm teaching science courses) the STEM fields, the STEM culture. So in many ways, they're having to do many of the same things I have to do as a student, and I'm able to relate and interact with them in a sort of environment that is very familiar to me.

Liz: We're actually are this season asking everybody how they've handled COVID.

Adán: In spring, we had COVID and we all had to teach remotely after starting in-person. My campus, as I mentioned, is a very diverse for many of our students (mostly a commuter campus) and for our students, many of them are living at home. And so having to go remote meant that students had to adjust to this remote environment and at the same time trying to get an education. They had to deal with many challenges, many challenges that are not very different from what I had to grow up with. I have six siblings and so there's a very large family that I grew up in and I would understand, for instance, that if a student is having to try to take classes from home and there are siblings at home and there's additional

responsibilities from parents and other family members, their lives have gotten very complicated. So during COVID I think that we really have to step back and understand our students better. I spent a lot of time on zoom with individual conversations with students to try to better understand they were experiencing so that I could modify my teaching in ways that would accommodate this new reality. I think that having my own personal experiences and bringing that to the classroom allowed me to sort of ask those questions to those individuals and figure out how I could best assist in their learning, which I think was helpful.

21:10 **Ivan:** So that was for your students in terms of your classes. Have you opened your lab back up?

Adán: Yes and no. I mean, we're only recently allowed to go back in, and so at the moment only the graduate students have come back in and it's been difficult because we do have to go in in shifts. Undergraduates are still not back into the lab. I do have one student who has personal issues that prevent him from being back in the lab, and so this makes it challenging for him completing some of the work that he needs to do. It has definitely been hard, absolutely. I have a new project that is based in Puerto Rico; we were supposed to start in July. We haven't really been able to start it because it's based in Puerto Rico and we can't travel there; it just made it really difficult.

22:03 **Liz:** Thinking about this while you were discussing about as a teacher (and it's exactly the same as being a research mentor, right?) being able to see the complexities of each students' experience. I think it's something that many of us on the privilege higher up on the privilege spectrum . . . I mean, I knew it theoretically, but there was something about the COVID response. My school spent a lot of emails and a lot of time really letting professors know this is the time you need to give your students grace; you need to be aware that not everybody has high speed internet access there.

You don't know what's going on behind the scenes. You just don't know what they're dealing with.

I feel like it was a great educational experience for me, but it's that that's not new. It's not like those students didn't have those problems before. It's just COVID magnified it.

23:14 **Adán:** Exactly. I think what we should be reminded of too, is the potential for taking advantage of the multiculturalism that exists in individuals and use it as a strength and as an advantage. What I mean by this is that someone who is a multicultural individual, what they bring to the table are sort of these soft skills. You know, one person person's able to adapt and persists in these hostile, difficult, challenging environments and stress.

23:51 **Liz:** Abiotic stress.

23:54 **Adán:** [Chuckling] Yeah, abiotic stress – exactly. Or biotic stress! We're constantly perceiving the societal challenges (these microaggressions in the places that we work and study) and we respond to those. In responding to those (I'm thinking about, for instance, my own experience here, too) is that we utilize some of these social networks that we developed over time. In my case, I utilize the diverse network of mentors that I've developed in my own career - in my life - to help me persist in STEM or whatever fields or careers that we choose to move into for our lives. That's true. At the same time, one may argue that if conditions are too toxic, a multicultural individual will likely adapt and move into a new area of study or work. What I'm talking about here . . . think about maybe this talented undergraduate student of color, let's say, who changed their major to something else that was not STEM. What were they doing? What they were doing was that they were adapting and persisting in an environment that maybe was not *as* toxic. Certainly preliminary studies that my colleague Rosalyn [Negrón] and I have done here at UMass Boston for the

last eight years has indicated that both of these types of scenarios are at play when we're thinking about diversity and stuff.

25:31 **Liz:** By both scenarios, you mean the scenario where they are able to persist and the one where they go somewhere else in order to persist?

