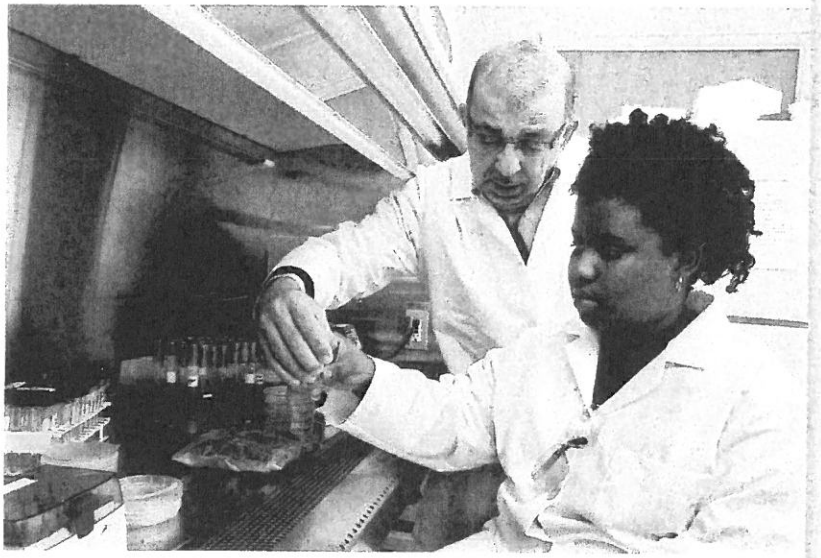
Undergraduate Research Scholars Program

The Agricultural Research Program provides opportunities for students in the School of Agriculture and Environmental Sciences to develop 21st-century skills. For information on applying to the program, please contact the Agricultural Research Program at sjhymonp@ncat.edu.



Food and nutritional sciences major Alani Adkins, right, works with Dr. Salam Ibrahim on a food microbiology experiment.

Discovering career options

Research is all about discovery. For Alani Adkins, a senior majoring in food and nutritional sciences, research has also meant discovering life options that she never knew existed.

As a teen, she never considered a career in science, but after getting a taste of it as an undergraduate research scholar in the Agricultural Research Program, Adkins now thinks research and product development, with a focus on food safety, might very well be in her future. That's quite a departure from just a few years ago, when she thought she'd go to a two-year culinary school after high school, and study to become a pastry chef.

Her mother encouraged her to get a four-year degree instead and Adkins agreed. As she reflected on her undergraduate experience, Adkins said she had no regrets. Food safety, a field that relies on microbiology, is particularly interesting to her.

"If you work for industry, you get to help a lot of people, instead of just one," Adkins said.

She developed the career focus while working in Dr. Salam Ibrahim's food microbiology lab in Carver Hall, a place that is always buzzing with bright students. Ibrahim, whose research specialty is food safety and probiotics, has solidified a reputation in A&T's ag school for drawing forth young talent in food sciences, and for giving many young scientists opportunities for hands-on research projects. In fact, it was Ibrahim who first spotted promise in Adkins, and encouraged her to apply to the demanding, but highly rewarding, Undergraduate Research Scholars Program.

"I always look for really serious students who are interested in advancing in their professional life," he said. "Food microbiology is a small community of scientists. We all know each other, so it's important to have a good reputation in the field for producing top-notch students."

During the program, Adkins discovered and reported on the effects of cinnamon and caffeine in reducing E.coli bacteria. Before she could do that, however, she had to learn how to create bacterial cultures, how to get them to survive and

reproduce in the lab, and how to develop mutant strains. Naturally, she also learned the importance of safe lab protocol.

"You have to be very careful in a lab," Adkins said. "Things you take for granted like touching your face or scratching an itch, you can't do."

The experience also involved travel to a professional conference in San Jose, Calif., to report her findings, a summer internship at Michigan State in East Lansing, and writing a manuscript in hopes of getting published.

Again, Adkins says, she has no regrets about having to work so hard. Having the research experience has opened more financial aid options, she said. Now, she is looking forward to graduate school. Maybe even a Ph.D. is in her future, she says.

"Since I'm doing research, I've found I have more opportunities," she said.

