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INTERVIEW

Professor Carla Bottoli, an enthusiastic scientific researcher, kindly spoke to BrJAC

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Carla Beatriz Grespan Bottoli holds a degree in Industrial Chemistry from the Federal University of Santa Maria (1996), as well as a Ph.D. in Chemistry (2002), and a postdoctoral degree in Chemistry (2002-2004), both from the State University of Campinas (Unicamp). In 2005, she undertook an internship at the Institute of Nuclear Sciences of the National Autonomous University of Mexico (UNAM) to study radiolysis in vitamins using gamma radiation from a source of Cobalt 60. In 2017, she presented her habilitation thesis (associate professor's thesis) at Unicamp. She is Associate Professor and Postgraduate Advisor at the Institute of Chemistry at Unicamp (IQ-Unicamp), where she works in the area of analytical chemistry, with emphasis on separation methods, mainly liquid chromatography. Currently, she is a Visiting Scholar at the Department of Chemistry at University of Michigan (USA), developing a Metabolomics research project.
Prof. Bottoli coordinates the NovaCrom – Liquid Chromatography Laboratory (https://novacromlab.wixsite.com/novacrom), which is a research group that has been working on the development of new monolithic stationary phases for capillary liquid chromatography. Research is also focused on the development of analytical methods that employ liquid chromatography coupled with mass spectrometry to study the translocation of pesticides in plants such as coconut, palm, and soybean She is a member of the Brazilian Chemical Society and a researcher at the National Institute of Science and Technology in Bioanalytics (INCTBio).
Carla Bottoli is the mother of Murilo, 14 and Mateus, 11.

How was your childhood?

I was born in Toledo, a small town in the interior of the Paraná state, in southern Brazil. I am the middle child, with an older sister – a historian – and a younger brother – a veterinarian. My father was a farmer and my mother a housewife. I had a peaceful childhood, with the privilege of always studying at a private school, finishing the music theory course and studying piano from the age of seven until I entered university. The street I lived on was quiet, and most families in the neighborhood had children. We played a lot in the street, rode our bikes all over the city, walked to school, and spent the afternoons at the social club. I have always been very studious and methodical, both in the organization of the house, as well as books and school supplies.

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What early influences encouraged you to study chemistry? Did you have any influencers, such as a teacher?

My first contact with chemistry took place in high school, at "Colégio La Salle", through Prof. Alberto Zimmermman. The school had a laboratory where it was possible to take practical classes in chemistry, physics, and biology. Many experiments were carried out in this laboratory. I kept the "report folder" for a long time. Today, with my graduation, remembering the chemistry experiments we did in the laboratory, I remember Prof. Alberto with great admiration because I see that he truly cared about transmitting as much knowledge as possible to his students. Experiments of the most varied types were carried out; among them, one of chromatography, precisely the analytical technique that I work with in my line of research. My ease with subjects in the exact sciences, mainly chemistry and mathematics, was decisive in enrolling me in the entrance exam for the Industrial Chemistry course. I believed that, when I finished the course, I would know the formula of all the chemical products that could exist, and this fascinated me. I have always liked to know about the composition of "supermarket products".

How was the beginning of your career in chemistry?