25:41 **Adán:** Correct, that's right. The difference there is whether an individual who is multicultural has an enriched environment, in that there are interventions in place that allow those individuals to potentially persist. So you know, a professor who takes the time to individually mentor that student to provide that flexibility in how they learn or to be flexible with their time and making sure that that student learns. Sometimes within STEM, our structures are so rigid where we teach large classes and we don't take the time to do that - to really think about the diversity of the learners that we have in the classroom.

26:34 **Liz:** I think I'm reducing what you're saying, but it sounds to me like one of the huge benefits of your background is empathy.

Adán: I think that's right.

Ivan: You know, as a white man I think, "Oh, I have empathy," but maybe I don't have all of the antenna to sense where it's needed as easily.

Adán: Ivan, I agree, but what I'm also thinking about is the mentors I had in my life; my PhD mentor was a white male from the Midwest. But I think that he did have empathy and he did understand what it means to be a good mentor, and he had the skills.

Ivan: I think that's totally true. It's not a panacea, but I think it's easier to be empathetic with your grad students who you develop a long-term relationship with than it is for an undergrad who spends a few months in the lab or an undergrad in your class, or an undergrad that you happen to

meet at the meeting.

Liz: Yep.

Ivan: I think that's part probably where some of those antenna come up is that it's all these micro interactions that we may not have a sense for.

Adán: Yes. When you were saying that, I was reminded of this one example from a class (not this past semester, but a previous semester). I had this one student who was coming into class; he clearly was bright. He interacted with me out of class. He would come into class (it's the 9:30am class) and sure enough, he would always be falling asleep and I didn't get it. I thought I was an interactive person in class but, "Why is this person...?" I sensed that something was not right. Here I see a very intelligent person; there's something else.

28:47 So I pulled him out after one of the classes and I asked, "Fernando, what's going on? I noticed that this was happening." I learned that he works nights. He worked all night. He comes to class; he's a full-time student and he's working all night, and then comes to school. He was dead tired. He was *dead tired*. But understanding that individuals have complex lives (certainly students on my campus), I can't assume that he's just goes back to his dorm because that doesn't exist. So I had to really think about, "Okay, what is it about his life that is making this happen?" My radar, Ivan is that I'm very alert to those complexities of live, and I ask students what's going on.

Liz: So if you were to give a student advice, a student who says, "This is who I am. It doesn't feel like the right fit. I feel like I'm being squeezed." What advice would you give them?

29:53 **Adán:** The kind of advice that I give a student who is sort of between these different pressures and I guess challenges in their lives really comes

down to asking them to think about what makes them happy. A lot of times students (whether they're non-traditional students or more traditional students, you know, an eighteen year old), it comes down to are they doing whatever they're doing in terms of their studies for themselves or because of pressures from family or culture or whatever. If I focus their attention on that (on what makes them happy), I think that we sort of move in the direction of trying to identify what things they like, what they don't like, and at that point being able to identify strategies that they can take moving forward. But starting with what makes you happy, always works in in my experience with students who are being pulled in all these different directions.

Liz: That's really great advice, all the way through the career ladder.

31:16 **Ivan:** The question of, "What makes you happy," once you know all the possibilities is a really good way of thinking about it because I think obviously it makes you happy (if you don't know that grad school's an option) is very different; is tough for somebody that some of the things through.

One of the things I wanted to ask you is I think this idea of the multicultural approach is great and I think it's something we should really strive towards, but one of the things that I struggle with is trying to make sure that we're moving in the right direction. And if you define, "We want our society, our program, our faculty to be more multicultural," does that make it harder to quantify whether we're actually making progress? Because it's a lot easier to try and say, "We want to have good gender balance," or, "We want to have specifically more Chicano," or more Black scientists and say, "Can we measure that?" In reality, we really do want this sort of more multicultural approach, but it can be much harder to quantify. I think about this intersectionality; we don't want to solve the problem of not having enough Black faculty by hiring all Black men, right? That's not what we want to do.

We want our departments and our programs and our societies to reflect the nation at large - our whole society. So how do we sort of balance those?

