

EKU Professor Explores Beef Burger Aroma in Plant-Based Beef

Plant-based meat analogues have been available to consumers for over 20 years. The early prototypes of these analogues were very different in flavor and aroma from traditional meat products. Recently, there has been a surge in the development of these alternative meat products and you can now find them in restaurants, grocery stores, and even at popular food chains. Information on the environmental benefit for choosing plant-based products over animal, especially beef, has also become more commonplace.



Dr. Li Li Zyzak

The new prototypes are making significant progress in appearance and flavor; nonetheless, all of them have significant aroma and flavor differences from real hamburger. Dr. Li Li Zyzak, assistant professor in the Department of Chemistry at Eastern Kentucky University (EKU), became curious about these plant-based meats when she tried some of the products and noticed some distinct differences in the aromas produced during the cooking process. This curiosity launched Dr. Zyzak's research which centers upon identifying the important compounds responsible for hamburger aroma and comparing how close these plant-based prototypes are to the traditional beef burger aroma.

In her research, she found that most of the aroma (of hamburger) occurs during the cooking process which implies that there are starting materials or precursor compounds that, upon heating, convert to aroma molecules. These precursors are present in both animal and plant proteins, but in different ratios which lead to different aromas. "The problem with plant-based burgers is that the plant protein itself contributes a strong odor to the plant-based burgers. For example, pea protein smells like green, cut grass, so companies have to find a way to mask that aroma," said Dr. Zyzak.

She uses gas chromatography/mass spectrometry (GC/MS) combined with olfactometry to correlate an aroma to a specific compound in her research. The process requires that volatiles produced during the cooking process are injected into the GC/MS instrument with some of the volatiles diverted to a sniffing port. When a subject smells an aroma, such as meaty, fatty, buttery, or sweet, they mark (using a clicker) the exact spot on the chromatogram that corresponds to that aroma they describe. The remaining sample is analyzed by MS and the

information obtained allow researchers to correlate specific compounds with the aroma smelled by the subject.

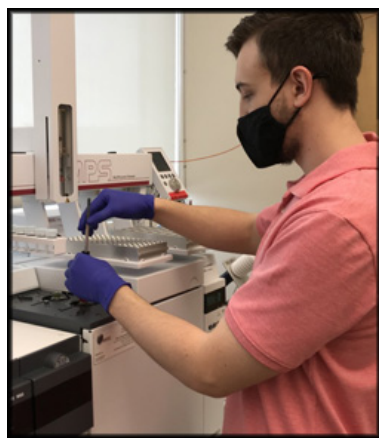
Dr. Zyzak has identified approximately 100 compounds, however only about 30 of those are odor distinctive compounds. According to Dr. Zyzak, “the research shows that it is really challenging to recreate ‘hamburger aroma’. Flavor reactions are very complicated and I imagine there is still a lot that we do not know when it comes to the complexity of aroma formation in the cooking process. Even some of the largest food companies in the world have difficulty discovering how to recreate aroma and flavor in plant-based foods.”



Dr. LiLi Zyzak using the olfactometer in her research.

The results of Dr. Zyzak's research identified some areas where companies could readjust their formulation or approach toward creating plant-based meat products. "An improvement in most products could come by reducing the over flavoring and pyrazines levels along with a focus on elevating the sweet, lipid oxidation compounds associated with cooked beef fat," she said.

Dr. Zyzak hopes to utilize a novel device that she is currently developing to unlock the characteristic hamburger aroma footprint by identifying the exact compounds at the specific concentrations that contribute to the characteristic grilled hamburger aroma.



Mr. Nathaniel Britt works on research.

This research was presented in a paper titled "Investigation into the sensorial and analytical differences of traditional hamburgers versus the plant-based analogues" at the American Chemical Society (ACS) National meeting, fall 2021 in Atlanta, Georgia. The paper was selected for press briefings by the ACS which can be found on [YouTube](#), and in a [press release](#). This work has also been featured in over 65 media outlets, including [Danish Broadcasting Corporation](#) (Denmark), [Engineering and Technology](#), [MSN](#), [Inside Climate News](#), [The Daily Mail](#), [iNews](#), [TodayUKNews](#) (United Kingdom), [CNBeta](#) (China) and [National Post](#) (Canada). Dr. Zyzak was also invited to appear live on the [BNN Bloomberg Commodities](#) show to discuss her research and findings.

