Ecuadorian essential oils

Ancestral knowledge meets scientific research

Ecuador has one of the highest biodiversity indices, but also one of the world's highest rates of deforestation. New reforms and scientific research are needed to safeguard its biodiversity, which not only provides climate-balancing carbon capture but a world of natural medicines. Professors Paco Noriega and José Luis Ballesteros of the Universidad Politécnica Salesiana, in Quito-Ecuador, are leading research to define the antimicrobial activity of molecules within the essential oil produced by an Andean shrub, Piper barbatum Kunth.

Ecuador is a biodiversity hotspot with around 25,000 plant species (accounting for 10% of the world's total), 1,632 species of birds, and 492 species of amphibians. The country is also home to a diverse culture of people with a deep and profound knowledge of its natural resources, including natural medicines. However, the balanced dynamic between these peoples and the natural world is under threat. Deforestation for timber, crops, land for cattle, and mineral and non-renewable resources is destroying the homes of these people and endangering the invaluable web of life that humanity relies upon for survival.

It is also taking away the opportunities for 'Western civilisation', as it is known today, to learn about and to understand the wonders of plant medicines that comprise Ecuadorean peoples' natural medicine cabinet. Professors Paco Noriega and José Luis Ballesteros have spent many years searching for and recording ethnobiological information surrounding Ecuadorean plant species. Their overall goal centres on scientifically validating the traditional knowledge of the people of Ecuador and identifying plant-based compounds that could be used to generate new pharmaceutical therapies. Recently, Professor Noriega and Professor Ballesteros have undertaken research to elucidate the medicinal properties of the Andean shrub, *Piper barbatum* Kunth, using antimicrobial bioautography.

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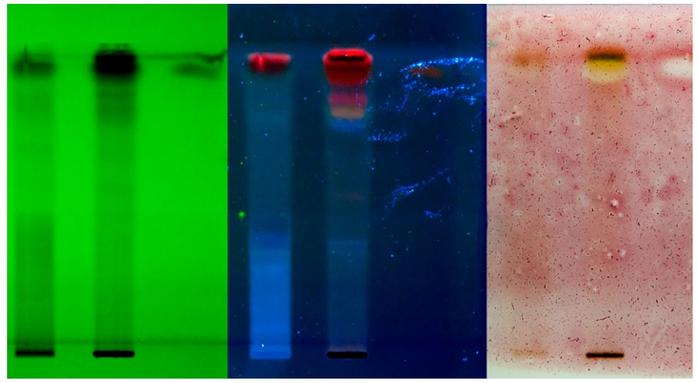
Ecuador is a biodiversity hotspot.

PROPERTIES OF PLANT ESSENTIAL OILS

In a study conducted in 2019, Professor Noriega investigated the chemical composition and biological activity of essential oils extracted from five other medicinal plant species from the Ecuadorian rainforest. These plants included: *Siparuna aspera, Siparuna macrotepala, Piper leticianum, Piper augustus, and Hedychium coronarium.* Within the study, Professor Noriega and colleagues analysed the antioxidant properties of the essential oil from each plant species, the composition of each essential oil, the antiradical of particular molecules within the essential oils, and any antimicrobial activity exhibited against certain yeast and bacteria.

Among common tests used to determine essential oil properties and compounds, a bioautographic method was used in this study to investigate antiradical activity. Bioautography is a technique that allows for the identification of bioactive components of plant extracts. Chromatography is typically used along with a biological detection system. Chromatography is an analytical tool that helps separate and detect the contents of a mixture, or in this case, a solution containing plant extracts.



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Thin layer chromatography bioautography assay. This technique can be used to detect antimicrobial activity of plant extracts.

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Thyme extract is known to have several health benefits.

Antiradical activity can be an important factor when considering plant essential oils for human use.

Antiradical activity can be an important factor when considering plant essential oils for human use. Free radicals are thought to be a contributor to the development of diseases including cancer and cardiovascular diseases through promoting cell degeneration. The potential antioxidant and antiradical activity of certain medicinal plant species under study can be beneficial for converting free radicals in the human body into more stable molecules that may reduce the development of such harmful conditions. Plants with favourable antioxidant and antiradical profiles could be used as natural food additives in place of potentially harmful synthetic counterparts. Antimicrobial activity is another important medicinal component that, if favourable, can be utilised in a pharmaceutical setting to help fight off infection of harmful pathogens.

In their 2019 study, Professor Noriega and colleagues recorded the chemical composition of *S. aspera* and *P. leticianum* for the first time. The essential oil of *S. aspera* contained the molecules germacrene D (23.2%), bicyclogermacrene (7.8%), and α-pinene (7.0%). *P. leticianum* contained β-caryophyllene (21.8%) and germacrene D (9.0%) as primary compounds, and *P. augustum* essential oil had a similar composition. The researchers reported interesting levels of cadinane compounds for *S. macrotepala* and interesting antioxidant activity for one molecule within its essential oil, germacrene D. The five essential oils were found to have low antioxidant activity compared to the positive control: *Thymus vulgaris* essential oil.

