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URUGUAY

A ROAMING BLUE SKY

OLIVAE

OFFICIAL JOURNAL OF THE INTERNATIONAL OLIVE COUNCIL

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"A roaming blue sky"

This is an excerpt from a traditional Uruguayan song – "Río de los pájaros" by Aníbal Sampayo – which references the meaning of the word "Uruguay". It places particular emphasis on the landscape and illustrates the special connection between Uruguayans and the sky: the colourful sunsets, the horizon, the clear and uncontaminated skies, open-cast production, the intangible things.

Here is a link to one of its many available versions.

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OLIVAE

CONTENTS

EDITORIAL

URUGUAY: ON A JOURNEY OF TASTE

Dear reader,

We would like to extend our warmest welcome to the Uruguayan olive sector for this year's edition of Olivae.

Of the many things that strike me about this country, one is its ability to devote so much attention to a sector that would seem to lead the pack locally, and yet does not. Uruguay clearly understands the importance of olive growing in the ongoing quest for an ecologically sustainable balance with the country's other products.

While the gross value added of agriculture is equivalent to 7.7% of GDP, 4.6% of the total population lives in rural areas and average life expectancy is well over 78 years.

This means that not only is there room for growth, but there is also clear support for that growth. To show just how committed the authorities are to olive growing, Uruguay hosted the first Latin American olive oil sector conference in 2020. Indeed, olive growing is a major link in the chain of agricultural activities the length and breadth of the country. So it comes as no surprise that Uruguay is a strong supporter of the 2015 International Agreement on Olive Oil and Table Olives, and sits with conviction and voting rights alongside its fellow members of the International Olive Council.

Although their figures are not in pole position, Uruguay's olive oil institutions and industry are able to tap into the domestic market while keeping a keen eye on regular importers of Uruguayan goods like Brazil, EU and the United States. All of them are known for seeking out quality, which is appreciated as a new trend in international markets, particularly when it comes to extra virgin olive oil.

I am sure Uruguay will continue to surprise us well into the future, not only thanks to the quality of its extra virgin olive oils, but also due to its clear drive to integrate tourism into the production and supply chain, thus leveraging the product to give it the attention it deserves. Uruguay is on a journey of taste. And this is only the beginning.

Enjoy reading.

Mr. Abdellatif Ghedira

Executive Director
of the International Olive Council

PREFACE

Uruguay is one of the world's most valued food producers for the excellence and safety of its products and it has a long tradition in agro-industrial exports. Its olive industry has made important progress in both local and foreign markets and has received well-deserved relevant international recognition and awards.

The main strength of Uruguayan olive oil is its quality. The chain is vertically integrated and applies high quality standards on both the productive and the industrial level, as well as advanced technology. Uruguay has been proactive in promoting R&D&I projects in the olive sector, which are implemented by several institutions that work with an interinstitutional and interdisciplinary approach. This has led to Uruguay hosting the first Latin American Olive Oil Conference in 2020.

The sector comprises a number of institutions such as the National Institute of Agricultural Research (INIA), the Technological Laboratory of Uruguay (LATU/Latitud) and the University of the Republic – with the special participation of the Faculties of Chemistry, Agronomy and Medicine – that work closely in areas such as research and sensory and chemical analysis. Likewise, governmental actions led by the Ministry of Livestock, Agriculture and Fisheries (MGAP), the Ministry of Industry and Energy (MIEM), the Ministry of Foreign Affairs (MRREE), the National Agency for Development (ANDE), the National Agency for Research and Innovation (ANII), the Uruguay XXI Institute, and others, support the development of the sector. Another feature worth highlighting is the linkage and collaboration between the public sector and the private sector, represented by the Uruguayan Olive Association (ASOLUR). Lastly, Uruguay's participation in the International Olive Council enables the sector to be aligned with the most rigorous international standards.

Olive growing has gained momentum in recent decades in the country. Changes in eating habits with consumers turning towards healthier products produced in an environmentally friendly way provide opportunities for continued growth both in domestic consumption and in foreign markets. The Brazilian, US and EU markets are among the most dynamic in terms of world imports, and Uruguay has exported to all of them.

In addition, the olive sector has developed synergies with other agricultural sectors, particularly livestock and forestry, and other activities such as olive oil tourism. This has resulted in an interesting range of diversification and the challenge now is to achieve greater commercial interaction with other more traditional export sectors in Uruguay, such as meat or wine.

Ing. Agr. Fernando Mattos
Minister of Livestock, Agriculture and Fisheries

HISTORY OF OLIVICULTURE IN URUGUAY

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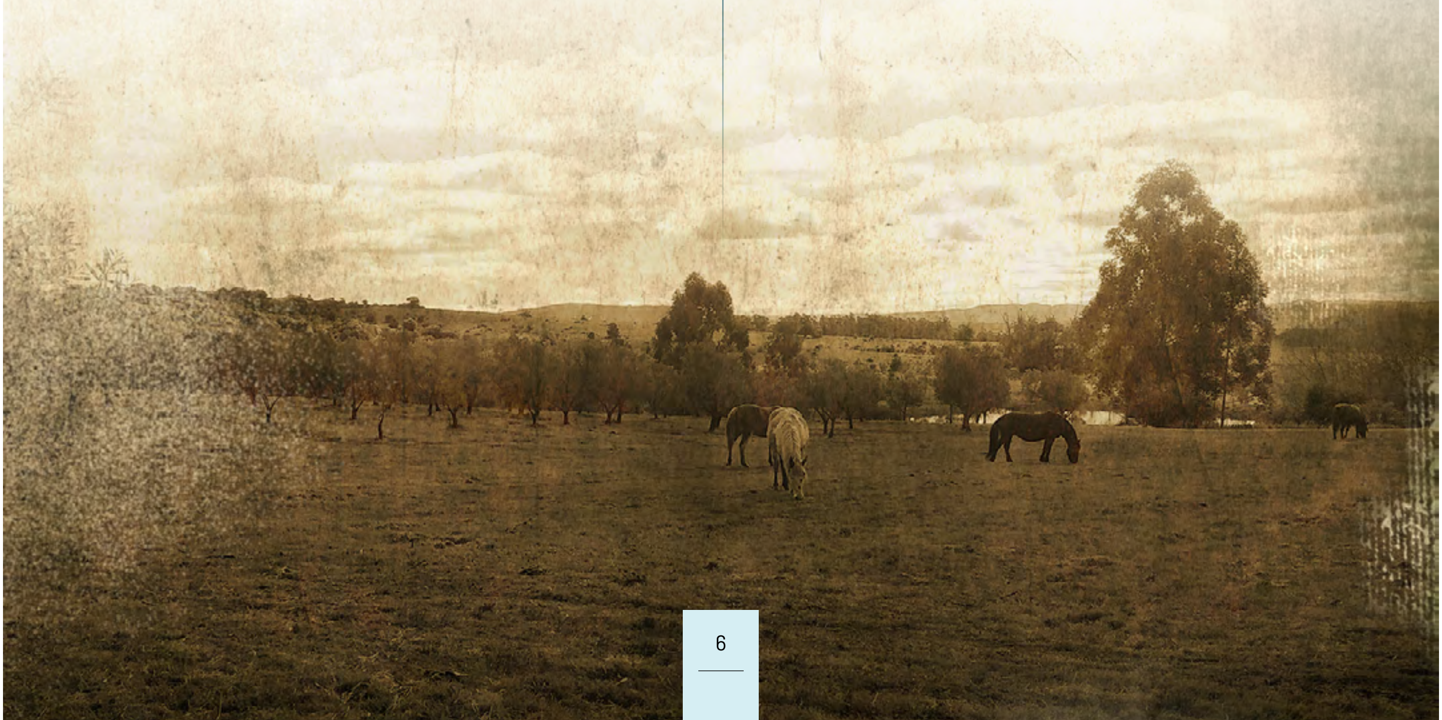
Jorge Pereira


Sylvia López


Alejandra Silveira

The origins of olive growing in Uruguay date back to the founding of Montevideo and its development can be traced in various stages throughout its history. Two specific moments in time provide the background to the introduction of olive trees into Uruguay. The first was around 1780 when plants originally from Spain were brought into the country from Buenos Aires and cultivated locally, as documented at the time by the priest Pérez Castellanos. His notes, written between July 1813 and February 1814, confirmed the establishment of "the second batch of 250 plants that arrived in 1810, and were planted in his farm on the banks of the Miguelete stream."

The olive growing momentum continued in a number of different areas in Uruguay. In 1811, Francisco Aguilar settled in the department of Maldonado on "La Florida", "La Paz" and "Azotea" country estates, where he planted pine trees, tobacco, olive groves, potatoes and mulberry trees. In 1858, De la Torre brought



Access road to "Granja Pons" (1895)

Current access road to "Granja Pons"

15,000 young trees to Montevideo from Buenos Aires that were used in plantations, nurseries and for trading. Francisco Piria acquired 2,700 hectares in 1890 and founded an "Agronomics Establishment" in Maldonado, between Cerro Pan de Azúcar and the Atlantic coast, importing chestnut and olive trees from Italy and France.

In another department, Canelones, Diego Pons established a plantation called "Granja Pons" in Suárez in 1888, which at one point was producing as much as 7,000 litres of olive oil annually. In 1944 Ramón and Antonio Varela acquired that farm and continued growing olive trees and vines there. However, only a few examples remain today out of the thousands of olive trees that used to grow on the original farm.

In 1895, the National Congress of Livestock and Agriculture was held and one of its conclusions was the recommendation "to do everything possible to develop the cultivation in the country of the olive tree, which grows and bears fruit admirably, producing abundant and excellent oil that can compete with the best from Europe". In the early 20th century, Domingo Basso grew olive trees from Italy and Spain in the Sayago and Colón area for the production of olives and olive oil.

In 1890, Juan and Clara Jackson de Heber donated a farm to the San José Citeaux congregation, members of St. Joseph's religious order, who were taken over later by the Salesians in 1897, just a few kilometres from Montevideo, where they started to farm crops and in 1915 an agricultural school was opened there. By 1934 there were already 50 hectares of vineyards and a 10-hectare olive grove. As part of their studies, the students attending the school were taught how to maintain olive groves and how to make oil. At this same location, the priests used to make oil in a small oil mill located on the same property. Currently part of the plantation is maintained within an area of one hectare.

Another stage of the history of olive growing began in 1937 with the enactment of the "Olive Development Law " (known as "Cannesa Law") by the Ministry of Livestock and Agriculture, and the publication in 1938 by agronomist Hilario Urbina of the "Olive Tree Cultivation Primer" that promoted the planting of olive trees with its associated benefits and incentives. Following the enactment of that law, between 1940 and 1960 several enterprises emerged in different locations, one of which was an olive market, "El Mercado Olivarero del Uruguay", which was set up by the Colonia Agrícola "San José de Mayo" with private and official financial support.

In 1950 a group of French nationals arrived in Uruguay and founded the "Los Ranchos" farm in the Rincón de las Gallinas area in Río Negro, where there is a favourable Mediterranean microclimate for crop growing. The olives from these olive groves were sold and processed in a nearby mill built by the Barón de Mauá in the 19th century. In 1994 olive growing on the farm was resumed and the olive grove reconverted using


Ancient olive trees in the western area of Uruguay (Colonia Department)

Access road to "Los Ranchos" olive farm

Former "Jackson" Agronomy School

Spanish and Italian varieties. In 1999 extra virgin oils were once again produced under the name "Los Ranchos".

The impetus of that period also reached the department of Salto where in 1953 Urreta SA set up a business by installing a modern oil mill to extract olive oil from nearby olive trees. In the same decade, the Compañía Agrícola Olivarera del Uruguay SA was set up in the department of Florida by Fray Marcos as a business supplying olive tree plants with payment facilities. Based on technical reports, the company identified regions suitable for plantations in departments along the north coast (Paysandú, Salto and Artigas), in the south and east (Florida, Lavalleja and Treinta y Tres) and consequently promoted large-scale olive growing and excellent quality oils that won awards in international exhibitions.

Between 1940-50, Babuglia and Bergeret, in the university chairs of fruit growing and agricultural technology within the Faculty of Agronomy, carried out research work on the oil value of existing varieties grown in official institutions and private establishments in the country. Their research provided information on the adaptation of the varieties to the country as well as production and conditions for both oil and canning purposes.

In late 1960, there was a boom in the manufacturing from seeds at a lower cost in the oil industry and as a result olive tree growing waned in importance and plantations were abandoned. At the end of the 20th century, olive growing was taken up again marking the start of the current dynamic phase in the development and consolidation of olive growing in Uruguay.

Agronomy School
(Salto Department)

"Piria"
agricultural
establishment
(Maldonado
Department)

In Montevideo today there are numerous olive trees that are a vestige of the old Miguelete farms in General Hornos street (formerly Quinta de Posse), Emancipación (formerly Quinta Canessa) and Camino Coronel Raía. In the rural area of Montevideo, Paso de la Arena, there are remains of plantations with trees that are over 200 years old, still in good health and productive condition and so are an excellent source of adapted germplasm.

Another possible event marking the early introduction of olive growing, although there is no exact information about it, may have occurred earlier in the south west of the country, in the Portuguese enclave of Colonia del Sacramento, between 1680 and 1760. The remains of those olive trees can still be found in the town and surrounding area today and the size of their crown and trunk diameter strengthen this hypothesis.

Olive trees in the streets of Montevideo; remnants of the old orchards by the Miguelete stream

CHARACTERISTICS OF OLIVE GROWING IN THE AGRICULTURAL SCENARIO IN URUGUAY

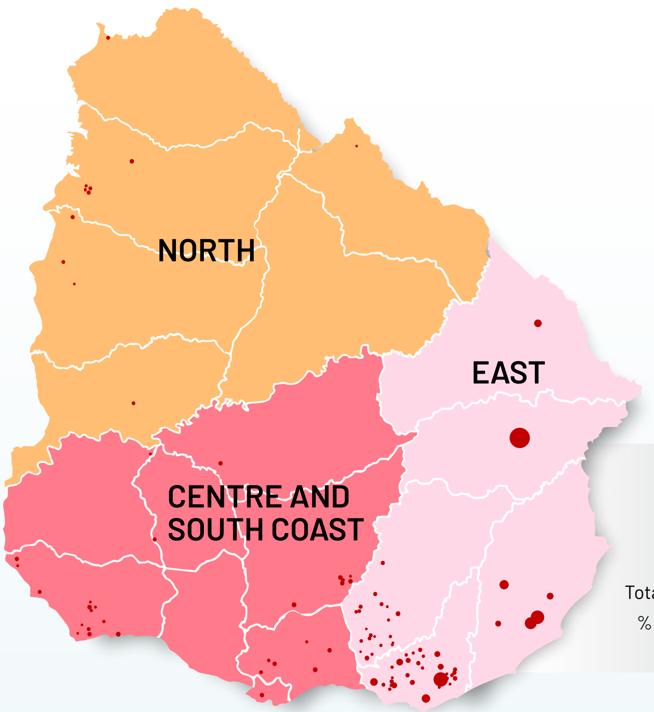
Office of Agricultural Statistics DIEA

Ministerio de Ganadería, Agricultura y Pesca | Estadísticas Agropecuarias

During September 2020, the Agricultural Statistics Office (DIEA) in Uruguay's Ministry of Livestock, Agriculture and Fisheries (MGAP), which is the agency responsible for producing and publishing statistical information on agriculture, conducted the First Census of Olive Producers. This exercise enabled all the relevant data about olive growing in the country to be updated.

The research identified 162 productive olive farms with a total area of 46,881 hectares and 5,916 effective hectares of olive trees (13% of the area cultivated by these producers). This indicates that olive growing is associated with other agricultural activities in Uruguay. The total number of existing plants is just over 1.7 million, with an average density of 289 plants per hectare.

The eastern part of the country accounts for 81% of the effective area, while in the central and southern coastal area the olive groves have a higher average density of plants per hectare (375 plants per hectare) (Figure 1).



CENSUS AREA	NORTH	EAST	CENTRE AND SOUTH COAST
Farms	31	94	37
Effective area	451 ha	4,767 ha	699 ha
Total plants (thousands)	147	1,300	262
% plants in production	71%	90%	96%
Density	325 (pl/ha)	273 (pl/ha)	375 (pl/ha)

Figure 1. Distribution of olive farms, effective area and total plants by zone
Source: MGAP - DIEA, Census of Olive Producers 2020

A total of 80% of all the farms operate under rain-fed conditions, while the remaining 20% have some kind of irrigation system installed (32 farms). These farms account for 13% of the effective olive grove area (768 hectares).