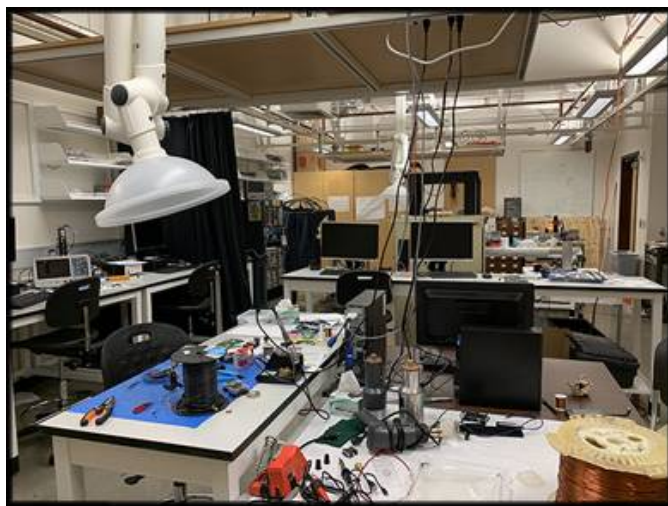
Student researchers in Dr. Zyzak's group who contributed to this project include Mr. Nathaniel A. Britt, Ms. Callie E. Boggs, Mr. Phillip K. Gilbert, and Ms. Lucy E. Jones.

Mr. Britt, who graduated in May 2021 and is currently applying to medical school, had this to say about his experience, “My undergraduate research gave me invaluable experience and the opportunity to present research at a national conference. It has made me interested in doing

research as a doctor in the future. Dr. Zyzak was a wonderful mentor who helped me every step of the way. My research would not have been nearly as fruitful or meaningful without her guidance and support. Presenting and being recognized at the ACS National meeting was a surreal experience that helped me feel validated as a researcher and presenter. It allowed me to get a look into what it means to be a scientist and researcher. It has helped me be more comfortable in public speaking and confident going into the future.”

PLACES AND PROGRAMS

EKU Department of Physics, Geosciences, and Astronomy Nuclear and Partical Physics Detector Lab



The Nuclear and Partical Physics Detector Lab

The newly formed ECU Nuclear and Particle Physics Detector Lab (NPPDL), overseen by Dr. Jason Fry, assistant professor in the Department of Physics, Geosciences, and Astronomy, is a 630 sq. ft. laboratory on the third floor of the Science Building.

The laboratory is one large space that has been divided into two separate areas by a large curtain. The curtain creates a second research space that is completely dark to accommodate experiments and research that are light-sensitive.

Equipment in the NPPDL includes data acquisition computers and Field Programmable Gate Array (FPGA) boards, power supplies, amplifiers, timing modules, Sodium-Iodide scintillation detectors, plastic scintillation detectors, a 3-D printer, vacuum systems, and various other nuclear instrumentation modules for signal processing.

“The ECU NPPDL is centered around student learning and training. Students have the opportunity to collaborate on large fundamental physics experiments at national labs while gaining hands-on experience in our fully equipped laboratory space. Students build, test, and characterize equipment in the laboratory. If these tests prove viable, then they conduct larger experiments at national labs such as Oak Ridge or Los Alamos,” said Dr. Fry.

Dr. Fry and his research students are currently involved with an experiment at Oak Ridge National Laboratory, located in Oak Ridge, Tennessee, to study the kinematic correlations of how the neutron decays. This will, in turn, provide data as to how quarks transform through the weak interaction thus providing valuable input to the Standard Model of Physics.

They are also involved with experiments to uncover new forms of Time-Reversal Symmetry Violation at Los Alamos National Laboratory in Los Alamos, New Mexico.



Mr. Jonathan Mills testing the effect magnetic fields have on light collection from a Sodium Iodide (NaI) detector.

The chance for undergraduate students to work on research at well-known national laboratories allows them to gain valuable experience in the field of physics. Mr. Jon Mills, a junior physics major and one of Dr. Fry's research students remarked, "My physics research has created a channel in which I might utilize my knowledge from the classroom to achieve a practical discovery. It has also allowed me to gain a deeper appreciation for the field."

Certificate in Environmental Education



Elementary students learn about snakes at Taylor Fork Ecological Area.