I've got an undergraduate degree in Industrial Chemistry at the Federal University of Santa Maria in Rio Grande do Sul. I was so delighted to study at a great university; initially, the distance of 1000 km from my parents' house was not an obstacle. The first year of university was very difficult for several reasons: I was alone in an unknown city, far from home, and I had to study like never before in my life. In the second year of the course, more accustomed to university life, I joined the scientific initiation in the area of analytical chemistry under the supervision of Prof. Martha Adaime. This period in the laboratory provided me with great academic growth. I presented several works in congresses, including an oral presentation in a coordinated session at the National Meeting of Analytical Chemistry in Belo Horizonte in 1995. It was at this meeting that I met Prof. Carol H. Collins. At the end of the undergraduate course, I felt the need to study and learn more, and therefore decided to continue my studies. I had already chosen the area of activity that I would like to pursue: analytical chemistry. With that in mind, I tried to determine if Prof. Carol from Unicamp could be my master's advisor. With a positive response, I prepared for the test and entered the master's degree course in Chemistry; the following year I went on to the Direct Doctorate program. While I was a member of the Liquid Chromatography Research Laboratory (LABCROM) at the Institute of Chemistry at Unicamp, I experienced great personal and professional growth. Many were responsible for this, but Prof. Carol and her husband Prof. Kenneth Collins played a fundamental role. With them, I learned to see scientific research as a project of life, love, and giving. Prof. Kenneth managed to convey a very important message to my scientific life by always emphasizing that it is critical that scientists practice the highest standards of professionalism and integrity when communicating the results of their work in scientific journals. After defending my doctorate, I received a postdoctoral researcher position for two years, also at Unicamp, under the supervision of Prof. Isabel Jardim. During this period, a vacancy was open to hire a professor at the Institute of Chemistry in the area of separation methods. Since then, I have been working at the Department of Analytical Chemistry at Unicamp.

Prof. Bottoli and Prof. Carol Collins.

What has changed in your profile, ambitions, and performance since the time you started your career?

We are all in constant change and evolution, whether as a professional or as a person. The more we get to know each other, the more we can enhance the skills and abilities necessary for professional performance. The career of a university professor has the characteristics of multiple themes, a variety of tasks, and a plurality of information and people, and we have to constantly orchestrate this set on a daily basis.

Analyzing my profile and performance since I started my career, I notice greater emotional maturity, resilience, agility in carrying out tasks, better communication, and assertiveness, skills that have been developed over the years.

Could you comment briefly on the recent evolution of analytical chemistry, considering your contributions?

Analytical chemistry laboratories, both in academia and in industry, work with instrumentation. In addition, we currently have many equipment options available, because this is a very dynamic field. Many of these tools are used not only in chemistry labs but also increasingly in other areas, such as the biological sciences. One of the main advances in analytical chemistry has been the miniaturization and simplification of analytical tests by microfluidics, one of the areas that has advanced the most in analytical chemistry. Consequently, the increase in mobile laboratories and portable devices has allowed greater versatility in applications. Other areas that have had significant advances are tandem mass spectrometry (MS/MS), a technique in which two or more mass analyzers are coupled to improve the analysis of varied samples, and green analytical chemistry, a trend in several areas that meets sustainability in scientific research. Green analytical chemistry focuses on reducing the use of substances with a high degree of toxicity, allowing greater safety for operators and the environment.

In general, analytical instruments have advanced significantly; as a result, it has been increasingly possible to perform complex tasks with high detectability and accuracy. For example, the technique of high-performance liquid chromatography (HPLC), even though it is a well-established technique, continues to evolve, with a focus on column development and biopharmaceutical and protein separation. The interface for mass spectrometry has expanded the limits of liquid chromatography, enabling the reduction of column sizes and increasing mass sensitivity, giving rise to new applications for capillary chromatography and nano-LC. Both capillary and nano-LC chromatography can be considered among the most recent topics of interest in liquid chromatography. Great efforts have been made in miniaturized LC to achieve better separation efficiencies, lower solvent consumption, and waste generation. My research group has been working on the development of new monolithic stationary phases for capillary liquid chromatography.

What are your lines of research? You have published many scientific papers. Would you highlight any?

My lines of research focus on the development and application of separation techniques, mainly HPLC. Within this context, we essentially have two lines of research in our laboratory: the development of monolithic capillary columns for liquid chromatography and the development of methods for analyzing complex samples using liquid chromatography.

My first line of research as a professor at Unicamp was the development of monolithic columns for capillary electrochromatography, an analytical technique that was on the rise. With the experience acquired in the preparation of these columns, we started to apply this knowledge to the development of monolithic columns for nano chromatography and capillary liquid chromatography. We have developed monolithic capillary columns of various types, the most recent of which are hybrids, which have advantages over other conventional types. Different monolithic structures have already been synthesized to increase the selectivity of stationary phases, with promising results. We have recently applied these materials as extraction sorbents in miniaturized devices. This is a line of research that I like a lot and that makes my eyes shine because it is quite challenging and innovative. I have supervised several students within this theme, with several publications, book chapters, and partnerships with groups in the US and Europe.