People in places

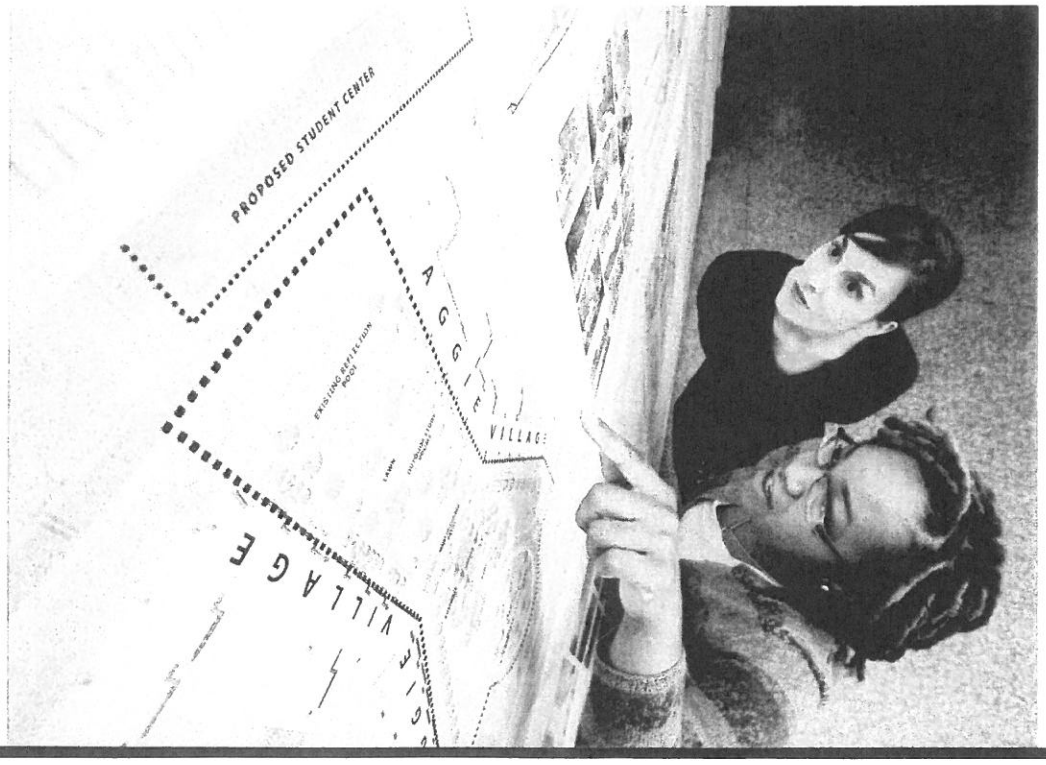
Erin Daniels discovered that asking a compelling question can be as important in landscape architecture research as coming up with a solution. Her experience as an undergraduate research scholar brought that lesson home.

"I kept coming back to her (Daniels' faculty mentor, Anna Reaves, assistant professor of landscape architecture) with really broad topics, like 'green infrastructure,' or 'stormwater management,' and she said, 'That's really broad; I need you to come up with a topic that you can really quantify.'"

The task was especially challenging because, unlike many other agricultural and environmental sciences disciplines, landscape architecture does not have a substantial body of research literature to draw upon for inspiration. So Daniels spent her early weeks in the program reading everything and anything about current issues in the field. That's when she stumbled on an article about livable communities, a concept that the landscape architecture profession is struggling to develop methods for measuring.

"I thought, 'that's interesting. I don't hear them saying the same thing about campuses. I wonder if you can actually determine if a campus is livable, or if you can even evaluate livability?' At the time, I didn't even know if there were standards."

Landscape architecture major Erin Daniels, foreground, and Assistant Professor Anna Reaves, discuss Daniels' design for the livable campus.



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Behavior and changes in cell morphology of *Escherichia coli* O157:H7 in liquid medium and skim milk in the presence of caffeine

Comportamiento y cambios en la morfología celular de Escherichia coli O157:H7 en un medio líquido y en leche descremada en presencia de cafeína

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The objective of this study was to investigate the antibacterial effect of caffeine on the behavior and changes in cell morphology of *E. coli* O157:H7 in a liquid medium and in skim milk. The inhibitory effect of caffeine at different concentrations was determined by inoculating *E. coli* O157:H7 in laboratory medium and skim milk samples. Samples were incubated at 37°C for 48 h, and *E. coli* O157:H7 population was enumerated. Our results showed that caffeine significantly ($P < 0.05$) inhibited the growth of *E. coli* O157:H7 in laboratory medium and milk samples. A greater than 3.0 log CFU ml^{-1} inhibition was observed in milk containing 5.0 g/L caffeine within 12 h of incubation. Moreover, using flow cytometry, marked changes in the morphology of *E. coli* O157:H7 were also observed. Caffeine has potential as an antimicrobial agent and could be used as an effective natural additive to improve the safety of food products.