Some 4% of the olive growing effective area (72 hectares) is under organic management[1], i.e., six farms reported managing their olive groves with this kind of techniques. In these cases, the average planting density was 348 plants per hectare.

According to the size scale based on the actual effective area managed, just over 70% have groves of less than 20 hectares, representing 14% of the effective area (Table 1).

TABLE 1: NUMBER OF FARMS, EFFECTIVE AND PRODUCTIVE AREA BY PRODUCTIVE SIZE

PRODUCTIVE SIZE (effective area)	FARMS		AREA			
	Nº	%	Effective (ha)	%	In production (ha)	%
Total	162	100	5,916	100	5,306	100
Less than 20	117	72	856	14	750	14
20 to 49	23	14	634	11	513	10
50 and over	22	14	4,427	75	4,043	76

Source: MGAP – DIEA, Census of Olive Producers 2020

Sixty per cent of the effective area of olive trees is associated with the industrialisation phase of production where the farms have their own olive oil mills for this stage in the process. In total there are 26 olive oil mills in the country. The production of the remaining 40% of the area is also processed in these mills, under different contract modalities.

Main cultivated varieties

More than twenty varieties of olive trees are grown in Uruguay, although only four varieties account for 90% of the total cultivated area. Arbequina has the largest share with 47% of the surface area, followed by Coratina, Picual and Frantoio, with 21%, 11% and 10% respectively (Table 2).

TABLE 2: VARIETIES PLANTED ACCORDING TO EFFECTIVE AREA

VARIETIES	EFFECTIVE AREA (HA)	%
Total	**5,916**	**100**
Arbequina	2,788	47
Coratina	1,259	21
Picual	652	11
Frantoio	613	10
Other (*)	604	10

Source: MGAP – DIEA, Census of Olive Producers 2020.

(*) The following are grouped together: Leccino, Koroneiki, Manzanilla de Sevilla, Hojiblanca, Barnea, Arbosana, Picholine, Moraiolo, Maurino, Alfafara, Arauco, Ascolana, Carolea, Canino, Pendolino, Carrasqueña, Taggiasca, Santa Catarina

1 According to decree 557/008: organic production is understood as the non-use of chemical synthesis products, genetically modified organisms (GMOs) or their derivatives

Age of the forest

Half of the olive area is in full production (more than 11 years old). The other half is in the development or early production stage (less than 10 years) (Table 3).

TABLE 3: AGE AND AREA OF THE OLIVE FOREST BY MAIN VARIETIES

TOTAL	EFFECTIVE AREA (HA)	AGE (YEARS)				
		Less than 6	6 to 10	11 to 20	More than 20	Unspecified
	5,916	**528**	**2,332**	**2,951**	**10**	**95**
%	100	9	39	50	0	2
Arbequina	2,788	238	1,024	1,517	10	-
Coratina	1,259	145	604	510	-	-
Picual	652	59	345	248	-	-
Frantoio	613	56	198	358	-	-
Other varieties (*)	604	30	161	318	-	95

Source: MGAP - DIEA, Census of Olive Producers 2020

(*)The same species in Table 2 were grouped together

By production zones, the eastern zone presents similar values to national averages, whereas the central zone and southern coast zone have almost 70% of the area in full production age. The northern zone has the youngest forests.

New plantation and uprooting intentions

By 2020, producers reported a planting intention of 79,647 plants (5% of the current plants stock). On the other hand, they plan to uproot 18,177 plants (1% of the current total plants) in the short term. This results in a positive balance of 214 hectares in addition to the current total.

Main products

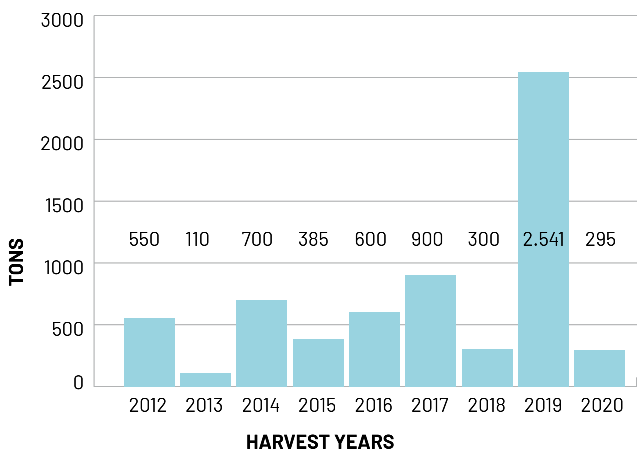
The main purpose of olive cultivation is extra virgin oil production, with 99% of the harvested production earmarked for this purpose. The remaining 1% is intended for table olives production[2].

2 About this type of production (table olives) there is currently no information available to characterize it in terms of handcrafted or industrial and regular or occasional

Click to access to the full report of the Olive Producers Census, 2020.

Production trends

In recent years, the production of extra virgin oil has been variable, which can be partly explained by the "alternate bearing" that characterises the worldwide olive trees production (Graph 1). In 2019 record production was achieved in the country, with just over 2,500 tonnes of oil. In June 2021, at the end of a new harvest, the estimated olive oil production is 2,160 tonnes.



Graph 1: Olive oil production 2012-2020.

Source: MGAP-DIEA based on private sector information and Census of Olive Producers 2020

THE OLIVE OIL CHAIN IN URUGUAY: A SUPPLY AND DEMAND ANALYSIS

OPYPA-MGAP

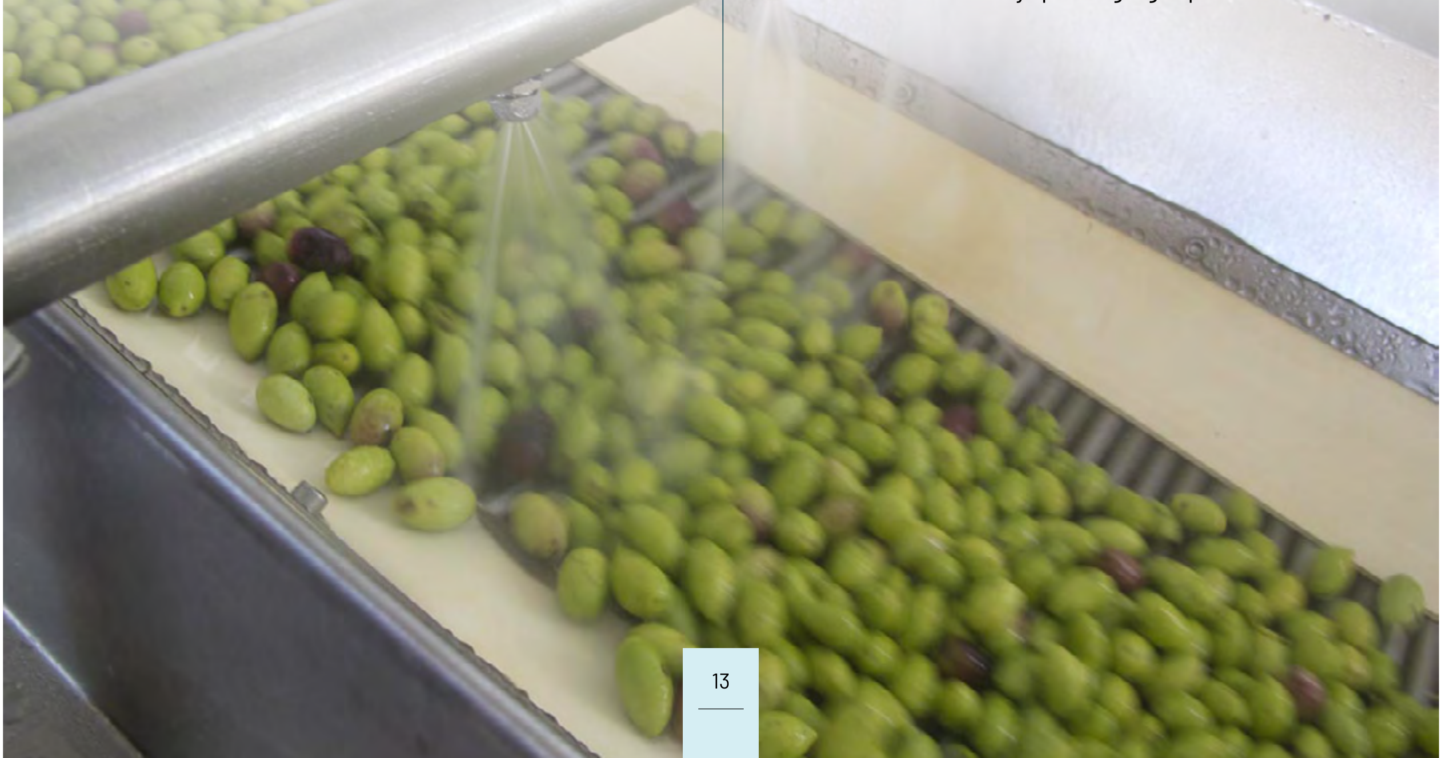
Leidy Gorga

María Noel Ackermann

Structural characteristics of the olive agro-industrial sector

The olive sector in Uruguay is the set of companies, agents and transactions that exist and take place throughout the olive oil production-consumption chain.

In Uruguay there are currently no mills dedicated exclusively to olive oil processing, i.e. there is no mill sector separate from olive production. At the same time, there is almost full integration between the activity involving processing olives into extra virgin olive oil and packaging. There is also a high level of integration of nursery activities with the above. In addition, there are companies that supply inputs and/or services to the sector, such as agricultural or industrial machinery, packaging inputs, fertilizers



and phytosanitary products, irrigation, technical advisors, financial institutions, etc. Then there is the commercial distribution sector that makes the olive oils available to consumers. Lastly, there is the array of different public and private entities, universities and other public and private research, technological development and innovation centres, which support the olive sector (Gabinete Productivo, 2014). This is evidence of significant institutional development around the olive sector that is still consolidating and adapting to the needs of the sector in Uruguay.

Olive oil production

In 2020, there were 162 olive farms with around 6,000 effective hectares dedicated to olive growing; 300 tonnes of extra virgin olive oil were produced (after the record achieved in 2019, when 2,500 tonnes were processed) in 26 olive mills located throughout the country. The mills use modern technology and have bottling machines.

Two characteristics of Uruguayan oil production are worth mentioning. First, the primary objective is to produce very high-quality products in order to compete nationally and internationally. Second, there are synergies between olive growing and other agricultural activities (in particular livestock and forestry) and tourism that make for interesting diversification prospects.

The olive sector in Uruguay still has a large proportion of young trees, so production is expected to grow in coming years. This situation could strengthen the sector's export growth.

Imports

Uruguayan olive oil imports have averaged 1,000 tonnes per year over the last five years. Purchases of virgin or extra virgin olive oil from abroad have recorded a downward trend since 2017, whereas those classified as "other olive oils" have increased since that year. In 2020, the volume imported was 1,046 tonnes of which 827 tonnes (79%) corresponded to virgin or extra virgin olive oil.

Uruguay imports virgin or extra virgin olive oil primarily from Argentina and Spain, followed by Italy and Chile in order of importance. Oils classified as "other olive oils" are imported mainly from Spain and Italy.

Domestic demand

Domestic consumption of olive oils and olive pomace oil in Uruguay has averaged around 1,700 tonnes in the last three years, equating to about 500 grams per capita per year. Olive oils represent 2% of the total oils consumed in the country, due to the fact that the population that buys olive oils tends to restrict their use to a dressing for salads or other dishes (Gabinete Productivo, 2014). All in all, despite the growth trend, domestic consumption of olive oil remains at low levels and is a market with considerable upside.

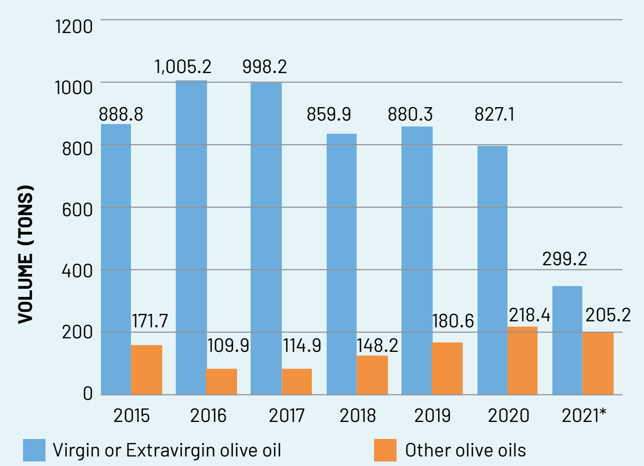


Figure 1. Imports of olive oil into Uruguay

*2021 corresponds to imports between January and June.

Source: OPYPA/MGAP based on Urunet

Likewise, changes in consumer behaviour towards healthier, more natural, safer and high-quality foods offer possibilities for further development of the sector in the future.

Uruguayan olive oil consumption is supplied by both local and imported production (currently the share is 40% and 60% respectively). Increased local production has meant that the share of domestic demand accounted for by imported production has fallen. However, the current level and significant variations in domestic production makes it incapable of fully supplying the Uruguayan market yet and access to production from abroad is still necessary to satisfy demand.

Commercial distribution is concentrated around supermarket chains. Nearly half of the oil is distributed through supermarkets and wholesalers, followed by olive growers' direct sales (especially during olive oil tourism visits) with 30% of the volume. Some 19% of the production is sold to companies that offer it under their own brand and the remaining 5% through other channels.

Exports

Uruguay exports only extra virgin olive oil. The volume exported varies from year to year depending essentially on domestic production. In 2019 (a year of record production) exports reached an unprecedented level of 1,013 tonnes. In 2020, 128 tonnes were exported, at an average price of USD 5,218 per tonne (Table 1).

Olive oil exports from Uruguay are mainly concentrated in two large companies, although smaller mills have also been selling their production to other countries.

The destination countries of Uruguay's foreign sales vary from year to year, which would seem to indicate that they are not fully consolidated. However, destinations such as the United States and Brazil have maintained significant shares over the last five years, and Spain and Argentina are also on the list of the main destination countries for Uruguay's exports (Figure 2). In addition, there have been exports to other countries such as China, Japan and Germany.

URUGUAY EXPORTS OF EXTRA VIRGIN OLIVE OIL

YEAR	VALUE (USD FOB)	VOLUME (Tons)	AVERAGE PRICE (USD/ton)
2015	303,621	76	3,991
2016	376,947	93	4,074
2017	822,811	141	5,830
2018	204,345	28	7,243
2019	2,633,465	1,013	2,599
2020	666,413	128	5,218

Table 1
Source: OPYPA based on Urunet

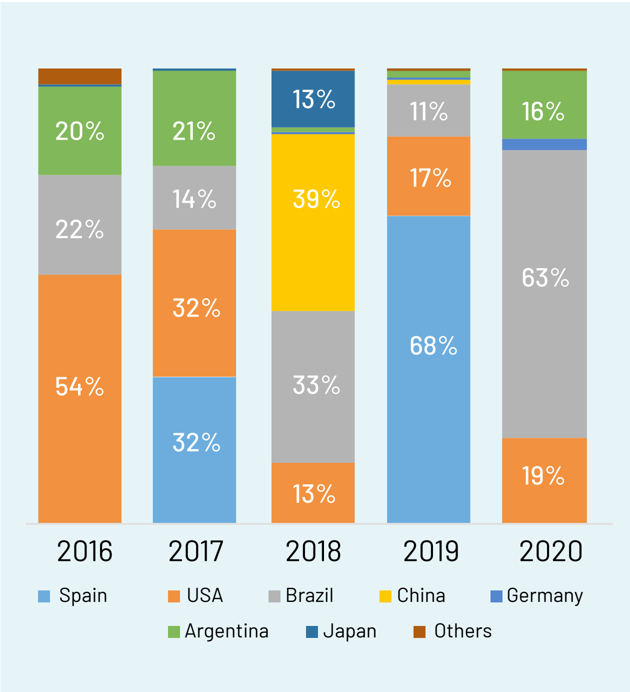


Figure 2. Share of export value by destination
Source: OPYPA based on Urunet

URUGUAYAN OLIVE PRODUCTION ASSOCIATION

ASOCIACIÓN OLIVÍCOLA URUGUAYA

ASOLUR ASOCIACIÓN OLIVÍCOLA URUGUAYA

EXTRA VIRGEN DE URUGUAY

The Uruguayan Olive Production Association – ASOLUR – is a non-profit Institution set up in 2004. It is the sole trade body in this production and business sector in Uruguay. It currently has 70 members. The association covers the whole olive production chain from nurseries, producers and oil mills, right through to professional advisors and technicians. Its primary goal is to foster the sustained and sustainable development of the whole olive growing sector.