The other line of research, relating to the development of methods for analyzing more complex samples, has brought much learning and partnerships with national research institutes, universities, and private companies. As an example, I can mention a work that we recently developed together with “Embrapa Tabuleiros Costeiro” and “Sococo”. This work involved different researchers, such as agronomists, mathematicians, and chemists. We evaluated two methods of application of the fungicide cyproconazole on coconut stems using the endotherapy technique, which has been little explored in agriculture but has potential for the treatment of several crops. From the data, a mathematical model was made to extrapolate the translocation of the fungicide in taller coconut trees, in addition to a simulation for leaf diseases. Chromatographic analyses and modeling showed that pressurized endotherapy had faster translocation using fewer products than non-pressurized endotherapy. This is an example of work in which liquid chromatography was essential to obtain the response of applications made in the field.

Group members in the lab. Back Row (Left to Right): Mariana Gama, Marcella Schmidt, Lucilia de Melo, Carla Bottoli, Fabiane Pires, Letícia Shiroma, Gabriela Almeida, Jucélio Saturno, Lucas da Silva. Front Row: Julie Otálora, Gisláine da Silva, Mary Perez.

What is your opinion about the current progress of chemistry research in Brazil? What are the recent advances and challenges in scientific research in Brazil?

Chemistry in Brazil is very well developed and has excellent research groups in all areas with international prominence. The research funding policy in Brazil has been improved over the years; currently, the incentives of funding agencies have directed research in chemistry toward a more collaborative science, with multidisciplinary projects and approaches focused on the numerous challenges that society faces day to day. This incentive from funding agencies has forced researchers to develop projects in thematic areas, with groups of specialists in different areas, increasing interaction between researchers. Another trend has been the publication of works in specialized journals with open access. The main objective of the open access movement is to encourage the reading and releasing of scientific information to all interested parties, especially poorer countries that cannot afford subscriptions to commercial publishers. This is a worldwide trend, and Brazil has followed this movement, despite the high cost of publishing the article, which often consumes resources that could be invested in research. This model was initially considered a

form of democratization of knowledge; however, only those with a higher level of funding can pay the costs of publication in the most prestigious journals.

With regard to the challenges before us, we all have different challenges to be overcome. One of them is people's lack of knowledge about the scientific work carried out, especially at universities, which means that the population does not know the impact generated by these studies. During the pandemic, scientists played a prominent role, mainly due to the exposure achieved by the media, increasing people's trust in scientists. Moreover, despite the difficulties and attacks on science and researchers, many people have come to learn more about the importance of science during the pandemic.

Cuts in education and science are also major challenges for the scientific research carried out in Brazil. Public universities have difficulty maintaining themselves, and since universities are centers of scientific development, the research carried out in them is jeopardized.

For you, what have been the most important recent achievements in analytical chemistry research? What are the landmarks? What has changed in this scenario with the COVID-19 pandemic?

In my perception, a great achievement in analytical chemistry research was the development of mass spectrometers coupled to liquid chromatography. Mass spectrometry is an analytical technique that determines the molecular mass of compounds while also identifying and quantifying the compounds under analysis. It is used to understand the fundamental atomic and molecular processes. When coupled to liquid chromatography, it helps to diagnose diseases, discover new drugs, analyze natural products, and protect the environment and consumers.

The COVID-19 pandemic brought analytical chemists closer to health researchers, and mass spectrometry has been widely used in the detection and characterization of molecules associated with COVID-19, due to its high selectivity, accuracy, and versatility. MS-based omics strategies have contributed to the fight against COVID-19 and are extremely useful in medicine, to identify, characterize, and quantify all molecules involved in the diagnosis of SARS-CoV-2 infection.

Another approach related to fundamental analytical science that played an important role in the pandemic scenario was scientific data evaluation. The definition of uncertainty has become very important in all scientific approaches, mainly in the presentation and dissemination of results.