The College of Science, Technology, Engineering, and Mathematics, through the Division of Natural Areas, offers both undergraduate and graduate certificates in environmental education. The 12-hour certificates provide the skills to be a leader in environmental education in both formal and non-formal educational settings. The certificate is accredited by the North American Association for Environmental Education (NAAEE) and designed in conjunction with the Master Plan for Environmental Education approved by the Kentucky Legislature. In addition, the NAAEE formally recognized EKU's program as a Distinguished College

and University Program, a special designation for high-performing programs that consistently prepare well-qualified environmental educators.

The Division of Natural Areas has housed the Center for Environmental Education since 2002, with the mission of providing pre-service and in-service teacher training and professional development opportunities. The division worked with the former College of Education (now the College of Education and Applied Human Sciences) for several years on a teaching endorsement and this certificate is an outgrowth of that effort.

According to Dr. Kelly Watson, associate director of the Division of Natural Areas and interim director of the Center for Environmental Education, "Environmental education is important because it connects the community to the outdoors and the amazing natural world all around

us, while teaching about the importance and value of our environment and the issues we face.”

The new certificate is open to all students, not just education majors or teachers. As Dr. Watson explains, “People working in any outdoor setting, such as parks, recreation areas, or conservation districts, provide educational programming, interpretive talks, and educational materials for the public. The environmental education certificate prepares students from a diversity of majors to be effective educators, emphasizing an active-learning approach that encourages critical thinking and creativity.”

Students have a choice of courses in science education, geosciences, biology, chemistry, and recreation in the certificate, so they may tailor the certificate courses to their needs.

FACULTY/STAFF AND STUDENT SPOTLIGHTS



Dr. Larry Tim Ross, Jr.

Dr. Larry Tim Ross, Jr. (Tim)

Dr. Larry Tim Ross, Jr. (Tim), associate dean in the College of Science, Technology, Engineering, and Technology, grew up in Tompkinsville, Kentucky, and graduated from Tompkinsville High School. He received his B.S. degree from Western Kentucky University (WKU) in Bowling Green, Kentucky, his M.S. degree from Indiana State University (ISU) in Terre Haute, Indiana, and his Ed.D. from the University of Kentucky (UK) in Lexington, Kentucky.

Dr. Ross initially began his post-secondary education majoring in mechanical engineering technology but after his first year, changed his major to industrial technology because he was drawn to the hands-on, problem solving aspects of the program at WKU. “I have always been a very hands-on person and I like to fix things. I took a class in metallic processes and really enjoyed learning

about the structure of ferrous and non-ferrous metals and how those materials are used in the manufacturing process. Industrial technology was a natural fit for me, and I really enjoyed solving problems using various technologies,” he said.

As part of his degree program, he started working with the initial version of Autodesk Computer Aided Design (AutoCAD) and was fascinated with the computer drawing/design software. His proficiency with the software led him, in his junior year, to the directorship of the WKU

Authorized AutoCAD Training Center, which was one of only eight across the U.S., and teaching workshops in the software for local industry.

After graduating from WKU in 1989, he continued to work in the Department of Industrial Technology as a technician until he enrolled at ISU. He chose the M.S. degree program in industrial professional technology at ISU to extend his technical and managerial experience with the intent to work in the manufacturing industry. He held a graduate assistantship, an adjunct instructorship, and had the opportunity to conduct industry training while working towards his M.S. degree and realized that he truly enjoyed teaching. Dr. Ross commented, "I really enjoyed teaching technical-heavy subjects and gained satisfaction in knowing that my teaching was making a difference for those in my classes." This provided the impetus for Dr. Ross to continue his education to receive his Ed.D. in vocational and industrial education.

After completing the course work for his Ed.D. degree at UK, he was recruited to lead a new, state-of-the-art manufacturing program at Powell County High School (PCHS) in Stanton, Kentucky. "This was an opportunity to develop and build a manufacturing-related program from scratch and it was a challenge I could not let pass by."

Dr. Ross was asked to teach part-time in the Department of Technology at Eastern Kentucky University (EKU) in 1998 and enjoyed the experience. When a tenure-track position became available in the department, he decided to change his career path and applied for the position. He was hired by EKU in the Fall of 1998 as an assistant professor to teach in the industrial technology program.