ASOLUR has been working for more than ten years with a number of ministries and official institutions including the Ministry of Livestock, Agriculture and Fisheries, the Ministry of Industry, Energy and Min-

ing, the Ministry of Foreign Affairs and the Ministry of Tourism, as well as with INIA (National Institute for Agricultural Research), UDELAR FAGRO and FCHEM (Faculties of Agronomy and Chemistry in the University of the Republic) and LATU (Technological Laboratory of Uruguay). During this period, they have implemented joint actions aiming to raise quality standards and increase productivity in the sector, improve the quality of the oils produced, make the sector more competitive, develop new products, encourage the consumption of quality olive oils, promote these high-quality national products at home and abroad and make the public more aware of their health-related benefits based on scientific evidence.

Following the initiative and actions taken by ASOLUR, in 2009 Uruguay joined the International Olive Council (IOC) as an observer country and then became a full member in August 2013. The IOC is the sole international organisation devoted to olive oil and table olives.

As of 2013, the olive-producing sector in Uruguay which ASOLUR represents was selected as one of the productive chains to receive government support. A national discussion panel was set up for the olive growing business which helped to strengthen the relationship between the public and private sectors, as well as generating a "Strategic Plan for the Olive Producing Sector". This work was led by Manuel Parras Rosa, a professor at the University of Jaen in Spain who is an international expert on the subject, and benefited from the participation of numerous national olive oil experts.

Since then, following up on the guidelines set out in the Strategic Plan, ASOLUR has undertaken multiple actions, including those listed below:

- Institution-building.
- Participation in the IOC.
- Seminar on Olive Oil Technology.
- Pruning Courses.
- Workshop and training in Good Farming Practices.
- Workshop on Integrated Pest Management (IPM).

- Development of the first version of the Manual of Good Farming Practices and Field Notebook.
- Publication of the book "Olive Trees and Olive Oils of Uruguay", as a key tool to promote Uruguayan EVOO (Extra Virgin Olive Oil) at home and abroad.
- Participation in trade delegations at diverse international trade fairs.
- Fostering compliance of proper trading in defence of consumers.
- Promotion of the olive oil sector and its products through school, culinary, health-related and rural tourism initiatives.

Proper marketing and defence of the local industry

Up until December 2014, all virgin olive oils entered the country through tariff item 1509.10.00, corresponding to "virgin olive oil". This position included three types of virgin olive oils: extra virgin oils, virgin oils and lampante virgin olive oil (not fit for human consumption).

After that date, and through actions undertaken by ASOLUR, Uruguay split that tariff position into four different items:

- 1509.10.00.1: Extra virgin
- 1509.10.00.2: Virgin
- 1509.90.10: Refined
- 1509.90.90: Other

Uruguay is the first country in the world to have tariff items to differentiate between virgin olive oils and is regarded as a leading country in this area.

Oils entering the country as tariff item 1509.10.00.1: Extra virgin must have undergone a physical and chemical analysis evidencing their authenticity, as well as a sensory analysis to likewise ensure their quality.

Registration of phytosanitary products

In 2016, acting in coordination with private companies in the sector, ASOLUR implemented the registration of several phytosanitary products which enabled technical information and legal provisions to be brought up to date and their compatibility ensured. This has facilitated certification procedures for those companies that request them and also satisfied the demands of the destination markets for Uruguayan EVOOs (extra virgin olive oils).

Training activities and field visits

Together with other public and private organisations, ASOLUR regularly organises refresher courses and talks for its members on agricultural and trade topics, with the participation of national and international experts. Some examples of these events are: "Olive Oil Technology and Quality of Extra Virgin Olive Oil" run by Spanish expert Miguel Abad; "Strategy and Implementation of a Commercialisation Plan for EVOO" presented by Spanish consultant Manuel Parras Rosa; "Olive Fertilisation" presented by Juan Carlos Hidalgo, a specialist from IFAPA in Spain; "Ecophysiology of Olive Tree Growing", a session given by the Spanish expert Luis Rallo Romero; "Producing High Quality Extra Virgin Olive Oil: Agricultural and Technological Factors", with Brígida Jiménez Herrera.

Field visits to olive oil producing establishments are also organised in order to share information and strategies to foster the sustainable development of the olive oil producing industry, drive production enhancements and improve the competitiveness of the sector.

EVOO promotional campaigns

In order to inform people about the quality of extra virgin olive oil and the benefits of consuming it, ASOLUR ran a campaign in 2016 on the "Promotion of national EVOOs, their nutritional properties and health benefits". This promotional initiative targeted chefs, teachers and students at gastronomy schools, nutritionists, doctors and health associations, as well as the general public. The campaign was run through workshops and conferences and was co-funded by the IOC.

In coordination with ten state schools and to mark the holding of the 2018 International Day of the Olive Tree, Dr. Ana Claudia Ellis from the Faculty of Chemistry ran a number of workshops in which 600 children were taught about olive tree growing, olives, and the benefits of consuming olive oil for human health, growth, and development. EVOO tastings were held and an olive tree was planted in the school playground at each school to keep building up an olive oil culture in our country. It was found that olives and olive oil are readily accepted as a food product among schoolchildren.

In 2020 and until this year there was also a promotional campaign on the radio and social media targeted at consumers and the general public. On this occasion, the message was conveyed through famous chefs in the country who recommended Uruguayan extra virgin olive oil and suggested ways of using it. This campaign was a public-private partnership project in which Uruguay's Ministry of Industry, Energy and Mining and ASOLUR participated.

This campaign was successful in achieving the inclusion of the consumption of national EVOOs as part of the healthy diet promoted at different levels by the State.

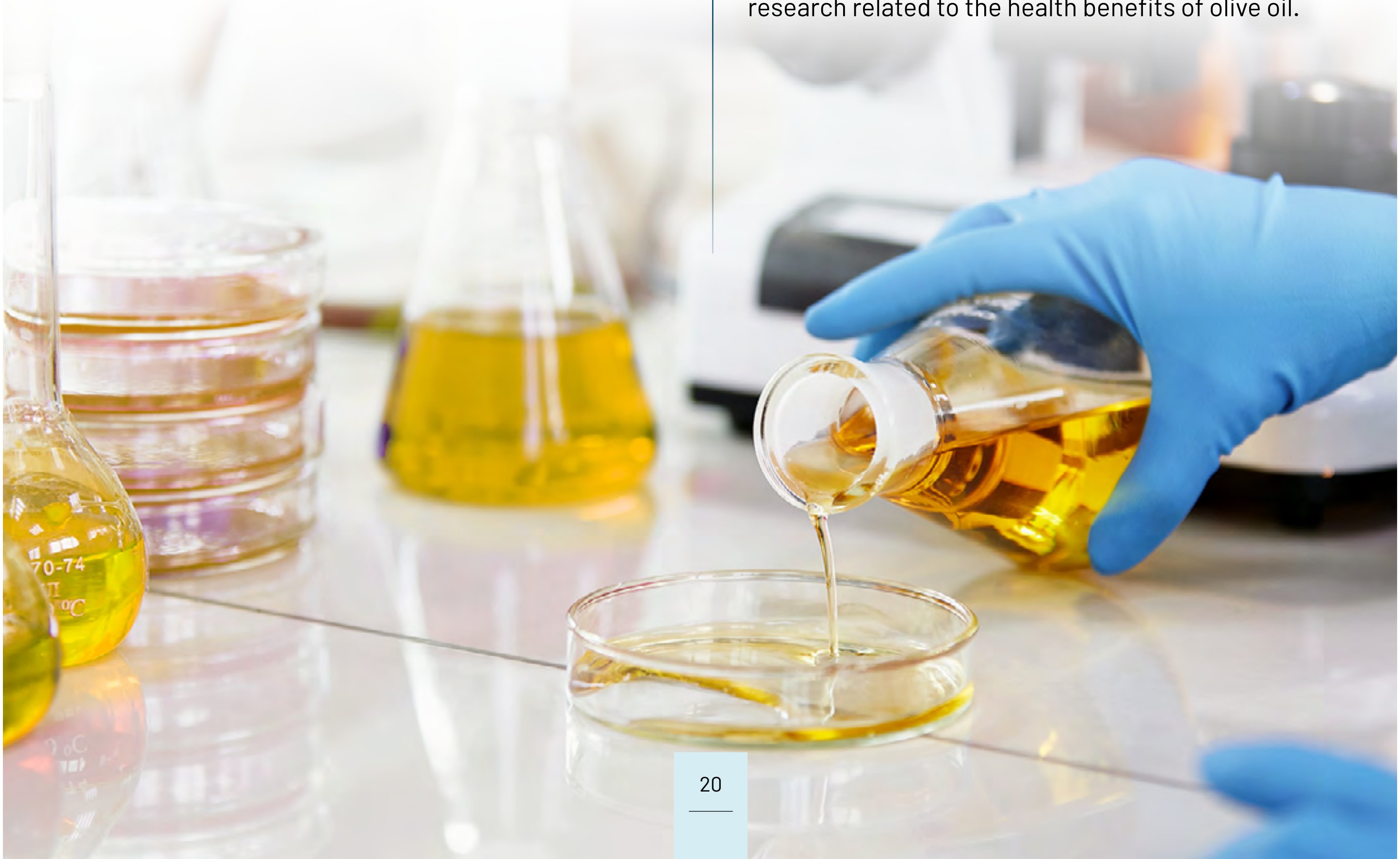
Since 2015 and with the support of organisations involved in the olive sector, ASOLUR has been holding annual social events to present oil production and olive tree by-products (soaps, cosmetics, handcrafts, etc.) as a way of generating better knowledge of olive growing and its products, especially Uruguayan extra virgin olive oil.

Uruguay has demonstrated its expertise in the olive oil producing industry and its willingness to continue improving. Thanks to its characteristics as an agro-industrial country and its strong commitment to respecting nature, Uruguay has managed to position itself internationally alongside other high-quality extra virgin olive oil producing countries.

R&D&I IN THE URUGUAYAN OLIVE SECTOR

FQ, INIA, LATU/Latitud, FAGRO, ASOLUR, FMED

The National Institute for Agricultural Research (INIA), the University of the Republic – through the Faculty of Agronomy (FAGRO), the Faculty of Chemistry (FQ) and the Faculty of Medicine (FMED) – and the Technological Laboratory of Uruguay (LATU/Latitud) conduct diverse research projects and often work closely with an interinstitutional approach. Uruguay has three laboratories recognised by the International Olive Council (the Faculty of Chemistry and LATU for chemical analysis and the Faculty of Chemistry for sensory analysis) that are engaged in work to ensure oil quality controls at both chemical and sensory levels. INIA and FAGRO have been working for several years on research related to agricultural management in close collaboration with the production sector and FMED is involved in research related to the health benefits of olive oil.



Some of the research projects carried out in recent years are presented in the table below with a brief description of their objectives, the institutions involved, and the people responsible for each project.

Title	Responsible people	Institutions involved	Year	Description/Objective
OLIVIA Project: Olives, Research and advisory services.	Mª Antonia Grompone †, Adriana Gámbaro & José Villamil	FQ /INIA	2009 - 2011	To create a comprehensive service to advise producers on how to obtain high quality olive oils. To provide olive oil certification and quality control services.
Use of olive oil and oil sub products in cosmetics.	Emma Parente	FQ	2011 - 2013	To study the feasibility of using different qualities of olive oil as the raw material for cosmetic products and its potential consumer market.
Virgin olive oil shelf-life.	Mª Antonia Grompone †	FQ	2013 - 2014	To characterise (from a physicochemical standpoint) and determine the oxidative stability of Uruguayan virgin olive oils from different manufacturers and for two consecutive vintages. To study the shelf-life of two Uruguayan virgin olive oils and their acceptance by consumers.
Development and study of oxidative stability of flavored virgin olive oils.	Adriana Gámbaro	FQ	2014 - 2015	To obtain flavoured virgin olive oils by prior maceration and incorporation of flavouring substances during the production of the oil. To study the shelf-life of flavoured Uruguayan virgin olive oils.
Application of mega sound techniques in virgin olive oil production.	Mª Antonia Grompone † and Adriana Gámbaro	FQ	2016 - 2018	To apply different mega sound intervention techniques on a pilot scale (Abencor plant) in selected steps of the EVOO production process to determine the improvements in its performance, quality and/or oxidative stability. To determine the changes in the quality of oils throughout its storage life.
Influence of calcium carbonate additive on the extraction performance and the quality of national production EVOO.	Adriana Gámbaro and Ana Claudia Ellis	FQ	2018 - 2019	To evaluate the effect of calcium carbonate on the physicochemical and sensory quality of extracted oils and on shelf-life.
Validation of olive oil production with truffles.	Adriana Gámbaro	FQ	2019	To validate the feasibility of producing and bringing to market a new product incorporating truffles.
Use of by-products and residues from the olive oil industry in Uruguay to obtain value-added compounds.	Ignacio Vieitez	FQ	2020 to date	To obtain and evaluate the antioxidant and antimicrobial power of supercritical extracts of different residues from the Uruguayan olive oil industry for their revalorisation through clean technology applications.
Valorisation of olive mill wastewater.	Blanca Gómez	LATU/Latitud and ASOLUR	2021	Technical-economic feasibility study for the recovery and extraction of value from polyphenols contained in oil mill waste.

Title	Responsible people	Institutions involved	Year	Description/Objective
Conservation, characterisation, prospection and use of olive tree genetic resources (RESGEN).	Jorge Pereira	FAGRO	2014-2016	To determine the number of cultivars making up the olive genetic resources in the countries participating in the project; primary and secondary characterisation of the different cultivars; conservation of cultivars in national and international collections; registration of the primary descriptors of those that are not yet known. IOC-funded project.
Evaluation of the susceptibility of olive cultivars to olive scab (V. *oleaginea*).	Carolina Leoni	INIA	2015-2017	Evaluation of the susceptibility of olive cultivars to *Venturia oleaginea* through natural and controlled inoculations.
Establishment of a threshold for anthracnose olive rot (*Colletotrichum* spp.) in order to obtain EVOO (extra virgin olive oil).	Carolina Leoni	INIA	2012 - 2015	To establish the maximum acceptable percentage of anthracnose olive rot (infected olives) for EVOO production for Arbequina and Frantoio cultivars.
Characterisation of the Uruguayan *Venturia oleaginea* population.	Carolina Leoni	INIA	2015-2017	To generate a Uruguayan collection of *Venturia oleaginea* isolates from different regions and orchards and identify them using molecular tools. To assess the genetic and phenotypic diversity and population structure of the collection.
Agronomic behaviour of olive cultivars and development of cultivation techniques applicable to Uruguay's agroecological conditions.	Paula Conde	INIA	2013 - 2018	Reproductive phenological study of cultivars and management technologies applicable in olive trees to maximise productive efficiency.
Sustainable Use of bioMass from Oleaginous Processing (SUMO).	Roberto Zoppolo	INIA	2015 - 2017	Valorisation of olive oil mill waste through optimisation and the methodological adjustment of the composting and pyrolysis processes.
Physiological response of the olive tree to biotic and abiotic stress.	Paula Conde	INIA	2017 - 2022	To provide the National Germplasm Banks of the IOC Network with an authentic and healthy initial material for the certification of nursery plants. IOC-funded project.
True Healthy olive cultivar (THOC 1 y 2).	Paula Conde Carolina Leoni	INIA	2019 to date	To provide the National Germplasm Banks of the COI Network with an authentic and healthy initial material for the certification of nursery plants. IOC-funded project.
Competitiveness of olive growing: technological and economic analysis.	Mercedes Arias	FAGRO	2015 - 2017	Phenological evaluation of 5 cultivars in different regions of the eastern part of the country. Response evaluation to management measures to regularise production.
Aetiological, epidemiological and control studies of *Colletotrichum* spp. associated with blossom blight and fruit rot in olive.	Sandra Alaniz / Pedro Mondino	FAGRO	2018-2023	To generate knowledge of the aetiology and epidemiology of anthracnose disease in commercial olive production. To evaluate control strategies for Integrated Management System design and implementation for this disease.

