

Interdisciplinary research on the specific problems of today's society

Science Faculty



Pontificia Universidad JAVERIANA Colombia

G.A.T: Generation of Therapeutic Alternatives for Cancer from Plants

The GAT project sought to generate therapeutic alternatives for cancer from cultivable plants that have traditional knowledge of use by communities.

It was carried out through four objectives:

- 1. To establish an agricultural model for the production of plants of interest.
- 2. To establish biological models to study the pathophysiological mechanisms of cancer and understanding the activity of plant extracts or metabolites.
- 3. To integrate and consolidate the institutional capacities to carry out clinical studies (Translational Medicine).
- 4. To consolidate a platform for the discovery of Phytopharmaceutical products using bioinformatic and artificial intelligence tools.

The study of our biodiversity has led us to investigate all aspects of the medicinal plant production chain. From peasant work to product development, clinical research and transference into existing business sectors. As well as the creation of spinoffs based on knowledge.



Achievements

- Consolidation of production chains of medicinal plants with 2 phytodrugs in phase I and II clinical studies in patients with breast, gastric, pancreas cancer and leukemia.
- Impact on policies that promote the development of knowledge networks and sustainable funding that allows for value generation.
- More than 50 scientific articles categorized as Q1, 14 patents, 42 technological development products that include business secrets, innovations in process, prototypes and ready-to-market products, 73 scientific dissemination events, and over 60 students who are associated with researchers.

Alliances

The organization works collaboratively with both public and private universities, the Colombian National Institute of Health and Cancer, as well as the private and public sector to position natural products with high added value in health -plant medicines and supplements- within the objectives of the national development plan based on mission.



Use of CRISPR/Cas9 in the Study of Inborn Errors of Metabolism

Inborn errors of metabolism are diseases caused by mutations in the genes responsible for protein synthesis that play a crucial role in the metabolism of amino acids, carbohydrates, lipids and nucleic acids.

At our Institute, we have been using the genomic editing tool CRISPR/Cas9 to investigate the molecular and cellular bases of these diseases and to develop gene therapy strategies. In the first case, we are generating cellular models of some of these diseases using astrocyte cells and neurons. To achieve this, we have adapted the CRISPR/Cas9 technology to interrupt the genes involved in disorders such as Tay-Sachs and mucopolysaccharidosis IIIB. This allows us to study closely the underlying mechanisms of these pathologies at the molecular and cellular level. As for the second case, given the genetic nature inherent in these diseases, gene therapy is presented as a therapeutic alternative of great relevance.

In this context, we use CRISPR/Cas9 technology in combination with nanoparticlebased nonviral delivery systems to design **gene therapy strategies to treat diseases such as mucopolysaccharidosis IVA and IIIB, Tay-Sachs disease and the phenylketonuria**.

The results obtained in both cells and animal models have shown that our therapeutic approach has the ability to correct the biochemical, cellular and phenotypic alterations associated with these diseases. This underlines the effectiveness and versatility of the CRISPR/Cas9 tool as a promising option for treating inborn errors in metabolism.





- Award for best research work at the XVII Research Congress at the Pontifical Javeriana University (2023).
- Three research articles derived from this project have been published. Since the first publication, in May 2022, these articles together have reached 12 citations, and nearly 5,400 views.

Alliances







Nemours. Children's Hospital



Identification of endangered butterfly species of high altitude in the American tropics: the Colombian endemics

The project uses species of butterflies restricted to high altitudes as an ecological tool to recognize the effects of global warming on the upslope displacement of the Andean endemic biota.

In addition to the current habitat destruction, these species can be endangered by the quick increase in global temperature, since they have no place to migrate or time to respond to the change. Several high-altitude species belong to isolated mountain systems as unique as their ecosystem biota. Despite their endemism and reduced area of distribution, not one of these species has been listed as endangered; however, several can be included in the categories of vulnerable, endangered, or critical risk. Unfortunately, not enough information is available to define this status.

This project aims to identify the status of endangered species of butterflies restricted to high altitudes in Colombia, estimate the effect of global warming on their distribution, and extrapolate the results to their unique biota and ecosystems.

Additionally, we are estimating populational sizes and their change over time using molecular markers. We are defining species distribution and generating models of geographic and ecological amplitude for species under the current conditions and under different scenarios of global warming.



Relevant data

- 1. 90% of 192 endemic species recorded for Colombia are restricted to mountain ecosystems.
- 2. 127 of these species have been recorded in Colombian Natural National Parks (NNP) and 93 were recorded in only one place (unique species).
- 3. Mostly, endemic species are distributed in the Andean region and important areas with endemic species are not protected.
- 4. The NNP Santa Marta has the highest number of total and unique species.
- 5. When the pattern is extrapolated, it is evident that most of the Colombian endemic biota are principally distributed in the high-altitude areas of the country. Populational sizes are currently being estimated.

Alliances

Colombian Natural National Parks (NNP), Entomological collections of Colombian Universities and research institutions.



Resilience of tropical crops to climate change: searching for the mechanisms and genes of tolerance to water stress in cacao

Cacao is a tropical perennial species with economic and cultural importance in Colombia.