In 2005 he was asked to serve as the program coordinator for the industrial technology program and in 2007 he became chair for the Department of Applied Engineering and Technology, a position he held until becoming the associate dean in the newly formed College of Science, Technology, Engineering, and Mathematics in July, 2021. "The years I served as department chair were some of my best at EKU. I worked with exceptional faculty, staff, students, and other stakeholders to focus on programs," said Dr. Ross.

During his tenure as chair, the aviation program grew from 120 students to over 320 and the construction management program and engineering technology management programs hit their highest enrollments in a decade.

The best part of his job at EKU is working with students and the support, both personally and professionally, that he received from his colleagues and supervisors. With regards to his newest position as the associate dean for the College of Science, Technology, Engineering, and Mathematics, Dr. Ross said the following, "I am excited to serve the college as the associate dean under Dean Otieno's leadership. I look forward to working closely with the faculty, staff, and students. The college has a number of exciting and innovative initiatives and I am thrilled to be a part of the work we do that changes lives."

He commented about his time working with students, “Whether it was advising, mentoring, or teaching in the classroom/lab, there was no greater reward than seeing the students succeed and knowing you had a part in their success. There is nothing more rewarding than watching the excitement of the students and their families at graduation and knowing you made a difference in their lives.”

With regards to his colleagues, he said, “I had the opportunity to leave the university several times to pursue other opportunities but declined those offers to remain at ECU. I felt like I was part of something more than just my job. There is a great deal of satisfaction in working with talented and dedicated faculty, administrators, students, alumni, and other stakeholders.”

Dr. Ross has been married to his wife, Jeanette for over 28 years. They have four children, Jonathan, Jaelyn, Jenna, and Jessica, three of whom graduated from ECU. His youngest also plans to attend ECU after graduating from Madison Southern High School in Berea, Kentucky.

In his free time, he enjoys spending time with his family at Dale Hollow Lake and Lake Cumberland. He is a college football fan and enjoys home renovation projects as well as maintaining the family vehicles.



Ms. Samantha Radomski

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Ms. Samantha Radomski was born in Little Rock, Arkansas, and lived in a rural farming town until she was 10. Her family relocated to Western Kentucky due to an employment opportunity and lived outside the small antique town of Hazel, Kentucky. She graduated from Calloway County High School in Murray, Kentucky, as valedictorian of her class.

Ms. Radomski, a junior, biomedical sciences major (biomedical research concentration), chose to move to Richmond to attend Eastern Kentucky University (EKU). “It was important for me to stay in Kentucky for the duration of my undergraduate degree program as I have a wealth of resources and support here. I looked at ECU as part of my college search process and was convinced to tour the campus after talking with an ECU representative. I finally chose ECU because of the financial aid I was offered and the connections I was able to create. I was able to tour the

new Science Building and even talk with a professor regarding their research projects. Seeing the way in which ECU encouraged involvement with the STEM field and the research facilities, I knew that this was the school for me. Overall, the experience really made me feel like I was welcomed and allowed me to catch a glimpse of potential opportunities,” she said.

Ms. Radomski participates in multiple organizations on campus, participates in research, and holds a part-time job outside of class. She is on the board of Green Crew and was previously president in the Mu Chapter of the Lambda Sigma National Honor Society. She is a member of the Crime and Chemistry Club, the ECU Honors Program, Phi Sigma Biological Sciences Honor Society, and the 97%. She commented, "All of these organizations have important messages and I feel as though I am helping to spread these messages by attending meetings, virtual events, and connecting through social media." She has also been an Honors Ambassador and a Green Dot Ambassador during her time at ECU.

Her academic success includes several scholarships and awards. In 2019, her team attained second place in the Department of History, Philosophy, and Religious Studies' first "Bioethics Bowl". This is a debate-style team competition focusing on ethical issues in the practice of medicine and/or biomedical research. She also received the "I AM ECU" award from Student Life which recognizes leadership efforts by students that positively impact the ECU experience for others.

Ms. Radomski also received a Premier Scholar scholarship, participated in the Battelle-ECU Science Scholars Program, and has been on the College of Science/College of Science, Technology, Engineering, and Mathematics Dean's List.

Ms. Radomski believes that one of the most important factors for success is a strong support system. "Success is not guaranteed or easy. It is extremely important to have a network of people that have your best interests in mind to support you during tough times and to help you make important decisions regarding your future. Surrounding yourself with people who want you to succeed and having someone that truly believes in you makes a difference."