Title	Responsible people	Institutions involved	Year	Description/Objective
Susceptibility of olive cultivar during floral differentiation and fruit development to *Colletotrichum* species and evaluation of the effectiveness of fungicides.	Pedro Mondino / Sandra Alaniz	FAGRO	2021-2023	To evaluate the susceptibility of different phenological stages of flower panicles and fruit development of the main olive cultivars to *Colletotrichum* spp. To determine the effectiveness of fungicides with good behaviour in vitro essays, to *Colletotrichum* spp. control applied to flowers and fruits.
Aetiological, epidemiological and control studies of "leaded olive" or Cercospora leaf spot in olive trees in Uruguay.	Pamela Lombardo / Pedro Mondino	FAGRO	2017-2021	To confirm the aetiology by identifying a representative collection of isolates by analysis of different gene regions. To determine periods when infections occur and determine the times of peak inoculum production. To assess the sensitivity of isolates to different fungicides.
Aetiological, epidemiological and control studies of species of the *Botryosphaeriaceae* family in apple, olive and grapevine.	Sandra Alaniz / Pedro Mondino	FAGRO	2018-2022	To generate knowledge about the aetiology and epidemiology of the *Botryosphaeriaceae* family fungi associated with apple, olive and grapevine. To evaluate control strategies for the design and implementation of Integrated Management Systems in these crops.
Conservation management of natural enemies in olive orchards with different spontaneous vegetation management.	Juan Pablo Burla/ Enrique Castiglioni	CURE-UdelaR	2018-2020	To characterise and model the populations of phytophagous arthropods, parasitoids and predators present in olive trees, in order to understand the diversity present and design conservation management of natural enemies.
Genetic improvement in fruit growing for healthy and sustainable production; MF4 - Maintenance and updating of active germplasm banks.	Maximiliano Dini / Paula Conde	INIA	2021-2025	Maintenance and updating of INIA's active germplasm banks (AGB), including olive trees, and the evaluation and agronomic characterisation of native or naturalised genotypes.
Characterisation of the sex pheromone of *Palpita forcificera*, a pest in olive trees in Uruguay and Rio Grande do Sul.	Andrés González Ritzel	FQ	2019 - to date	Chemical identification of the sex pheromone of *Palpita forcificera*. To develop monitoring traps to detect the presence of the pest and generate knowledge for the evaluation of the sexual confusion technique. Work in collaboration with EMPBRAPA Clima Temperado (Brazil).
Development of a new soybean oil enriched with antioxidants derived from the olive industry in order to prevent oxidative degradation.	Beatriz Sánchez	FMED	2021-2023	Generation of a polyphenol-enriched soybean oil from olive mill waste, and evaluation of the formation of nitrated fatty acids as an indicator of oil quality.
Detection, quantification and biological properties of nitrated lipids in Uruguayan olive oils.	Homero Rubbo	FMED	2014-2019	Identification, quantification and biological effects of nitrated fatty acids present in olive oils from Uruguay.

OLIVE GROWING IN THE URUGUAYAN EDAFOCLIMATIC CONDITION

Faculty of Agronomy, UdelaR

Mercedes Arias-Sibillotte

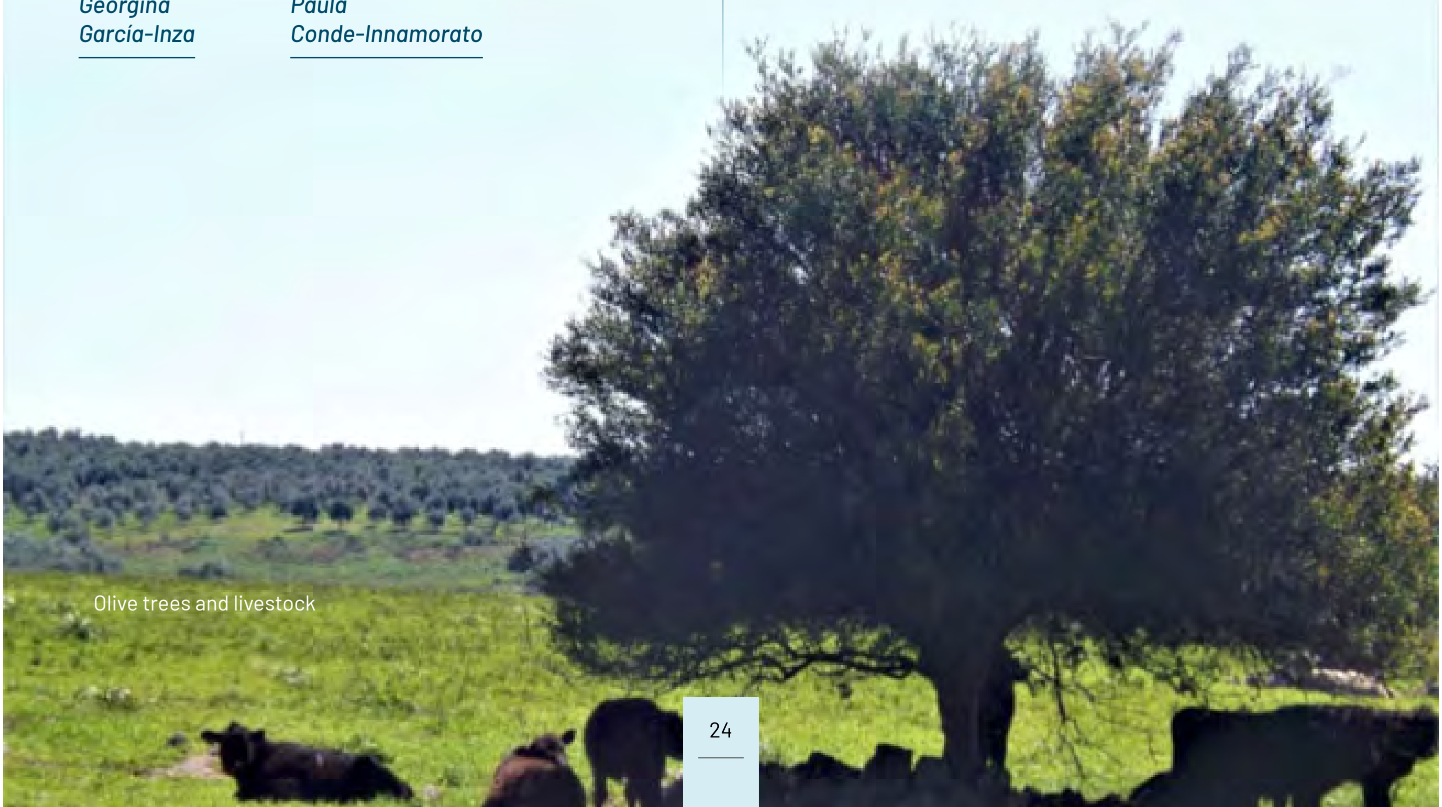
Vivian Severino

INIA Uruguay

Georgina García-Inza

Paula Conde-Innamorato

Uruguay is the second smallest country in South America and is included in the temperate zone of the south-east of the continent, between 30º and 35º latitude south and 53º and 58º longitude west. The country has more than 670 km of coastline along the Río de la Plata, the widest river in the world, and on the Atlantic Ocean, so its climate is strongly influenced by the oceanic mass. It lies less than 513 m above sea level and the predominant biome is grassland. The types of soil are highly variable across the country with textures ranging from sandy to clayey, shallow and acidic, with a pH lower than 7. More than 90% of the country's land is dedicated to livestock and agricultural production. Orchards are characterised by intensive rainfed plantations, with planting densities between 300 and 400 plants per hectare, identified as an "S5" system by the IOC.



Olive trees and livestock

The climate is temperate humid with high intra and interannual variability in rainfall and thermal regimes. Annual rainfall varies between 1100 and 1600 mm and due to its unequally distribution, periods of water excess and deficit are frequent. Relative humidity is high, normally close to 70%, which generates favorable conditions for disease development throughout the year. The annual average temperature is 17 ° C, with mild winters, including years where there are very limited periods of cold temperatures and summers with average highs that do not exceed 30 °C.

The interannual thermal variability results in a long period of probability for the occurrence of both the beginning and the end of the different phenological states. Sprouting begins in August and flowering occurs from mid-October to mid-November, some 15 days earlier in the north of the country. Spring average temperature is below 18 °C, which can cause longer flowering periods, with desynchronisation among cultivars. Although spring rainfall can wash away air pollen, adequate fruit set percentages have been recorded. In the years of adverse climatic conditions for pollination, the presence of "zofairones" reported in the international bibliography as indicators of fruit set problems can be observed. The pit hardening process occurs at beginning of January and ripening begins approximately in March, depending on the year and the cultivar. The negative effects of summer water deficits could be aggravated in our rainfed production systems with soils that have low water storage capacity. However, when rainy summers and autumns occur, efforts are focused on early harvests to avoid yield losses due to disease.

Different harvesting methods are used in establishments, from olive tree shakers with reverse umbrellas to electric shaker rakes. Olives are collected over a mesh placed under the trees, avoiding soil contact. The climatic characteristics described above are determining and common factors of all agricultural production in the country and the experience in fruit production under our conditions have helped the development of new olive growing.

More than 10 years of research on the behaviour of cultivars from different origins in INIA's Experimental Stations under irrigation, have allowed for the identification of potential yields. Arbequina, Picual, Frantoio, Coratina and Koroneiki had the best productive performance. Average yields recorded exceed 8 tons/ha of fruit with oil yields (fresh basis) between 12 and 18% depending on the cultivar.

Harvest

Olive trees and native forest

Although under commercial rainfed conditions the productivity achieved is lower and highly dependent on alternate bearing, the most widely planted cultivars in the country currently coincide with those recommended. The strong connection between academia and the productive sector has produced rapid innovations in olive technology. This helps to identify the main challenges facing olive growing and enhances research. With the productive experience generated to date, we can affirm that it is feasible to produce EVOO's in orchards with high fruit yields.

Olive tree experiments

Olive trees and meadow

OLIVE GERMPLASM BANK AND CULTIVAR EVALUATION IN URUGUAY

INIA Uruguay

Paula Conde-Innamorato

Facundo Ibáñez

Carolina Leoni

Tasting judge; Consultant; former researcher at INIA Las Brujas

José Villamil

Olive Genetic Resources Expert

Jorge Enrique Pereira Benítez

Uruguay has a temperate-humid climate so it is crucial to find cultivars that have well adapted to our edaphoclimatic conditions in order to contribute with the productive development of the sector. Although in Uruguay some plantations are more than 100 years old, the expansion of modern oliviculture began in the 2000s. In this sense, the growing interest in olive production and the evident need to generate national information led to the establishment of the Introduction Garden of Olive Cultivars in 2002. The centre is located in two experimental stations of the Instituto Nacional de Investigación Agropecuaria - Uruguay, one at Experimental Station INIA Las Brujas - "Wilson Ferreira Aldunate" and the other at Experimental Station "Salto Grande".

Cultivars were introduced from traditional olive production countries in order to study their agronomic behaviour, with emphasis on phenology, productive

INIA Salto Grande - Experimental Station Salto Grande earliness, productive efficiency, accumulated production, tolerance to diseases (mainly fungal), oil yield, fatty acids profile and polyphenol content[1].

In addition to the introduction of cultivars, a survey of local materials has been carried out over the years in Uruguay. These local germplasm evolved from the first olive trees planted in the country at the end of the 18th century and from spontaneous crosses. In 2014, the RESGEN project (Project for conservation, characterisation, collection, and utilisation of genetic resources in olive) of the International Olive Council (IOC), in cooperation with the Faculty of Agronomy of the UdelaR, allowed for the morphological and molecular characterisation (by microsatellites) of the cultivar accessions in the Introduction Garden, joining IOC's network of International Olive Germplasm Banks (OGB).

The molecular and morphological characterisation activities were financially supported by national and international projects as well as with graduate theses and were supervised by the World Bank of Varieties of Olive of Cordoba (Spain). Cuttings from local centenary olive trees were collected and multiplied in the nursery, and there are now 10 autochthonous genotypes planted in the OGB at Experimental Station "Wilson Ferreira Aldunate". In the last two years these materials have been evaluated mainly for their fat content (using the Soxhlet method), polyphenol content and tolerance to *Colletotrichum acutatum* by *in vitro* inoculations.

Since 2019, Uruguay has participated in the True Healthy Olive Cultivar (THOC) project, which aims to provide the National Germplasm Banks of the IOC Network with authentic and healthy starting material for the certification of nursery plants. It is important to mention that *Prays oleae*, *Bactrocera oleae* and *Xylella fastidiosa* are considered Absent Quarantine Pests for Uruguay.

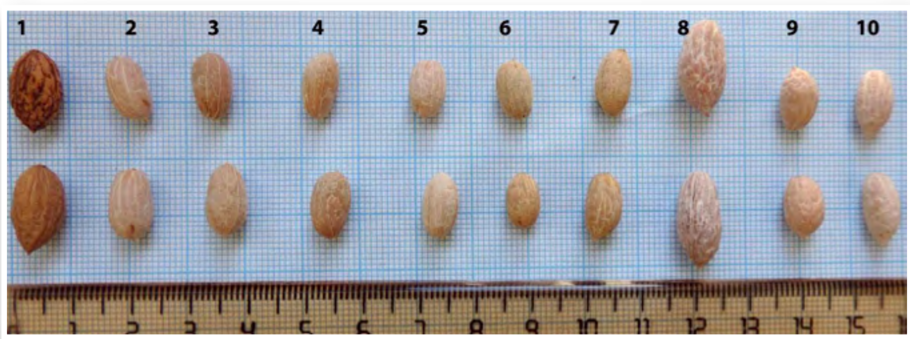
Since the objective is to obtain oils with differentiated quality, in all the experiments oil composition analyses are carried out in compliance with IOC and ISO standards. These analyses include the determination of acidity, peroxide index, conjugated dienes, fatty acid profile, and total phenolic compounds. In all the cases under study, it has been found that the oils obtained at the experimental oil mill comply with the compositional quality parameters of the IOC to be considered extra virgin, despite genetic characters, agroclimatic variables and tolerance to *Colletotrichum* spp.

1 Catalogue of INIA-evaluated olive cultivars. (http://inia.uy/Publicaciones/Paginas/publicacionAINFO-59932.aspx).

INIA Las Brujas – Experimental Station
Wilson Ferreira Aldunate

INIA has specialist researchers in different disciplines, namely genetics, physiology, phytopathology, oil quality and irrigation. The institution's germplasm bank is the only one in the country and currently has: 178 accessions, 28 introduced cultivars from Italy (14), Spain (9), France (2), Greece (1), Argentina (1), Israel (1) and 10 autochthonous genotypes. For the propagation of local plants there is a greenhouse with a hot bed system under nebulisation. For the harvest there is a trunk vibrator (Agruiz S.A.) and the oil is processed with an Oliomio of 50 Kg/h capacity and an Abencor System. In parallel, INIA has analytical capacities both for the determination of the oil quality parameters according to international standards, as well as minor components that contribute to the nutritional and nutraceutical properties. Likewise, leaf tissue and olive nutritional status are analysed to monitor the crops. For this, the Agrifood Quality Laboratory has HPLCs (high pressure liquid chromatography), GCs (gas chromatography), spectrophotometers and associated equipment for qualitative-quantitative determination. It is of great interest for the development of our olive growing sector to continue with the evaluation of local materials, as well as to continue with the introduction of promising cultivars tolerant to the main diseases present in the country (with emphasis on *Colletotrichum* spp.)