Adán: That's, um, it's tough and it takes a lot of work, and certainly it takes a long time. It's not something that's going to come overnight. If we think about Black Lives Matter and what's going on outside currently, it's not new. It's something that has been happening over decades, hundreds of years. Changing a system - an injust system - is really tough. I think that we can start locally (if I may borrow that), and make an environment / create an environment that is welcoming, where you think about your priorities and if having an environment and a place that is welcoming to people from different cultures or a multicultural person. I think that's a start, but certainly it takes initiatives. It takes the creation of potentially new systems of hiring people, of evaluating people. I mentioned the fact that a multicultural individual earlier who is in a toxic environment is not going to want to stay. They're going to adapt. They're going to move. And similarly, if the places that you have is not a welcoming place, people leave. Certainly if you're a talented scientists of color, you're going to go somewhere else. So you have to change the way that you do things so that people are welcome.

34:57 And it does take a long time. Some of these training programs that focus on underrepresented groups, they've been around for a long time but the needle hasn't been moved very much in terms of diversifying the faculty, right? Or even the scientific workforce. It's been taking a long time, but I think it's the right direction.

Liz: Do I hear you saying that these sort of traditional programs like the one you were in (you said from NIH when you were a trainee), you think they work well, or do you think there are some sort of ways we need to revolutionize the way we are? Because I always felt like in some ways, those programs are designed to, I don't know, make everybody the same.

It's like that deficit model idea; like people who are coming into science from these diverse backgrounds, we need to help them be more like the average white scientist. Maybe that's good, but it also seems like we're losing a resource there or something by asking people to change who they are in order to be accepted or something. I don't know; maybe I'm going too far with it. You probably have a better idea than I do.

36:21 **Adán:** I think that you're bringing up multiple issues in bringing that up, cuz I think that certainly those programs have now been evaluated. It's been studied and researched, and it's clear that having an experience like that where you are in a research environment early on and you're exposed to research careers (and what it takes and so forth) has an impact on their ability to stay within your major, graduate and pursue a career in science. That's clear. Those programs help based on the success of many decades, those individuals.

Now that doesn't mean that you've changed the system outside of those programs, right? Because if you're going to be a professor nowadays, you're having to deal with all these other things - being a postdoc, competing for jobs, being in the faculty of the department that's not very welcoming or whatever. It's not as simple as "We're going to have this program and this is going to change everything else." I think it's more complex than that.

Similarly, I think that the way that those programs started is very different than how some of these programs currently are. I think that programs nowadays *are* more holistic. They *are* thinking about mentorship. They *are* thinking about these other aspects of being a scientist. So such as the social issues that impact a scientist (such as imposter syndrome and microaggressions and other things that are not part of your scientific training that are important in you succeeding as a scientist), training programs nowadays are more holistic in that way. They not only put you in

the lab to have you do your science, but they also allow you to develop these other aspects of your identity that are important for you to succeed in science.

38:25 **Liz:** I think peer mentoring is really helpful in that regard, and that's sort of what you were talking about with your networking, too.

Adán: Yes, exactly.

38:33 **Ivan:** Adán, this has been fantastic; we really appreciate you taking the time today. How can people get in touch with you if they want to ask you a question or learn more

Adán: I'd love to hear from people if they have additional questions. You're welcome to contact me at my email: adan.colon-carmona@umb.edu. That's my email. Or you can use Twitter at @AColonCarmona and I would love to hear from you if you have additional questions.

Ivan: Fantastic. And Liz, how can people get in touch with you?

Liz: You can contact me on Twitter at @EHaswell.

Ivan: You can get ahold of me at @BaxterTwi and you contact the podcast at @TaprootPodcast on Twitter. We also have an email address, which is a taproot@plantae.org. With that, Adán, thank you again for just a really great conversation.

Adán: Thank you very much. Have a great day.

Liz: Thanks, Adán.

40:03 [Theme music]

Ivan: The Taproot is produced by the hosts in collaboration with the

Plantae team of Katie Rogers and Mary Williams at the American Society of Plant Biologists. On this episode, we received editing help from Plantae fellow Ananya Mukherjee. Jo Stormer provides our transcripts.

Thanks for listening. And we will return with another episode next week.

[Theme music]