After graduation, she plans to attend graduate school to hone her skills and investigate potential field options for her career. She would like to venture into the field of clinical or industry as a research biologist. "My career aspirations are constantly developing as I take classes and evaluate my interest in particular subject matter," she said.

She enjoys reading and crocheting when she is not in class, the lab, or working.

ALUMNI AND FRIENDS



Mrs. Jessica Harber

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“Remember that you are more than just an educator. Students need more than subject content and faculty often represent a sense of stability and the voice of reason for students who may not have guidance from friends and family.” Mrs. Jessica Harber

Mrs. Jessica Harber’s family moved around a lot during her early childhood, finally settling in Richmond, Kentucky. She first enrolled at Eastern Kentucky University (EKU) as a chemistry major during which time she had the opportunity to participate in undergraduate research. “Doing undergraduate research was one of the best experiences in my life. I learned a lot about chemistry through the synthesis and characterization of new compounds, including recording and analyzing about a million infrared spectra! Even more important, the undergraduate research experience gave me a great deal of confidence in my abilities and a sense of purpose. Dr. (Tom) Otieno gave me a chance when not many others had faith in me and for that I will always be grateful,” she said. Unfortunately, Mrs. Harber had to put her education on hold due to extenuating circumstances.

She later returned to ECU and earned two B.S. degrees, one in mathematics and one in statistics, and a M.S. degree in mathematics. She remained at ECU as a lecturer for an additional nine years after graduating with her master’s degree, teaching mathematics and statistics courses. “While I loved teaching all classes, my favorites were always developmental courses for incoming students with deficiencies in mathematics, MAT 090 and MAT 095,” she said. “I enjoyed working with those students and seeing them transform into successful college students after starting out (almost always) hating mathematics.”

Mrs. Harber provides the following advice for students aspiring to teach college mathematics, “Remember that you are more than just an educator. Students need more than subject content and faculty often represent a sense of stability and the voice of reason for students who may not have guidance from friends and family.”

Mrs. Harber and her husband, Jacob, moved to Port Charlotte, Florida in 2019 where she embarked on a new career path. She now serves as an institutional research coordinator at Florida SouthWestern State College in Fort Myers, Florida. Her job responsibilities there include

working with large data sets and providing information to various entities on campus for decision making. "I always thought I would end up teaching again but a crazy turn in life landed me a new career which was very scary and exciting considering such a big change happened when I was in my 40s," she remarked.

She has many fond memories of ECU, but it is the relationships she forged with colleagues and friends that stand out. "The best thing I gained from being at ECU was the amazing friends and colleagues I met along the way. I still keep in touch with so many people in Kentucky. ECU is truly a great place full of great people," Mrs. Harber said.



Dr. Stephen Fardo

Dr. Stephen Fardo

"The many years at Eastern Kentucky University, the U.S. Army Reserve career, and other life opportunities were made possible by the exceptional education I received. We should always be grateful for our heritage and the educational values that are formed throughout our lives. I was blessed with kind, loving and supportive parents—Hollis and Velma Fardo. They taught me to be kind and friendly to others, to be proud of my work and to always do my best." Dr. Stephen W. Fardo

Dr. Stephen W. Fardo was raised on a farm in the Peach Grove area in northeastern Pendleton County, Kentucky, and attended Pendleton County High School. After graduation, he enrolled at Eastern Kentucky University (EKU) and graduated with a B.S. degree in industrial education in 1969. He also enrolled in the Reserve Officers' Training Corps (ROTC) while he was a student.

"Continuing my education at ECU was made possible through the financial assistance of the student work study program and the ROTC advanced program fund," he commented. Upon graduation, Dr. Fardo was commissioned as a second lieutenant in the U.S. Army Corps of Engineers. He continued his education and earned a M.S. degree in industrial technology in 1970.

Following graduation from ECU with his master's degree, Dr. Fardo taught at Simon Kenton High School in Independence, Kentucky, and also served as a platoon leader in the 478th Engineering Battalion (U.S. Army Reserve) in Ft. Thomas, Kentucky. From there, he was on active duty at the U.S. Army Engineer School, Ft. Belvoir, Virginia and completed Engineer Officer Basic Course and Engineer Advanced Course. Later, he attended Command and General Staff College and National Defense University.