Olive Germoplasm Bank, INIA Las Brujas



CONTRASTING PATTERNS OF MORPHOLOGICAL DIFFERENCES BETWEEN ACCESSIONS									
1. Picual	2.Mont.2	3. ARU 1	4. ARU 2	5. VZ1	6. VZ 2	7. CSJ1	8. CSJ2	9. Piria 1	10. Piria 2

CONTENTS

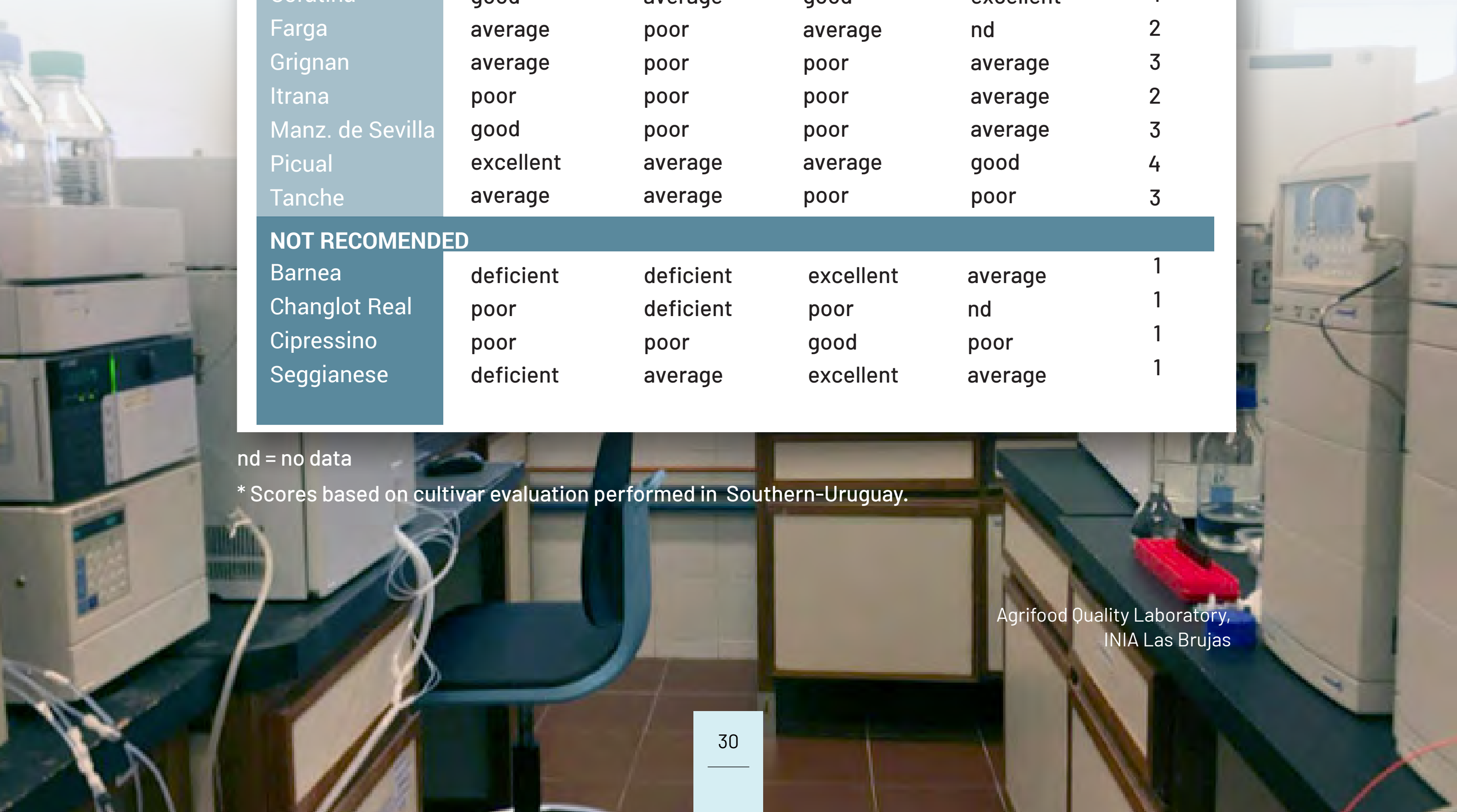
COMPARATIVE TABLE OF OLIVE CULTIVARS APTITUDE

Comparative table among olive cultivars for its agronomic behaviour, phytosanitary behaviour, oil yield, total phenols and cultivar global score based on the following scale: 1 (deficient), 2 (poor), 3 (medium), 4 (good) and 5 (excellent).

	AGRONOMIC BEHAVIOUR	PHYTOSANITARY BEHAVIOUR	OIL YIELD	TOTAL PHENOLS	GLOBAL SCORE
ACEITE					
Arbequina	excellent	average	average	poor	4
Arbosana*	good	poor	average	excellent	3
Canino*	good	excellent	average	good	4
Frantoio*	good	excellent	excellent	good	5
Koroneiki	excellent	excellent	good	excellent	5
Leccino*	average	average	average	average	3
Maurino*	good	average	average	good	3
Moraiolo	poor	deficient	good	average	2
Pendolino	excellent	excellent	poor	average	4
Picholine*	average	good	average	average	3
Taggiasca*	good	excellent	excellent	good	4
DOUBLE PURPOSE (OIL-OLIVES)					
Alfafara*	average	poor	good	good	3
Arauco	average	poor	average	excellent	3
Ascolana*	excellent	average	poor	nd	3
Bosana	average	average	poor	good	3
Carolea*	nd	poor	good	good	nd
Carrasqueña*	poor	poor	poor	good	2
Coratina	good	average	good	excellent	4
Farga	average	poor	average	nd	2
Grignan	average	poor	poor	average	3
Itrana	poor	poor	poor	average	2
Manz. de Sevilla	good	poor	poor	average	3
Picual	excellent	average	average	good	4
Tanche	average	average	poor	poor	3
NOT RECOMENDED					
Barnea	deficient	deficient	excellent	average	1
Changlot Real	poor	deficient	poor	nd	1
Cipressino	poor	poor	good	poor	1
Seggianese	deficient	average	excellent	average	1

nd = no data

* Scores based on cultivar evaluation performed in Southern-Uruguay.



Agrifood Quality Laboratory,
INIA Las Brujas

OLIVE PESTS AND DISEASES

INIA Uruguay

Carolina Leoni

Yesica Bernaschina

Modern olive growing in Uruguay is intended for high quality olive oil production. Its development required the introduction and evaluation of olive cultivars along with pest and disease surveillance in olive orchards, in order to define a phytosanitary strategy. As a result, and given our agroecological conditions typified by mild winters and high annual rainfall and relative humidity, the main problems are associated with fungal and bacterial diseases whereas pests are of relatively minor importance (Burla et al. 2019; Conde et al. 2013; Paullier 2013) (Table 1).

The relative relevance of diseases and pests varies along the life cycle of the olive. In the early stages -transplanting and plant training-, the main problems are associated with the root system (*Phytophthora spp.*, *Fusarium spp.*) and with defoliation (Olive scab, Cercospora leaf spot, Ants).

In second place are the diseases responsible for wood cankers (*Botryosphaeriaceae*) and tumours (Olive knot disease), because they require the stripping of twigs and branches affecting plant development. Also, the Olive shoot-worm moth, significantly affects young orchards.

In adult trees, the focus is placed on diseases and pests which affect productivity and fruit and oil quality, because they are responsible for direct olive yield losses as well as the reduction of the photosynthetic area. The main disease is anthracnose, which causes blossom blight and fruit drop and results in severe yield losses. In addition, fruit infections, especially from veraison to harvest, are responsible not only for yield reduction but also for lowering oil quality (Leoni et al, 2018, Moreira et al, 2021). In second place are the olive scab and the cercospora leaf spot, both responsible for defoliation and plant vigour reduction, and to a lesser extent poor oil quality. Olive knot could be of importance in mature orchards. Finally, although the pathogen *Verticillium dahliae* is present in Uruguay, the disease it causes in olive trees has not been observed yet. Regarding pests, those who most deserve attention are the black scale and olive bark beetle, the latter mainly in weakened trees.

It should be noted that some key olive tree pests and diseases are not present in Uruguay, namely the Olive fly (*Bactrocera oleae*), the Olive moth (*Prays oleae*) and the bacteria *Xylella fastidiosa* subsp. *pauca*, responsible for the Olive quick decline syndrome (FAO-IPPC, 2007). Three of these quarantine pests are absent in Uruguay, but X. *fastidiosa* is also classified as an emergent quarantine pest because it has been detected in neighbouring countries (EPPO, 2021) and there is a risk it may eventually expand into Uruguay.

Phytosanitary management of the olive orchard

Our final aim is to achieve good productivity and organoleptic quality of EVOO and VOO, while minimising environmental impacts and ensuring food safety. To this end, an integrated management system of the olive groves has been implemented in accordance with our agroecological conditions. This management system, favours the following practices: cultivars with disease tolerance, trees with proper training and pruning, soil management with cover crops and organic amendments, strategic irrigation and balanced fertilisation, and tailored harvesting. For example, early harvesting is crucial to the proper management of the anthracnose olive rot in years marked by conducive weather conditions and a high inoculum level in the orchard, otherwise the standards for EVOO can not be achieved (Leoni et al., 2018).

Chemical control is intended mainly for disease management, and eventually for pest management. In both cases, sprays are indicated based on the results of the pest and disease scouting where their presence and severity are registered (Figure 1), on weather forecasts and on problems detected in the previous season. As a result, on average six fungicide spray covers per year are made in order to control anthracnose olive rot, olive scab and cercospora leaf spot (Figure 2); while insecticides are applied based on specific problems in a particular orchard.

A weakness in the defined strategy is the poor availability of registered active ingredients to be used in olive production along with the high dependency on copper fungicides, which nowadays are being observed for their negative impact on the environment. For the near future, we face the challenge of exploring and developing new pest management strategies. For this we should go from the inclusion of microbial pesticides to the re-design of olive groves in order to promote natural pest and disease regulation mediated by the beneficial entomofauna which is present in the wild and associated flora, and by the plant and soil microbiome.

TABLE 1 – MAIN AND QUARANTINE DISEASES AND PESTS IN URUGUAYAN OLIVE GROVES		
DISEASE AND CAUSAL AGENT	**PART OF THE PLANT AFFECTED**	**RELEVANCE**
Anthracnose olivo rot (*Colletotrichum* spp.)	Inflorescence, olives, leaves and twigs.	High
Olive scab (*Venturia oleaginea*)	Leaves, inflorescences and olives	High
Cercospora leaf spot (*Pseudocercospora cladosporioides*)	Leaves, olives	High
Olive knot disease (*Pseudomonas savastanoi* pv. *savastanoi*)	Woody branches and twigs	Medium - Low
Wood diseases (*Botryosphaeriaceae*)	Woody branches and stems	Low - Medium
Collar and root rot (*Phytophthora* spp., *Fusarium* spp.)	Root system	Low - Medium
Xylella fastidiosa subsp. pauca	Xylem	Quarantine pest – Absent
PEST		
Ants (*Acromyrmex* spp., *Atta* spp.)	Shoots, leaves	High (in young orchards)
Black scale / Olive scale (*Saissetia oleae*)	Branches, twigs, shoots, leaves	Medium-High
Olive shoot-worm moth (*Palpita forficifera*, P. *persimilis*)	Shoots	Medium
Olive borer /Olive bark beetle (*Hilesinus oleioierda*, *Phloetribus scarabaeoides*)	Twigs	Medium
Olive Bud Miteo (*Oxycenus maxwelli*)	Buds	Low
Olive fly (*Bactrocera oleae*)	Olives	Quarantine pest – Absent
Olive moth (*Prays oleae*)	Olives	Quarantine pest – Absent

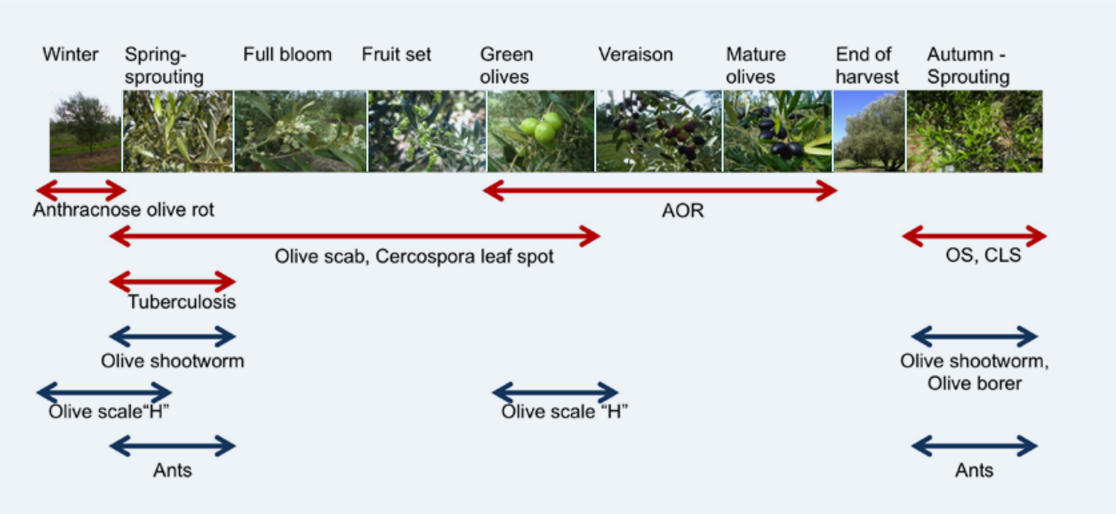


Figure 1. Scouting guide for the main olive diseases and pests. (Modified from Leoni et al., 2013)

SPRAYS	PURPOSE	TARGET DISEASE	ACTIVE INGREDIENT
(1)*	Winter cover		Copper
2	Protect young spring shoots and inflorescences	OS, CLS	Copper
3		OS, CLS, AOR	Copper/organic fungicide**
4		OS, CLS, AOR	
5	Pre-harvest	AOR	Copper
(6)*	Post-harvest Protect young autumn shoots	OS, CLS	Copper

OS: Olive scab *(V. oleaginea)*; CLS: Cercospora leaf spot *(P. cladosporoides)*;
AOR: Anthracnose olive rot *(Colletotrichum spp.)*
**Optional: based on previous season disease level* ***QoIs, IBE or carbamates*

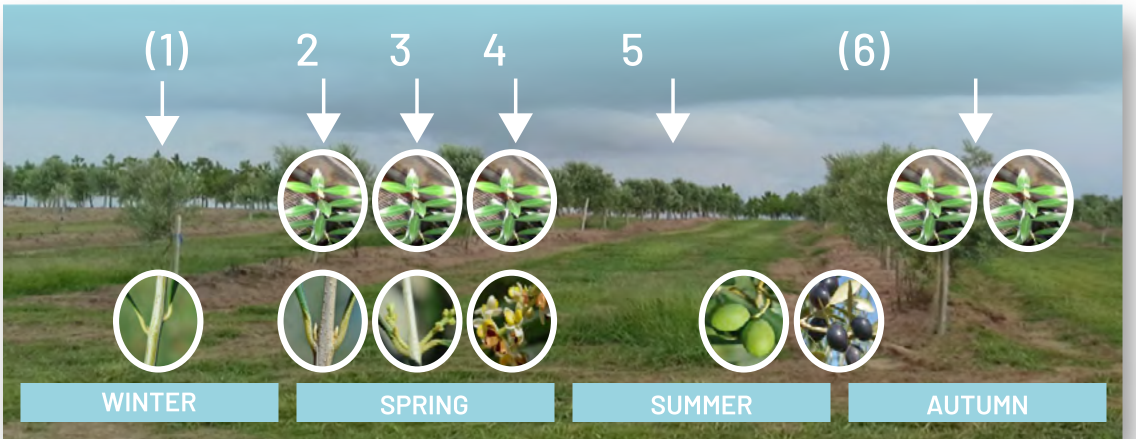


Figure 2. Spray strategy for chemical management of the main olive diseases. (Modified from Conde et al., 2019)

OLIVE ANTHRACNOSE IN URUGUAY[1]

Faculty of Agronomy, UdelaR

Victoria Moreira

Sandra Alaniz

Uruguay is characterised by recurrent rainfalls with around 1.100 mm per year and frequent high relative humidity days throughout the year. Olive growing in Uruguay was developed using an intensive plantation system with approximately 285-400 trees/ha. The climate conditions and production system, particularly favour the development of fungal diseases. Among them, the anthracnose caused by fungi of the *Colletotrichum* genus is the most significant disease affecting this crop. This disease, also called "Soapy fruit", is well known in all olive production areas worldwide, due to the significant yield losses caused by fruit rot and negative impact on oil quality.

Olive oil produced from infected fruits has a reddish colour and display, increased acidity and decreased organoleptic properties.

1 https://doi.org/10.1007/s10658-021-02274-z

Symptoms

The fruits are especially susceptible when ripe, but they can also become infected when still green. The symptoms consist of a brown lesion that is rapidly covered with an orange gelatinous mass corresponding to the fungus structures (conidia) (Figure 1). Althoguh the most frequent symptom of olive anthracnose is fruit rot, *Colletotrichum* can also infect laves causing necrotic lesions, dieback of branches and defoliation.