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Hedychium coronarium

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The researchers analysed the antioxidant properties of the essential oil from several plant species.

In terms of antimicrobial activity, the most notable results were recorded for *H. coronarium*. A method known as disk diffusion was used to measure the antimicrobial activity of the plant essential oils against a selection of yeast and bacteria. The minimum concentration of essential oil required to eradicate bacterial and yeast strains was recorded as the Minimum Inhibitory Concentration (MIC). The bacteria and yeast are grown in a petri dish with essential oil added to it. The minimum level of essential oil required to generate a clear zone of inhibition exemplifies the MIC. *H. coronarium* essential oil exhibited a notable ability to clear bacteria *Klebsiella oxytoca*, *Streptococcus mutans*, and *Listeria*

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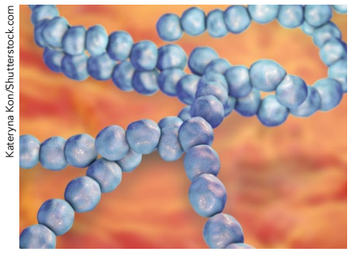
Klebsiella oxytoca



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Streptococcus mutans

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Listeria monocytogenes

grayi at a low concentration. Professor Noriega and colleagues conducted further analysis and identified 1,8-cineole and terpinen-4-o molecules as the molecules responsible for the antimicrobial activity.

PIPER BARBATUM KUNTH

Discovering the composition and properties of the essential oils of plants can point toward potential beneficial medicines. Not only this, the knowledge of Ecuadorian people can be learned and exchanged with Western cultures. This synergy can broaden the knowledge of humanity as a whole and bring attention to the preservation of Ecuador's biodiversity (both flora and fauna) and its people.

In their latest research, Professor Noriega and Professor Ballesteros turned their attention to uncovering the composition and properties of the essential oil of an important Ecuadorean shrub, *P. barbatum*. *P. barbatum* is known for having antibacterial and antifungal properties and is used by the Quichua people to wash female genitalia in cases of infection. The plant is also used to treat headaches, dermatitis, and stomach pain, and as a disinfectant and bodily cleanser. The Spanish name for the plant is "cordoncillo" and the Quichua name is "allupa".

Discovering the composition and properties of the essential oils of plants can point toward potential beneficial medicines.

Results of the study showed that the MIC of the *P. barbatum* essential oil is between 500-5.000µg/mL for most bacteria and yeast strains used. This implies a strong to moderate antimicrobial activity elicited by the essential oil. Lower MICs were found for *Staphylococcus aureus* (264µg/mL), *S. mutans* (132µg/mL) bacterial strains, and two yeast strains; *Candida albicans* (132µg/mL) and *Candida tropicalis* (264µg/mL). These two yeast strains are known to be common in infections of the female genitalia, which means that the science provides ample support for the ancestral use of *P. barbatum* in the treatment of such infections.

The researchers study the medicinal properties of *Piper barbatum* Kunth.

The most abundant components within the *P. barbatum* essential oil were α-phellandrene (43.16%) and oxygenated sesquiterpenes (close to 27%). Antimicrobial bioautography identified 4 hydroxylated sesquiterpene molecules; elemol (7.21%), trans-sesquisabinene hydrate (8.23%), β–eudesmol (3.49%), and 10-epi-γ-eudesmol (1.07%). The last two of these molecules were found to elicit greater antimicrobial activity. Professor Noriega and colleagues assert that further evaluation of the sesquiterpene molecules is required to confirm their activity.

This research on the *P. barbatum* essential oil could lead to the generation of new alternatives to present antibiotics. New intimate hygiene detergents and antimicrobial cosmetic products could also be created using the *P. barbatum* essential oil as an active ingredient. Learning about the uses of such species in Ecuador is also important in providing a bridge between different cultures, and fostering a stewardship mentality for the preservation of the Ecuadorian rainforest and its people, flora, and fauna.

Behind the Research

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Research Objectives

Professors Paco Noriega and José Luis Ballesteros analyse the ancestral knowledge of the Quichua people of Ecuador and seek to uncover the composition and antimicrobial properties of the essential oil *P. barbatum* Kunth.

Detail

Bio

Dr Paco Noriega is a full Professor and researcher at the Universidad Politécnica Salesiana in Quito-Ecuador, director of Group of Research and Development in Sciences Applied to Biological Resources and director of the master program in Natural Products.

Dr José Luis Ballesteros is a full Professor and researcher at the Universidad Politécnica Salesiana in Guayaquil-Ecuador, and director of the Biotechnology Engineering Program.

Funding

- Universidad Politécnica Salesiana
- Symrise AG

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References

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Personal Response

What is the next step in your research on P. barbatum? Will you be uncovering the activity of the key hydroxylated sesquiterpene molecules that you identified?

"At the moment we are working on a project entitled: "Studies of Antibacterial Mechanisms of Active Molecules from Essential Oils". The objective is to compare the activity between various molecules from essential oils and determine the true potential of the hydroxylated sesquiterpenes individually. We also seek to understand the mechanism of action of these components using chemical tools and to assess the damage produced in bacterial cell membranes with electron microscopy analysis."