In 1972, he returned to ECU to join the faculty in the newly formed Department of Industrial Technology to teach in the electronics technology program. While continuing to teach at ECU,

he completed a doctoral program in technical education administration at the University of Kentucky in Lexington, Kentucky.

For over 35 years, Dr. Fardo served ECU in various roles from teaching courses in electricity and electronics to coordinating the undergraduate and graduate career and technical education programs for pre-service and in-service teachers. He worked with countless teachers in more than 30 area technology centers and technical colleges in the central and southeastern regions of Kentucky.

“Dr. Fardo helped shape technical education in Kentucky by his dedication to teaching and mentoring countless new and continuing teachers, many whom came from business and industry, to teach their skills to the next generation. He was also instrumental in the creation and implementation of the New Teacher Institute for occupation-based teachers in Kentucky for many years,” said David Horseman, associate commissioner for the Office of Career and Technical Education (OCTE) at the Kentucky Department of Education.

Dr. Fardo was not satisfied with being an exceptional teacher and mentor to countless students. He gave time to serve on a myriad of university and state-level committees.

He also had a passion for writing. He and his mentor, Dale R. Patrick, published over 40 technical textbooks, including *Electricity and Electronics* (6th edition), and *Robotics Technology, Electrical Control Systems, Electrical Distribution Systems, Industrial Electronics and Electrical Power Systems Technology* (2nd edition).

He was well respected by his colleagues and in 1989, was nominated and selected as a Foundation Professor, one of the highest honors for a faculty member at ECU. The Foundation Professorship recognizes faculty who have demonstrated outstanding performance as teachers, and who have been recognized by their colleagues as exemplifying outstanding qualities relating to the University’s stated missions in teaching, scholarship, and service.

Dr. Fardo continued to serve in the U.S. Army Reserve with the 100th Division in Louisville, Kentucky and Fort Knox, Kentucky and with the 87th Division in Birmingham, Alabama throughout his tenure at ECU. He held positions that included engineer instructor, administrative officer, logistics officer, operations officer, chief engineer, battalion commander and brigade executive officer. The majority of that time was spent working with engineer units in the North Central and Southeastern United States. He retired after 28 years of service at the rank of lieutenant colonel.

He has a number of fond memories of ECU. The first was being hired as a student worker during his first semester to work with Mr. Dale Patrick who became his mentor, colleague, and dear friend. However, the fondest memory was meeting Helen McNay in 1967, whom he married in 1969. “Primary life decisions were made in these early years at ECU,” he said.

His fondest memories of the department were meeting his life mentor, colleague, and friend, Mr. Dale Patrick, and working with exceptional department chairs: like Mr. Ralph Whalin, Dr. Clyde Craft, Dr. William E. (Ed) Davis and Dr. Tim Ross. “These chairs had the vision to adapt and implement diverse technical programs that attracted students from many backgrounds and prepared them for high-tech and rewarding careers,” he commented. Dr. Fardo also discussed how rewarding it was to work with exemplary professionals in a nationally recognized department. “The faculty were great colleagues and demonstrated that they truly cared about the success of their students, professionally and personally. ECU provided a wonderful campus environment, a great place to work and skilled professors who really cared about students,” he said.

Dr. Fardo has contributed to scholarship funds in the department and has also established a “Faculty and Student Recognition” fund to recognize faculty and students who have made significant contributions to the Department of Applied Engineering and Technology as a way to give back to the university.

Since his “official” retirement in 2007, Dr. Fardo has continued to teach a course or two each term and mentor technical education teachers across the Commonwealth. However, he and Helen enjoy taking extended trips to travel internationally and across the US.

“Life was great as a student! Life was great as a faculty member at ECU! Now, life is great as an ECU Alumni and retired professor,” he said. He continued, “The many years at Eastern Kentucky University, the U.S. Army Reserve career, and other life opportunities were made possible by the exceptional education I received. We should always be grateful for our heritage and the educational values that are formed throughout our lives. I was blessed with kind, loving and supportive parents—Hollis and Velma Fardo. They taught me to be kind and friendly to others, to be proud of my work and to always do my best.”

Dr. Fardo and Helen were blessed with two sons, Brian and David, Brian's fiancé, Luci of Richmond, Kentucky, and David's wife, Karen, and their children, Hope and Emily who live in Lexington, Kentucky.