In the last years the Uruguayan olive growing industry suffered the consequences of an epidemic outbreak that caused losses of up to 90% of production. This event occurred mainly in the east, the major olive-growing region of the country. In this case, a high incidence of blossom blight symptoms was observed (Figure 2). This phenomenon shows that, under our conditions, this disease begins at the flowering stage and continues by affecting the fruits. Blossom blight is a little-known symptom worldwide. Until now, it has been only reported in South Africa, Greece, Australia and now in Uruguay. The damage in flowering increases the direct losses, but also has epidemiological significance since the affected flowers constitute a inoculum source for subsequent infections in fruits and, eventually, other organs.

Figure 1. Anthracnose symptoms in green and ripe olive tree fruits with mucilaginous orange masses of *Colletotrichum* spp. covering the affected zone

Figure 2. Blossom blight symptoms in olive flowers with details of mucilaginous orange masses of *Colletotrichum* spp.

Colletotrichum species

Worldwide around 15 species of the *Colletotrichum* genus associated with this disease have been identified. In Uruguay, based on a recent study developed alongside the epidemic outbreak, the species *C. acutatum* s.s, *C. nymphaeae*, *C. fioriniae*, *C. theobromicola* and *C. alienum* were found to cause olive anthracnose. Among these, C. *acutatum* s.s. was the prevalent species (Figure 3). The dominance of *C. acutatum* s.s. affecting olive crops has already been mentioned in countries in the Mediterranean region such as Greece, Italy or Tunisia. Apparently, when *C. acutatum* s.s. is introduced into a region, it is able to produce explosive epidemics, as was the case in Uruguay in recent years. However, the causes that explain why this species shifts from being undetected to being the most frequent, are still unknown. Regarding the other species, *C. alienum* was reported to be affecting olive trees in the world for the first time.

Challenges

The five species found in Uruguay, were able to infect both the flowers and fruits of olive trees in experiments conducted under controlled conditions. In both organs, anthracnose symptoms were visible few days after inoculation, and a few days later the typical *Colletotrichum* structures were developed. The rapid development of the disease is compatible with the explosive behaviour of the anthracnose in commercial plantations when environmental conditions are favourable. As to the anthracnose is an extremely dangerous disease, it is crucial that effective management strategies be developed in order to minimise its presence. Thus, research is currently underway to determine the behaviour of the olive cultivars produced in Uruguay against the local *Colletotrichum* strains, to elucidate the susceptibility of the different stages of flower panicle and fruit development to this pathogen and to determine the effectiveness of different fungicides for its control.

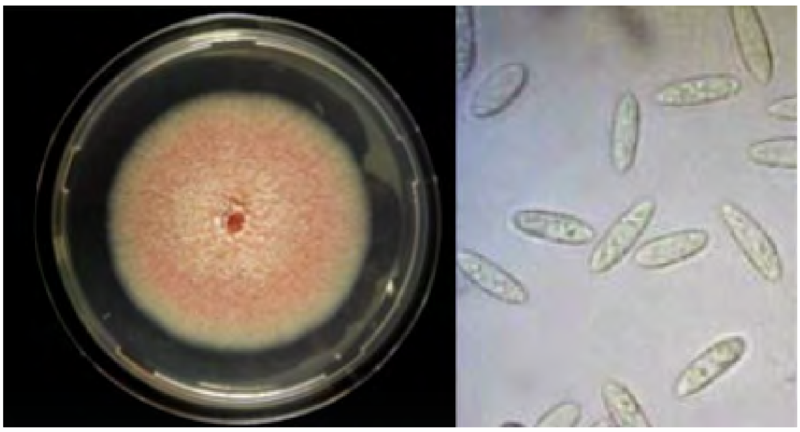


Figure 3. A typical colony of *C. acutatum* s.s. and details of asexual reproductive structures (conidia)

ANTHRACNOSE-CAUSING FUNGI: WHERE THEY THRIVE AND WHY REAL-TIME PCR IS SO USEFUL

Faculty of Agronomy, UdelaR

Bárbara Ferronato

Pedro Mondino

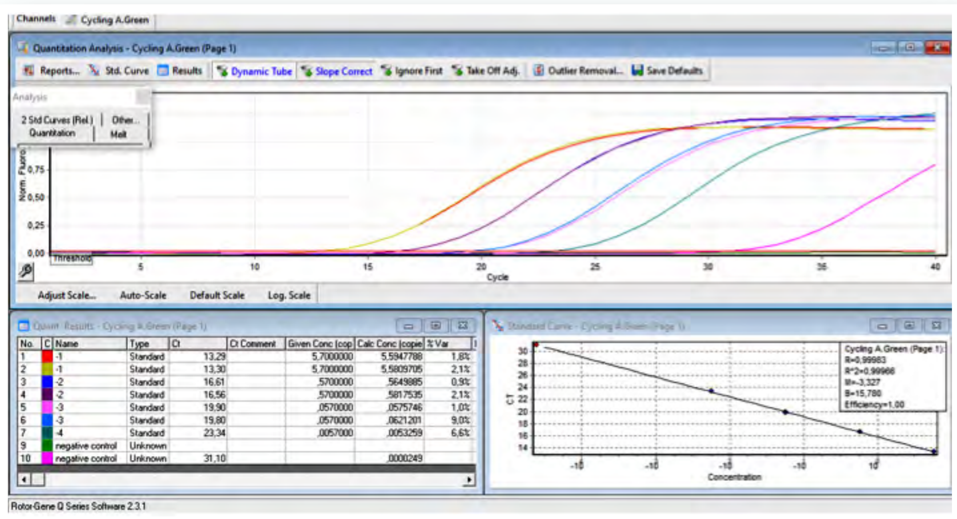
High relative humidity weather conditions and plenty of rainfall make up the scenario that characterises olive crop production in Uruguay. These climate conditions favour the development of anthracnose in olive trees, a disease caused by fungal species belonging to the *Colletotrichum* genus. The epidemic outbreak that Uruguayan olive growing recently suffered, which generated losses of up to 90% of the production in the eastern region of the country (i.e. the main olive production area in Uruguay), was mostly caused by *C. acutatum* s.s. A series of studies have looked at the etiology and epidemiology of this disease with the purpose of designing an integrated management programme under the paradigm of sustainable agriculture. It is essential to know where this pathogenic fungus thrives, in order to design management strategies aimed at reducing primary infections each season.

During research carried out by the Department of Plant Protection of the Faculty of Agronomy, a proposal was made to identify the sites where this pathogen was present throughout the year. To this end, over a period of two consecutive years, plant material samples taken from the aerial part of the trees (dry branches, green branches, leaves, mummified fruits) and from the ground (mummified fruits, pruning remains and leaves) were collected and analysed. In order to detect where the pathogen was present, two techniques were used. The first consisted in inducing the development of *Colletotrichum* species surviving in the collected material. For this, the plant material was placed at -18ºC for one hour and then in humid chambers to favour fungal growth. Pathogen presence and identification were carried out using magnifying glasses and microscopes. The second method consisted in detecting *C. acutatum* s.s.,, the currently predominant species in Uruguay, using a real-time PCR technique. This second method also enables pathogen quantification in each organ that is analysed.

As a result, we were able to determine that Colletotrichum remains in the tree throughout the year and can be detected in branches, leaves and mummified fruits. Similar results were obtained with the real-time PCR technique, although this technique proved to have a higher sensitivity. In this case, C. acutatum s.s. was detected and quantified in organs when using the conventional method was not possible. This is particularly important because it allows us to compare and contrast the different organs that serve as reservoirs of Colletotrichum.

Based on this research, olive anthracnose control strategies must take account of the fact that each affected tree acts as an inoculum source for the following season. This calls for management crop practices which aim to render the tree canopy microclimate not conducive to disease development. This is achieved through pruning, which allows sunlight tp better penetrate, favours ventilation, and maintains a balanced fertilisation.

Presence of Colletotrichum sp. on leaves and branches in a humid chamber. Salmon-coloured spore masses can be observed



Real-time PCR optimisation for the detection and quantification of Colletotrichum acutatum ss in field samples

FOLIAR DISEASE MANAGEMENT: LEADED OLIVE IN URUGUAY

UdelaR

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Pedro Mondino

The climatic conditions of Uruguay, with high relative humidity and abundant rainfall, favour the occurrence of diseases that affect olive foliage and fruit. "Leaded" or Cercospora leaf spot (CLS), caused by the fungus *Pseudocercospora cladosporioides*, is amongst the most significant ones. This disease is characterised by diffuse chlorotic spots on the leaves which later evolve into necrotic. On the underside of the leaves, the presence of pathogen spores gives them a leaden gray colouration. The affected leaves drop off causing severe defoliation, this being the main damage. The reduction of the foliar area causes significant yield losses as well. This fungus, finally, also affects the fruits, producing lesions that degrade oil quality by increasing its acidity.

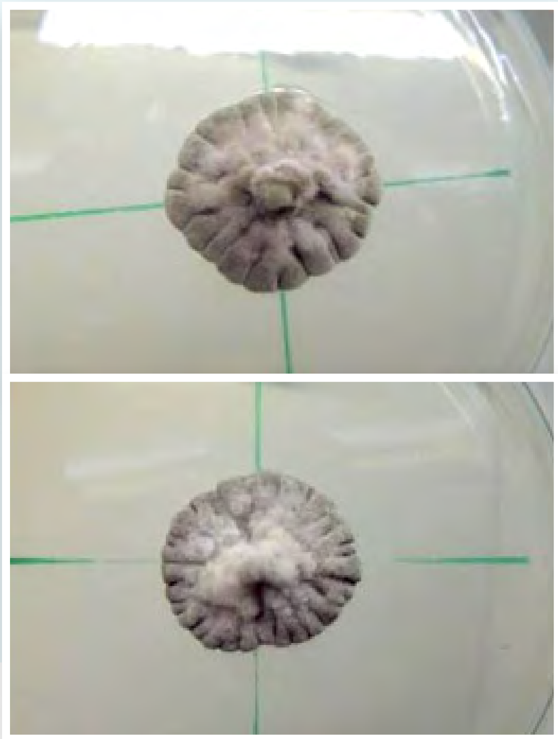
Sustainable agriculture implies designing management strategies based on knowledge of the etiology and epidemiology of diseases. For this reason, a series of studies were carried out both in the field and in laboratories with the objective of identifying and characterising the pathogen that affects the main olive cultivars in Uruguay. First of all, leaves showing symptoms were collected from the main olive producing areas of the country; a collection of isolates of the pathogen was also obtained. Using molecular biology techniques, the isolates were identified at a species level. At the same time, a phenotypic and morphological characterisation was carried out and its growth was studied at different temperatures. These studies showed that olive leadening in Uruguay is caused by *P. cladosporioides*, much like in other olive-growing regions of the world. The growth temperature of the isolates ranges from 5º to 30º C, with optimal growth around 20º C.

In the field, spore production was quantified throughout the year. To this end, monthly samples of leaves with relevant symptoms were taken from a commercial grove of the Arbequina variety. The spores were shaken off the leaves using sterile distilled water and then counted using a Neubauer camera. This way it was possible to determine that, although the inoculum production of this pathogenic fungus occurs throughout the year, there are two critical moments: one in spring-summer and the other in autumn, with a sharp decrease during winter.

In another experiment carried out in the field, the objective was to learn at what times of the year *P. cladosporioides* infections occur. To this end,, for a period of two years, branches with new shoots were bagged in the spring. The bags were removed sequentially, leaving the shoots exposed for a month. They were then re-bagged, thus generating 12 infection periods, one for each month of the year. Six months after exposure to infection by *P. cladosporioides*, the incidence and severity of the disease in the leaf branches were evaluated. This experiment made it possible to verify that although, the pathogen causes infections throughout the year, the highest percentage occurs from March to July in the south hemisphere.

More studies are currently underway to determine the sensitivity of *P. cladosporioides* populations to different fungicides. These studies aim to design an effective, environment-conscious, science-based management strategy.

Symptoms of olive leaded on leaves (above)
Symptoms of leadening of the olive tree on its fruits (below)



Appearance of the colonies of *Psedocercospora cladosporioides*

IRRIGATION RESEARCH ON OLIVE TREES IN URUGUAY

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The olive is a typical tree of the Mediterranean climate, and it has traditionally been cultivated under rainfed conditions. However, there is a body of information confirming that this crop responds well to irrigation, resulting in rapid growth of the young plant as well as olive yields. Most of the irrigation research on olive trees was generated in arid climates and is scarce for sub-humid climates such as Uruguay. In the country, precipitation produces more than 1100 mm per year, which would be enough to cover crop water requirements. About 80% of olive plantations are rainfed. However, the occurrence of water deficit periods in critical stages for fruit development (spring and summer) is frequent.

Olive trees planted in the rain-out shelter with drainage lysimeters in INIA Las Brujas

Another relevant climatic variable is the vapour pressure deficit (VPD) that takes into account humidity and temperature. This variable is positively related to crop transpiration and it increaseswith higher VPD values. In Uruguay, VPD during the summer is lower than in countries with a Mediterranean climate, since humidity is higher, close to 70%, and average temperatures do not exceed 24 °C.

In this context of variability of water supply and particular environmental characteristics, it is necessary to evaluate crop water requirements and its productive responses. Irrigation tests are necessary for efficient water management. The first step was to determine the local evapotranspiration (ETc) of the crop. For this purpose, olive plants were installed in drainage lysimeters located in a rain-out shelter for 4 years (2010-2014). This structure remains open permanently; it closes automatically after 3 mm rain. The recorded water consumption was related to the size of the tree canopy and physiological parameters. A positive linear relationship was observed between the crop coefficient (Kc) value in the summer and plant age, percentage of canopy cover and plant volume. The highest ETc value measured for a 6-year-old plant was 29 L d-1, equivalent to 2.1 mm d-1 referred to the distance between plants (5.5 m x 2.5 m). The Kc showed marked seasonality, with the lowest values in August and early September and the highest values in mid-April and May (autumn).

On-demand irrigation associated with good soil drainage resulted in rapid growth of the young plants. In one growing season, in their 3- to 4-year transition, the plants doubled in crown area and increased fivefold in volume. This rapid growth would accelerate the arrival of the forest to full production, achieved at an earlier productive age.

Field experiments in INIA Las Brujas. Soil was covered with nylon to avoid rain input

More recent studies (2016-2020) focused on evaluations of the effect of prolonged water deficit on yield. To this end, an experiment was carried out in an olive grove in full production of Arbequina and Frantoio cultivars. Two irrigation treatments were applied according to the maximum evapotranspiration of the crop: 50% and 100% of the ETc plus a treatment without irrigation or rain input (T0). The treatments were carried out from pit hardening to harvest, covering the lipogenesis stage of the fruit. Samples were extracted monthly to evaluate the evolution of the different yield components: fruit weight, pulp/stone ratio, oil content and yield; plant water status was also monitored. The field work was complemented with experiments carried out on the lysimeters.

The main result showed that, every year, supplementary irrigation is required. The adjustment of the irrigation requirement as well as the crop coefficient (Kc) is very important to improve the use of rainwater.

Studies on the effect of the water deficit have found thatwater restrictions caused losses in yield (both in kg of olives and in kg of oil per plant) in both cultivars. These responses were driven by the increase in fruit weight and pulp/stone ratio. However, the oil yield (determined by the Soxhlet method) was not affected by the treatments.

These experiments were carried out on clay soils of medium depth (50 to 60 cm) and with moderate-to-high water retention capacity. In the country, a large part of the olive production is developed on superficial sandy loam soils, with less water storage capacity where the negative impact of the water deficit could be greater. The conditions of high rainfall and low atmospheric demand could be suitable for an adequate crop yield. However, the high climatic variability causes reductions in oil yields if there is no infrastructure to supplement water during periods of water deficit, especially in the fruit growth phase.

Dehydrated fruits, corresponding to the rainfed treatment

Hydrated Arbequina fruits, corresponding to the 100% ETc treatment

OLIVE MILL WASTE VALORISATION FOR A SUSTAINABLE PRODUCTION AND THE PROMOTION OF THE CIRCULAR ECONOMY

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The production of olive oil has increased in recent decades as a valuable source of antioxidants and essential fatty acids in the human diet. It constitutes one of the most important trends indiets worldwide.