Cacao beans are renowned for the chocolate industry, with a global growing demand in recent decades, positioning it as a driver of environmental and social economic growth. **Colombia is the fifth-largest cacao exporter globally and is among the top ten cacao-producing countries**. Importantly, Cacao production is supported by 65,000 smallholders and it is central for the food security of their families. Cacao beans are source of antioxidants and bioactive compounds with great potential for the food, pharmaceutical and cosmetic industries. Additionally, it is an environmentally sustainable crop, grown in agroforestry systems that provide ecosystem services and support other food crops. However, this promising outlook is overshadowed by the effects of global warming, which is expected to increase periods of drought, negatively impacting cacao-crop production.

The resilience of cacao crop to this stress will depend on the effectiveness of their response, hence the immense importance of uncovering the genes and mechanisms involved in generating tolerance. We have addressed this using integrated approaches: functional genomics and plant physiology, generating useful knowledge to understand drought stress response in cacao, with tolerance candidate gene identification. This research should benefit breeding programs, contributing to improve yield, sustainability and welfare around cocoa cropping.





Achievements

- First transcriptomic resource related to Cacao response to water deprivation.
- Light response curves in seven local cacao genotypes as well ecophysiological characterization of their response and tolerance to water deprivation, which makes possible further evaluation of this trait for breeding purposes.
- More than 3000 differentially and significantly expressed genes in response to water deprivation and identification and validation of several tolerance candidate genes belonging to different genotypes.
- Collaborative research and teaching for capacity building in the field of multi-omics data analysis of Colombian genetic resources complemented with other ongoing projects: Integrated multi-omics analysis of the genetic and phenotypic diversity of Andean tubers (Tropaeolum tuberosum Ruiz & Pavón) from Colombia and Bolivia; Development of Strategies for the certification of seeds and seedlings of Passion fruit (Passiflora sp.); Root to food: Improving the yield of potatoes and other Andean tubers.

Alliances

- 1. Uk funding student mobility only (research secondment of Postgraduate student at EMBL-EBI) CABANA Program (UK-Latin America).
- 2. Geoambiente Ltda (Colombian private company).



Analysis of Mild Cognitive Impairment (MCI) as an Early Predictor of Neurodegenerative Disorders: A Multiomic Approach for the Atlantic Department

The main objective of the research project is the development of methodologies for the early detection of Mild Cognitive Impairment (MCI) and its relationship with neurodegenerative diseases in the department of Atlántico.

This issue is addressed in an innovative and systematic manner by integrating various types of data, including clinical, neuropsychological, electrophysiological, MRI, metabolic, genetic, exosomal, and intestinal microbiome information. The goal is to identify molecular and neuropsychological markers associated with MCI in this population, as well as to identify molecules with therapeutic potential.

Experimental data, such as exomics, genomics, and intestinal microbiome, will be used to develop genome-scale computational models (GEMs) of astrocytes and neurons related to neurodegeneration. These models will help identify key reactions affected during the development of MCI, known as controlling reactions.

The results of this research will be integrated into the multiomics computational platform ANSEP (Astrocyte Neuron Simulation Environment Platform). This platform will enable the study of neurodegeneration from a systemic perspective and facilitate the understanding of the molecular and metabolic interactions underlying MCI in the Atlántico population.



Relevant data

- Neurodegenerative diseases, affecting 50 million people worldwide and reporting 10 million new cases each year, are a growing public health concern.
- It is estimated that between 5% and 8% of the population over 60 years of age will develop dementia. In fact, by 2030, a total of 82 million affected individuals are expected, increasing to 152 million by 2050.
- According to the National Health, Well-being, and Aging Survey in Colombia, the department of Atlántico has the highest prevalence of dementia as an initial state in the development of these pathologies, at 12.9%, and the city of Barranquilla records a prevalence of 11.7%.

Alliances







Efficacy and safety of new complementary feeding guidelines with an emphasis on red meat consumption: a randomized trial in Bogota, Colombia

> **Iron deficiency is common during the complementary feeding period**, particularly in vulnerable populations with a high prevalence of maternal iron deficiency, low birth weight, infection, and poor dietary intakes and may be associated with adverse effects on cognitive outcome.

Zinc deficiency is also common and is associated with poor linear growth and increased infection risk, and it is recognized that meat is a good source of bioavailable zinc and iron as well as protein. Therefore, **our specific hypothesis for this project was that the new guidelines would result in increased red meat intake, improved iron and zinc status, and improved linear growth, without adverse effects on adiposity or breastfeeding.**

We also investigated the acceptability and affordability of the new guidelines and tolerance of the complementary foods recommended. The new guidelines showed efficacy with higher red meat intake and positive effects on haemoglobin and haematocrit and not iron deficiency anaemia in the intervention group -with the new complementary feeding guidelines-**The intervention was acceptable and affordable for most mothers.**



Alliances

The collaboration with UCL-ICH is focus on mother, infant and child research, because our aim is to explore causes and possible interventions to contribute in the solution of the main nutritional problems in the first 1000 days, that is considered the window of opportunity to improve and program health and nutritional status, regarding malnutrition as under nutrition, micronutrient deficiencies, overweight and obesity which are prevalent in Colombia and in the region, among mothers, infants and children.

The results of the projects with UCL ICH are relevant in terms of public health policies and programs because the results of the project provide a new approach to support an implement effective and acceptable nutrition interventions against anaemia due to iron deficiency in infants and young children, as well zinc deficiencies, which are the major micronutrient deficiencies during infancy with short- and long-term implications on health and children development, with socioeconomic implications that should be considered by the policy makers.

Publications and dissemination: the results of the projects include publications of papers, book, as well as presentations in international and national academic events and public institutions in Colombia to the policy makers.