Keywords: *E. coli* O157:H7; caffeine; inhibition; milk; flow cytometry

El objetivo del presente estudio fue investigar el efecto antibacteriano que tiene la cafeína sobre el comportamiento y los cambios de la morfología celular de *E. coli* O157:H7 en un medio líquido y en leche descremada. Se determinó el efecto inhibitorio de distintas concentraciones de cafeína, inoculando *E. coli* O157:H7 en muestras de un medio de laboratorio y de leche descremada. Dichas muestras fueron incubadas a 37°C durante 48 horas, enumerándose posteriormente la población de *E. coli* O157:H7. Los resultados demostraron que la cafeína inhibió significativamente ($P < 0,05$) el crecimiento de *E. coli* O157:H7 tanto en las muestras del medio de laboratorio como en la muestra de leche. En la leche descremada que contenía 5,0 g/L de cafeína, se observó una inhibición mayor a 3,0 log CFU ml^{-1}, ocurrida dentro de las 12 horas de incubación. Asimismo, a partir del uso de una citometría de flujo se observaron cambios significativos en la morfología de *E. coli* O157:H7. La cafeína tiene el potencial de ser un agente antimicrobiano, por lo cual podría utilizarse como un aditivo natural efectivo para mejorar la seguridad de los productos alimenticios.

Palabras Claves: *E. coli* O157:H7/; cafeína; inhibición; leche citometría de flujo

Introduction

Escherichia coli O157:H7, which is responsible for causing hemorrhagic colitis and hemolytic uremic syndrome, is considered as a significant foodborne pathogen (Doyle, 1991; Riley et al., 1983). *E. coli* O157:H7 has been implicated in outbreaks from a variety of foods including raw milk, undercooked ground beef, fermented meat, and lettuce (Ackers et al., 1998; Armstrong, Hollingsworth, & Morris, 1996; Hancock, Besser, Rice, Herriott, & Tarr, 1997; Mao, Doyle, & Chen, 2001). Milk contamination occurs usually during milking, although it is possible during storage and transportation. Pathogenic microorganisms such as *Escherichia coli* O157:H7, *Salmonella* spp., and *Listeria monocytogenes* in raw milk have been responsible for several outbreaks of foodborne illnesses (Omiccioli, Amagliani, Brandi, & Magnani, 2009; Proctor & Davis, 2000). Even though pasteurization is the established method of ensuring the safety of milk, foodborne pathogens have also been reported from the pasteurized milk (Ackers et al., 2000; Mazumdar, Hartmann, Kämpfer, & Keusgen, 2007; Olsen et al., 2004). There is ever-increasing consumer demand for fresher and minimally processed food. This demand has prompted the search for more effective non-thermal processing technologies for the treatment of different food products including milk (Ross, Griffiths, Mittal, & Deeth, 2003).

The use of chemical agents with antimicrobial activity is one of the most traditional methods to control foodborne pathogens (Kim & Fung, 2004). Nowadays, the content levels of chemical preservatives in food products are an important factor influencing the consumer's choice. Therefore, interest in naturally occurring compounds as antimicrobial agents has increased as the popularity of natural ingredients or foods has increased among consumers. Plants are rich in antimicrobial agents (Gyawali & Ibrahim, 2012). Plant products such as coffee and tea are the two non-alcoholic beverages consumed commonly all over the world and known to possess various biological properties including antibacterial activities (Arora, Kaur, & Kaur, 2009). Caffeine (1, 3, 7-trimethyl xanthine) is one of the three methylated xanthine alkaloid derivatives present in many plant species (Ibrahim, Salameh, Phetsomphou, Yang, & Seo, 2006) and has been shown to have antimicrobial activity against *E. coli* O157:H7, *Salmonella, Pseudomonas* sp., *Staphylococcus aureus*, and several strains of enterobacteria (Almeida, Farah,

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