In our country, the Uruguayan Olive Association (ASOLUR) is highly representative of the sector, where it has become a benchmark. The main strategy of our olive industry is based on the manufacture of a product of the highest quality standards (Extra virgin olive oil). This goes to the detriment of industrial yields, as Uruguay prioritises early harvesting and takes extreme care in all stages of the production process.

During production, almost all the phenolic content of the olive fruit (about 98%) remains in the by-products of the industry. In addition to generating a serious environmental problem, olive mill waste (OMW) represents a valuable source of phenolic compounds that must be recovered.

Due to the two-phase system used in the national industry, the ratio between OMW generated and processed olives is higher than 1, so we expect to reach 22,000 tons worth of OMW annually for the next few years. In addition to this, the generated waste has a moisture content close to 80%, which makes any treatment or recovery system extremely difficult.

So far, this residue has been applied to the ground directly and, although pilot experiments on composting and vermicomposting have been carried out in the sector, it continues to pose a problem in the medium term from an environmental point of view as well as in relation to the health of the soil ecosystem and the sustainability of the production process in general. The value of polyphenols in OMW,at the very least, calls for an assessment of their potential recovery.The alternative would entail having to degrade them in order to avoid problems in the biological treatment of the effluent, or issues related to phytotoxicity and ecotoxicity when discharging them into the environment.

Polyphenols are a group of chemical substances found in many plants and, due to their antioxidant capacity, have possible implications for human health such as the prevention of cancer, cardiovascular diseases, or even neurodegenerative diseases such as Alzheimer's.

Extracting polyphenols from OMW would allow them to be used as a food ingredient to add value and antioxidant capacity to different food developments, as well as used in the cosmetic and pharmaceutical industry. This extraction also facilitates the treatment of the remaining by-product, minimising the environmental impact.

There are different methods to extract polyphenols. Two studies of interest for ASOLUR that are being carried out are outlined below, based on the commitment to sustainable solutions for production and the search for alternatives for the recovery of by-products.

The first project is an initiative that has been in development since the 2019 harvest. Led by the Department of Food Science and Technology of the UdelaR, within the framework of a project funded by the Sectorial Commission for Scientific Research, the project addresses the problem of OMW from the point of view of clean extraction technologies. In this sense, the project explores the possibility of obtaining extracts with antioxidant and antimicrobial activity from two-phase olive pomace, with the aim of being able to use them as substitutes for synthetic antioxidants in the food industry.

Traditionally, the recovery of phenolic compounds has been carried out by maceration with different solvents or Sohxlet, but the interest in using more efficient and environmentally-friendly recovery processes has led to the development of non-conventional methods that permit reduced extraction time, as well as minimising the use of toxic solvents. Within this framework, supercritical fluid extraction (SFE) is used to obtain antioxidant extracts from olive mill waste. This technology is characterised by the use of solvents (mainly CO_2) at pressure and temperature values above their critical point, a range in which fluids have intermediate properties between those of a liquid and a gas, so their capacity for solvent extraction is enhanced. Unlike conventional extraction processes that use large volumes of solvent and generally require the use of high temperatures, extraction with supercritical CO_2 means it is possible to work at moderate temperatures, preserving the integrity of the thermolabile compounds. Furthermore, it is possible to obtain extracts of high purity selectively of the compounds of interest.

Research into dried olive pomace of the two varieties most widely planted in Uruguay (Arbequina and Coratina) examined the influence of the extraction conditions on the yield and antioxidant power of the extracts obtained. In addition, the antimicrobial activity of the extracts against bacteria of interest in food was evaluated. The Coratina variety extracts presented higher content of total phenols, tocopherols and antioxidant activity than those of the Arbequina variety. Both extracts were effective in inhibiting the growth of the bacteria studied. These results are encouraging and constitute a starting point to revaluing this waste, which until now has had no defined destination locally.

The second project was carried out by Latitud and ASOLUR. On behalf of the National Development Agency (ANDE) and within the framework of support to the

Flowchart showing the process for obtaining antioxidant extracts from solid waste using supercritical fluid technology

detection of sectorial opportunities for the implementation of actions in line with the Circular Economy, they manage the Olive mill wastewater valorisation project.

The project, which started with the 2021 harvest, aims to carry out a technical-economic feasibility study for the recovery and valorisation of the polyphenols contained in the OMW. For this, different activities will be carried out within the laboratory and pilot plant scale with the aim of finding out more about the process and the quality of the final product.

Polyphenols extraction at the pilot plant
and quantification in the laboratory

Current steps include:

- Quantifying the content of total polyphenols in the Arbequina, Coratina and Picual varieties across 5 locations in Uruguay, with different maturity indices.
- Evaluating the extraction of polyphenols from OMWW using tangential filtration membranes, beginning the process with a separation between the liquid and solid parts. Polyphenols tend to remain mostly in the liquid part and then, to concentrate them, several filtrations are carried out, starting with membranes with larger pores (micro and ultrafiltration) and then continuing with smaller pores (nanofiltration and reverse osmosis). At a certain size, polyphenols cannot pass through the pores and accumulate on the surface. At that stage they can be recovered.
- Analysing the profile or types of polyphenols that are recovered.
- Analysing the final effluent, after extraction, and putting forward corresponding treatments as well as possibility of water reuse after filtration by reverse osmosis.
- Studying the technical and economic feasibility of the construction of one or more plants for the extraction of polyphenols from the olive oil industry.

By supporting these investigations, ASOLUR seeks to find alternatives and give value to the main by-product of the olive oil industry, minimising the environmental impact of the production chain and promotingcircular economy.

THE DEVELOPMENT OF EVOO OLEOGELS FOR DIVERSIFIED USE IN THE FOOD INDUSTRY

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For several years the food industry has faced the challenge of reconciling the functional and sensory properties required by certain products with the nutritional properties demanded by consumers. This problem mainly arises in food products that require the use of fatty materials with a particular hardness or structure (such as margarines, spreadable creams, biscuits, pastries, etc.). This is traditionally provided by means of a high content of saturated and/or industrial trans fatty acids, which have proven harmful effects on human health. Additionally, food regulatory agencies in several countries, including Uruguay, have established clear guidelines towards reducing these types of fats in food products to keep consumers safe.

In this complex scenario, a novel technological alternative to provide structure to edible liquid oils without modifying their chemical composition(i.e. without the need for trans or saturated fats) has garnered attention. This technology is called "oleogelation" and is achieved by adding a small percentage of a "structuring agent" that forms a network within the liquid and efficiently "entraps" the oil, which prevents it from draining. Hence, a solid or semi-solid material can be obtained even though more than 90 % still remains liquid, offering many potential applications that are different fromtraditional ones.

Oleogels (right) prepared with edible liquid oils (left)

From left to right: bee, carnauba and candelilla natural waxes

The use of this type of process to structure different edible oils, particularly Uruguayan extra virgin olive oils (EVOO), has been thoroughly researched by the Fats and Oils Area of the University. Natural waxes of different origins (bee, carnauba and candelilla) have been used as structuring agents, all considered fit for human consumption (Generally Recognized As Safe or GRAS) by the Food and Drug Administration. These studies have shown that EVOO can be efficiently structured by adding a minimum structuring agent concentration of 2 %, leaving its natural virtues such as its healthy fatty acids composition unaltered as well as its characteristic bioactive compounds.

Some formulations have shown physicochemical properties (textural, thermal, rheological, etc.) that make them potential substitutes for edible fats with different applications. However, the major challenge remains in the residual sensation caused by the structuring agent itself, that leads to a loss of the sensory attributes of the original oil. Therefore, structuring mixtures with an enhanced effect are being evaluated, allowing their concentration to be reduced to a minimum and consequently minimising their contribution to the sensory characteristics of the products.

This line of investigation intends to expand the uses of national EVOO through the generation of healthy products which can totally or partially replace traditional fats used by the food industry, as these have demonstrated adverse effects on consumer health.

SENSORY PROFILE OF URUGUAYAN EXTRA VIRGIN OLIVE OILS

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Ana Claudia Ellis

Miguel Amarillo

Adriana Gámbaro

In national plantations, four varieties account for 90% of the cultivated area, the Spanish Arbequina variety having the highest presence with 47% of the area, followed by the Italian Coratina with 21% and the Spanish Picual along with the Italian Frantoio with 11% each. Other varieties planted with lower surface areas are: Leccino, Manzanilla de Sevilla, Koroneiki, Hojiblanca, Barnea, Arbosana, Picholine and Taggiasca.

Each variety from which olive oil is obtained features different sensory characteristics (colour, smell and flavour) their chemical compositions. Within the same variety, agronomic factors (type of soil, altitude, latitude, etc.) or bioclimatic factors (average temperatures, sunlight, periods of rain, frost, etc.) will affect smell and tastes.

Therefore, it is necessary to evaluate the sensory profile of the oils obtained from the crops in different environments.

The characteristic aroma of extra virgin olive oil is linked to a group of several volatile compounds associated with green notes, tomato, banana, and nuts among others. Although great progress has been made in knowledge of these compounds responsible for smell, colour and flavour, it is evident that the equipment used to date is far from sufficient for replacing our senses in sensory appreciations.

EVOO quality determination by sensory analysis basically quantifies the sensations perceived from the smell, the aroma, the taste and the pungent and astringent mouth sensations. Flavours such as bitter and mouthfeels such as pungent and astringent are linked to the phenolic antioxidant content found in olive oil, such as oleuropein and oleocanthal. These compounds have many beneficial health properties.

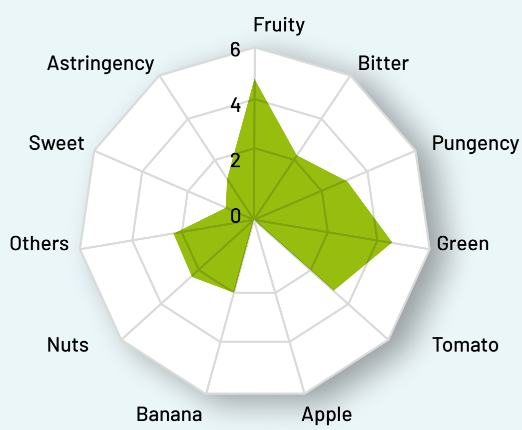
The evaluation of sensory characteristics in virgin olive oils was carried out by the virgin olive oil tasting panel within the Sensory Evaluation Laboratory of the Faculty of Chemistry, approved by the IOC in 2012.

The sensory profiles of the main varieties planted in our country will be described below.

ARBEQUINA: produces a very fruity, smooth, fluid oil with an extraordinary fragrance; slightly bitter and slightly pungent. For this reason, it is well accepted in markets that are not used to the consumption of virgin olive oil, making it a suitable variety for introducing the product to new markets. The oils obtained from Arbequina range from yellow to intense green.

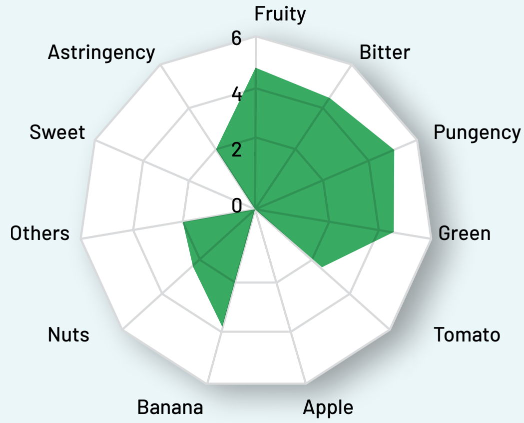
Uruguayan oils are characterised by balanced and complex aromas and flavours and sweetness. Fruity notes of tomato, banana, walnuts, almonds and molasses can be detected. Molasses is a national characteristic, since in Arbequinas from other countries this note is not present.

The following figure shows the average of 30 Arbequina samples obtained from different cultivars over three consecutive harvest seasons. Cultivars were located at the eastern and western areas of Uruguay.



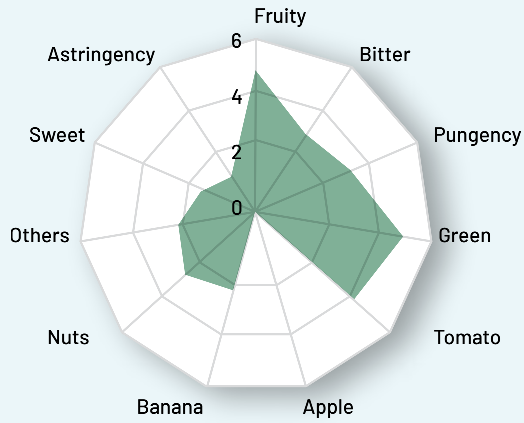
CORATINA: produces oils with medium-high fruity notes, andhigh-intensity bitterness and pungency. Fruity notes are mostly green (grass, olive leaf)and are accompanied by notes of green banana peel and green almond. The pungent attribute is considerably and interestingly intense and persists over time. This oil is commonly used in blends with Arbequina, which helps to mitigate the astringence and bitterness that new consumers do not usually enjoy.

The following figure shows the average of 30 Coratina samples obtained from different cultivars over three consecutive harvest seasons. Cultivars were located at the eastern and western areas of Uruguay.



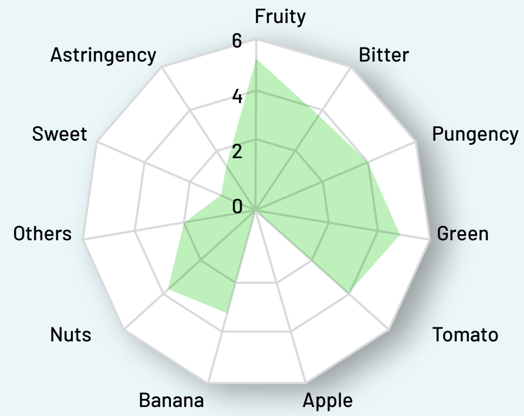
PICUAL: produces oil with a green colour and with medium-intensity bitterness and pungency, making it suitable for blends with Arbequinain different proportions.This can be a good strategy for educating consumers on less mild oils. The descriptors of the fruity attribute are in general very similar to those of Arbequina, as notes of green olive leaf, green almond and artichoke can also be detected.

The following figure shows the average of 30 Picual samples obtained from different cultivars over three consecutive harvest seasons. Cultivars were located at the eastern and western areas of Uruguay.



FRANTOIO: produces oil with a medium intensity of the green fruity attribute. It is evocative of freshly cut grass, green pepper, tomato and green almond, with medium bitterness and pungency and great persistence.

The following figure shows the average of 30 Frantoio samples obtained from different cultivars over three consecutive harvest seasons. Cultivars were located at the eastern and western areas of Uruguay.



In summary, Uruguayan oils have a unique sensory profile that testifies to their freshness, but they are also balanced, complex and harmoniousas a high-quality extra virgin olive oil should be.

WHAT DOES THE URUGUAYAN CONSUMER LOOK FOR IN AN OLIVE OIL?

Faculty of Chemistry, UdelaR

Adriana Gámbaro

Cultural traditions, level of education and culinary practices are contribute to a great extent to determining consumer attitudes towards foods. Olive oil is a relatively new product in many countries outside of the Mediterranean basin, as in Uruguay. At present, the mean estimated consumption is 0.4 L per person annually in Uruguay, which makes olive oil the least consumed of all the oils commercialised in the market (corn, sunflower, high-oleic sunflower, soybean and rice bran oil). Although Uruguayan consumers perceive olive oil differently from other vegetable oils, and describe it as gourmet, expensive, high-quality, and as having positive health effects as well as capable of arousing positive feelings in consumers, there is a lack of information and knowledge which does not allow consumers to evaluate the quality of this product nor to make purchase decisions.

In 2014, a study of 256 inhabitants of Montevideomeasured their objective and subjective knowledge of olive oil. The study showed that the surveyed population had little knowledge with respect to the composition and real health benefits of this product. They do not perceive themselves as having real knowledge regarding olive oil. Because olive oil consumption in Uruguay is not high, people are not confident in their knowledge of olive oil. The greatest subjective knowledge about olive oil in the surveyed population was related to a higher level of education, which reflected a higher consumption.