Prof. Bottoli at the 20th Brazilian Meeting on Analytical Chemistry.

There are, in Brazil and in the world, several conferences on chemistry. To you, how important are these meetings to the chemistry scientific community? How do you see the development of national chemistry meetings in Brazil?

Participating in conferences in Brazil and abroad is very important. When we participate in a conference, we have the opportunity to show our work to the scientific community and we increase our visibility and that of the institution we are representing. We have the opportunity to talk and personally meet other scientists, which can result in partnerships, the possibility of student exchanges, and stimulate new ideas. In my research group, I always encourage students to participate in scientific meetings, and I do everything possible to make that happen. During the pandemic, we saw how many opportunities we missed to make new connections when we could not travel to meetings or meet in person. Virtual meetings have brought an excellent way to share information and to meet people from different locations quickly, but they are not efficient in meeting new people or building personal relationships that happen in conversations after a presentation, at a dinner, or in a meeting room.

National chemistry meetings are essential for students to participate in this type of event, present their work, have contact with other researchers in their area, and realize the importance of these meetings. It is an excellent way for them to feel the immersion of scientific events, as the vast majority can only

participate in national congresses, since the costs of participating in international congresses are high and often not accessible for scholarship students.

What is the importance of awards for the development of science and new technologies?

Awards are important in the career of any professional, as they are recognition of their work. In addition, they can demonstrate positive models for the scientific community.

For you, what is the importance of the national funding agencies for the scientific development of Brazil?

The development agencies are and will continue to be fundamental in the training of researchers through fellowships, grants and in the financing of projects for the scientific and technological development of Brazil. It is difficult to find a good Brazilian scientist, whether in the public or private sector, who is not or has not been supported by a funding agency at some point in their career.

At the moment, the situation for scientific research in Brazil is one of decreasing investment. How do you see this situation, and what would you say to young researchers?

Brazilian scientists have faced a significant decrease in financial support for research and graduate programs in recent years. The immediate effects may seem contained to academia and universities, with interruptions to research and loss of grants. But these cuts will have a direct impact on society in the medium term, leading to a reduced production and dissemination of knowledge and a shortage of scientific discoveries that could provide practical solutions for daily living. Just as serious as the impact of the latest cuts is the instability that is created in the system and in the confidence of young researchers, which discourages them from pursuing an academic career. The phenomenon known as 'brain drain' may significantly increase in a situation of deep discouragement. Young researchers are people who bring new ideas, and Brazil is sending these young people as gifts to other countries.

What I say to young researchers is that a master's and doctoral education makes a difference in anyone's professional (and personal) life.

What I say to young researchers is that a master's and doctoral education makes a difference in anyone's professional (and personal) life. Moreover, the titles we conquer are ours; no one can take them away from us. Brazil needs qualified people, and we have many spaces to act. However, if they do not have job opportunities here in Brazil, look for opportunities outside of Brazil, but do not stop following your dreams of building a scientific career.

To mitigate this situation of talent evasion, we need to create public policies to value the scientific career, as it is the basis for the generation of knowledge and innovation, and for the technological development of the country. Science as a profession needs to be encouraged and respected, to attract brilliant minds and return to society all the investment made in training these researchers, through the advancement of knowledge.

What advice would you give to a young scientist who wants to pursue a career in chemistry?

This advice I would give to anyone who wants to be a scientist, regardless of the field: do not give up. When we are starting our career, it seems that the road is long. Follow each stage of your training with dedication, perseverance, and ethics. We do not become a scientist just by doing a doctoral thesis. You need to have a critical view of your work, be aware of trends in your area, do exchange programs, participate in conferences, talk to researchers from all areas, and be curious.

For what would you like to be remembered?

As scientists, we have the opportunity to inspire people close to our institutions, such as students, young scientists, and our peers. I would like to be remembered for the motivation and incentives given to the people around me, for the enthusiasm, even in the face of difficulties, and for the professionalism in carrying out the work.