An online survey was recently performed with 317 Uruguayan consumers of olive oil. A variety of olive oil labels were presented to consumers, differing in the countries of origin (Italy, Spain and Uruguay), in the information about the oil's properties (no information, "rich in antioxidants", "rich in polyphenols") and whether the oils had won awarded (some had, some had not). For each label, consumers were asked to indicate their purchase intention and how healthy they perceived the oil to be. Consumers showed a greater purchase intention towards Spanish and Italian oils and also towards the award-winning oils. The phrase "rich in antioxidants" on the label encouraged purchase as well as the perception of those oils as healthy products. The phrase "rich in polyphenols", conversely, had a negative effect, probably due to the fact that this word is little-known by consumers. This study also showed a lack of knowledge with respect to the Uruguayan olive oil industry and to the quality of national products.

Taking into account that the sensory characteristics of olive oil are one of the main determinants for consumer appreciation of the product, the sensory profile can have a great influence in consumers' perception of quality. In this regard, a study of 100 regular olive oil consumers (i.e. people who consume olive oil every day or several times per week) was carried out. Consumers were given 4 samples of olive oil for tasting: 2 extra virgin olive oils, and 2 ordinary virgin olive oils with clear defects such as rancid, fusty/muddy and winey. The consumers had to indicate their level of appreciation and their purchase intention for each of the samples and described them using a list of terms previously provided.

Two groups of consumers were identified with opposing behaviors. Group 1 (51 individuals) described the olive samples similarly to the panel of sensory judges. They associated the positive descriptors with extra virgin olive oils and negative descriptors with ordinary virgin olive oils, which were given low acceptability scores. Group 2 clearly preferred defective oils describing them as good-quality, tasty, sweet, aromatic, with a soft flavor, delicious and fresh. The results of the study showed that a high proportion of Uruguayan consumers are unaware of the typical characteristics of an extra virgin olive oil, clearly preferring lower quality oils with a high intensity of defects.

Other studies conducted on people with different levels of knowledge regarding olive oil showed that Uruguayan consumers cannot make a clear differentiation between samples of different qualities nor distinguish those that are defective from those that are not. In addition, most consumers tend to consider the fusty defect as an agreeable flavour, describing it as the flavour of table olives which are regularly consumed in our country.

These results show that much progress still needs to be made and that Uruguayan consumers need to be educated through talks and guided tastings so that they can learn about the characteristics that an extra virgin olive oil should have and can appreciate the real value of this noble product.

EXPERIENCE IN THE FIRST LATIN AMERICAN OLIVE OIL CONGRESS

Faculty of Chemistry, UdelaR

Adriana Gámbaro

Ana Claudia Ellis

In 2019, at a table of a bar in Jaén (Spain), Dr. Juliano Garabaglia of the Universidade Federal de Ciências da Saúde (Porto Alegre, Brazil), Dr. Ana Claudia Ellis and Dr. Adriana Gámbaro of the Udelar (Uruguay), who at the time were attending EXPOOLIVA, came up with the idea of organising, for the very first time, an academic event to help to disseminate the research being carried out on olive oil in Latin America.

After this meeting, the idea of the First Latin American Congress of Olive Oil (CLAO2020) emerged.

At first, it was planned to be an in-person event, to be held in July 2020 in Montevideo (Uruguay). However, due to the COVID-19 global pandemic and the particu-

larly difficult situation of our region at the time, the date of the meeting was postponed, and eventually the decision was taken to organize it in a virtual format.

The congress took place from Monday 19 to Friday 30 April 2021. All the pre-recorded conferences and the e-posters accepted were available from the very first day for all the registered attendees. Moreover, each conference had a virtual forum associated with it and also a live platform for the exchange of ideas, where attendees were able to directly communicate with the respective lecturers as well as exchange comments and ask questions.

CLAO2020 was organized by the Food Science and Technology Department of the Faculty of Chemistry, Udelar (Uruguay) and 26 lecturers with extensive experience were invited. Dr. Sebastián Sánchez of the University of Jaén (Spain), presented an expert conference on "Technological Innovations in the processes of elaboration of "virgin" olive oils" to open the congress. Next, Dr. Mónica Bauzá, Cuyo University (Argentina), spoke enthusiastically on "Olive culture in South America. A thrilling path: longstanding roots and evolution". After the opening conferences, system engineer Alexis Barbitta from the Universidad Católica (Uruguay) and system programmer Roberto Sierra from ORT University (Uruguay) spoke on an essential topic for Olive Oil Businesses: "Transformation of the olive oil sector. Challenges for its digitalisation and online commerce".

The other conferences were divided into four main topic areas and attendees were able to access any of them according to their interests. In Agronomics, lecturers from Uruguay referred to issues linked to the agro-climatic characteristics in Latin America, such as the physiological response of olives to biotic and abiotic stress, issues around fruit setting and the alternation in warm, wet and high variability year-on-year weathers. There were also presentations on olive diseases and the design and management of olive cultivars in the region.

In technology, Dr. Pablo Juliano of the Commonwealth Scientific and Industrial Research Organization (CSIRO) from Australia and food engineer Miguel Amarillo from Uruguay presented about the use of megasound and calcium carbonate in virgin olive oil extraction. Issues such as the use of aromatized substances to extend olive oil lifespan as well as olive oil oleogels as a novel innovation to reduce the use of saturated and trans fats in foods were also addressed.

In the Sensorial Quality area, experienced lecturers such as Dr. Luis Guerrero of the Instituto de Investigación y Tecnología Agroalimentarias (IRTA) from Spain referred to the importance of statistics in the data analysis of an oil tasting panel. Other lecturers spoke about essential issues such as whether a tasting panel is necessary to describe an olive oil, what exactly is sought in an olive oil competition and what information is required for obtaining olive oil blends.

In the Quality area, the analysis of volatile components was also addressed along with the detection of sophisticated frauds, the differential quality of Provincia de Mendoza (Argentina) olive oil and some new indicators of virgin olive oil quality: nitrate fatty acids.

Finally, lecturers from the region talked about how to take advantage of sub products (leaves and oil mill waste) and in reference to olive oil and health issues as well as the benefits of virgin olive oil in cosmetics.

More than 150 people, including producers, technicians, researchers, teachers, students and sommeliers attended this meeting. The excellent quality of lectures and the subsequent discussion among the participants allows us to confirm that this congress was an important milestone for the investigation and production of virgin olive oil in the region

The quality of the research currently underway in Latin America, which we were informed about through the conferences and through more than 30 research studies presented as an e-poster, showed that even though Latin American olive-growingis facing rapid changes at every turn, the region is prepared to tackle the growing global challenges of olive growing.

We hope that this First Latin American Olive Oil Congress is the start of a process that consolidates and disseminates research being carried out in the region. The second edition in Mendoza, Argentina is scheduled for the 2023, hopefully in an in-person format.

OLIVE OIL AS A SOURCE OF NITRO-FATTY ACIDS:

NOVEL ANTI-INFLAMMATORY, ANTIOXIDANT AND CYTOPROTECTIVE SIGNALING MOLECULES

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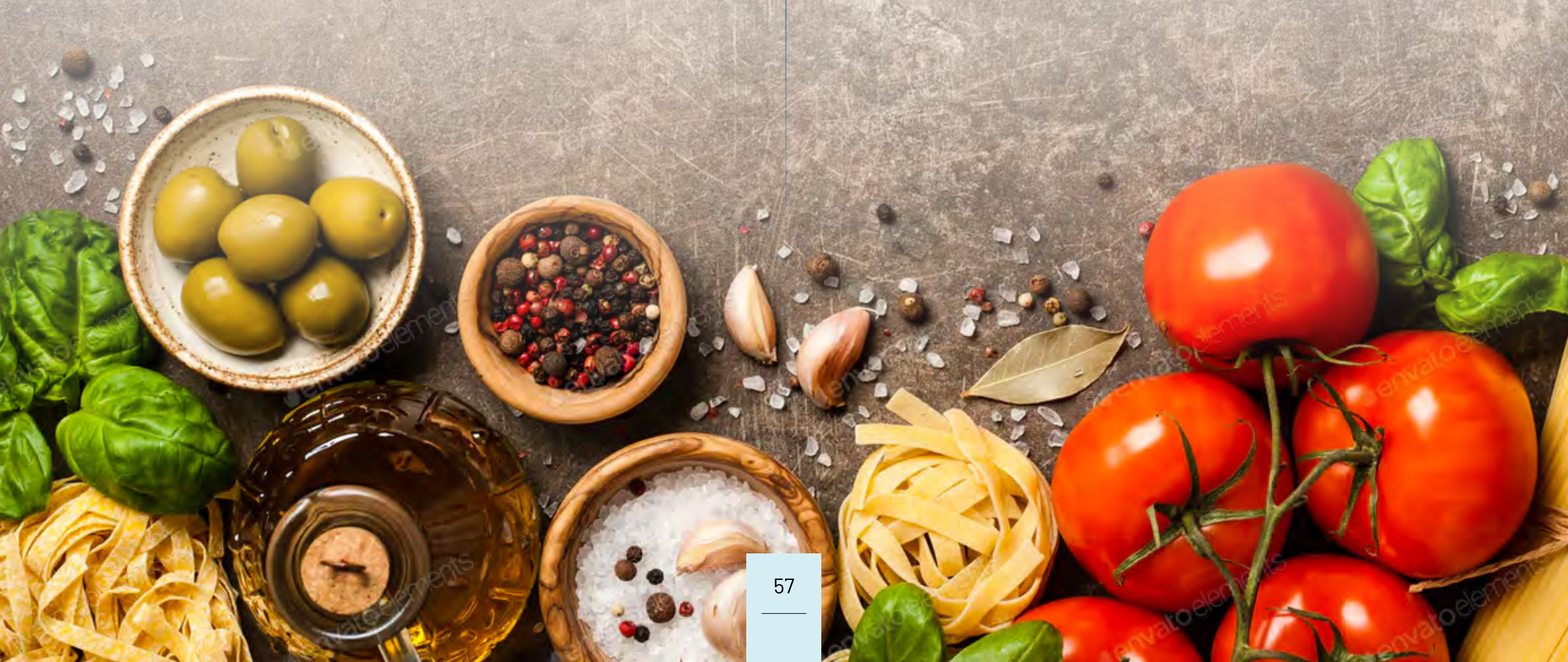
Olive oil is one of the main lipid sources of the Mediterranean diet and in recent years consumption has increased worldwide. In addition to providing nutrients, olive oil consumption produces a beneficial effect on health and helps reduce the risk of infectious, cardiovascular, liver, kidney and neurodegenerative diseases, among others. For this reason, it is considered as a functional food. In the last decade, our research group has worked on the determination, quantification and biological role of new minority componentsin olive oil: nitro-fatty acids (NFAs). They are derivatives of unsaturated fatty acids (nitroalkenes) and have powerful anti-inflammatory, antioxidant and cytoprotective properties.



These molecules have been detected by our laboratory both in the olives and in the extracted oil, the main ones being nitro-oleic acid (NO2-OA) and conjugated nitro-linoleic acid (NO2-cLA)[1].

In addition to their presence in olives and olive oil, there are physiological conditions that favour their formation at a gastric level. After the ingestion of olive oil, the unsaturated fatty acids that comprise it can nitrate as they pass through the gastric lumen. The stomach acts as a bioreactor favouring the necessary conditions for nitration reactions, such as acidic pH and the presence of nitrite from other foods (Figure 1). As a consequence, olive oilbecomes rich in NFAs, which enhances its bioavailability and increasesits ability to exercise protective functions at a plasma, tissue and cellular level. In this sense, we have shown that significant levels of NO2-OA are produced in gastric conditions, and this is one of the nitroalkenes of relevance in pre-clinical studies[2]. Based on these data, we propose to use NFAs as new olive oil quality indicators.

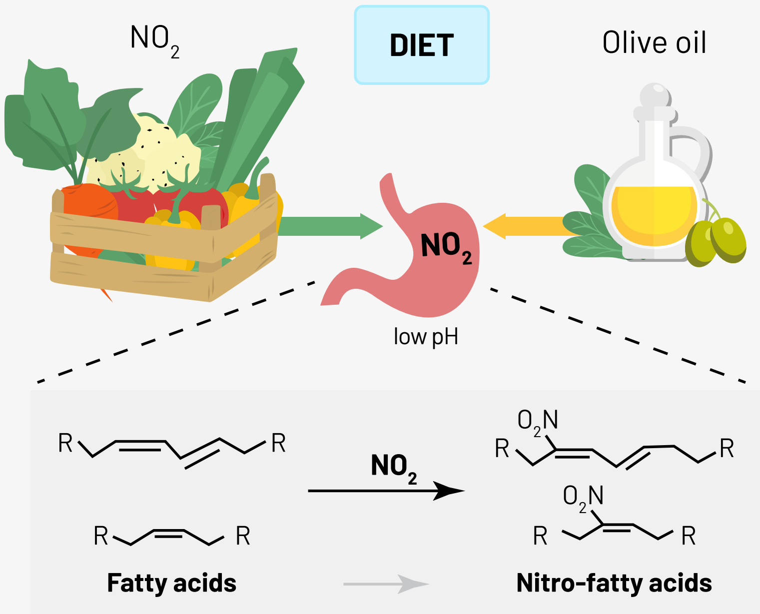


Figure 1. Nitro-fatty acids formation in gastric condition

1 https://doi.org/10.1371/journal.pone.0084884

2 https://doi.org/10.1016/j.tem.2019.04.009

Within the framework of a partnership project with the productive sector (Sectorial Fund for Agriculture, National Research and Innovation Agency, Uruguay) "Detection, quantification and biological properties of nitrated lipids present in olive oils from Uruguay", we determined the formation of NFAs in two contrasting varieties of commercial importance for the country, namely Arbequina and Coratina. A strong correlation between the formation of NFAs and the type of cultivar, as well as the stage of maturation reached was demonstrated, observing maximum levels of NFAs in the intermediate stage of olive maturation (i.e. when they start changing their colour). This information can be useful for making recommendations about which cultivars to use and at what stages of maturation the oil should be extracted in order to maximise the concentration of these compounds that are so beneficial to human health.

But what happens *in vivo*? Are NFAs generated and do they exert beneficial actions in the body? Based on the previous results, we proposed a new investigation on the formation capacity of these molecules in relation to olive oil consumption and their anti-inflammatory potential in an animal model of non-alcoholic fatty liver induced by the consumption of high-fat diets. This is a metabolic disease characterised by the accumulation of fat in the liver in the absence of alcohol consumption, and it represents the most common chronic liver disease in the Western world[3]. In our research, we demonstrated plasma formation of NO2-OA in mice on a high-fat diet supplemented with olive oil and nitrite. Concomitantly, a significant reduction in liver damage was achieved through the activation of antioxidant response enzymes. Body weight gain and liver steatosis, characteristic parameters of the disease,also decreased after supplementation with olive oil[4].

Lipid oxidation linked to the development of inflammatory diseases occurs due to an increase in the production of reactive oxygen and nitrogen species, affecting mitochondrial function and generating oxidative cell damage. In fact, hepatic mitochondrial dysfunction plays a critical role in inflammatory diseases[5]. Our work shows that olive oil supplementation is capable of improving cellular respiration in hepatic mitochondria, mainly due to the presence of NO2-OA. Based on these results, there appears to be a strong positive correlation between NO2-OA formation from olive oil intake and mitochondrial protection in liver diseases. Therefore, our research suggests that the physiological generation of these anti-inflammatory fatty acids helps to explain the reported benefits of olive oil consumption.

Finally, it should be considered that olive oil has other key bioactive components, such as polyphenols, which exhibit anti-inflammatory properties. We are currently studying how polyphenols play a role in modulating NFA formation and how all these components would be acting in synergy to exert antioxidant protection. It is important, in this regard, to generate information on this new nutritional characteristic of olive oils, where NFAs would represent novel markers of quality associated with the health benefits offered by this exceptional foodstuff.

3 https://doi.org/10.1111/j.1365-2036.2011.04724.x

4 https://doi.org/10.1016/j.jnutbio.2021.108646

5 https://doi.org/10.1002/hep.26226

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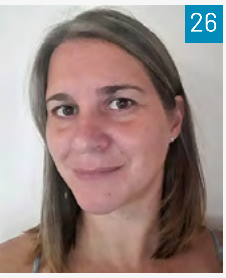

21 Paula Conde
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28 Homero Rubbo
29 Beatriz Sánchez
30 Jorge Pereira
31 Jimena Lázaro
32 Pamela Lombardo

33 Bárbara Ferronato
34 Iván Jachmanián
35 Miguel Amarillo

Uruguay is not a river,
it is a roaming blue sky.
A painter of clouds and pathswith
a flavour of roan honey.

Anibal Sampayo

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