OLIVÆ

ENGLISH EDITION

No. 113 • 2010

INTERNATIONAL OLIVE COUNCIL

CONSEIL OLEICOLE INTERNATIONAL • INTERNATIONAL OLIVE COUNCIL •
CONSIGLIO OLEICOLO INTERNAZIONALE
المجلس الدولي للزيتون
CONSEJO OLEICOLA INTERNACIONAL

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OLIVÆ NO 113 · 2010

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OLIVÆ
Official magazine of the International Olive Council
Published in five languages: Arabic, English, French, Italian and Spanish.

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ISSN: 0255-996X
Registration: M-18628-1984
Produced by Artegraf, S.A.

Geographical indications for olive products

Like its wine counterpart, the olive oil and table olive industry is characterised by a wide range of original products some of which have earned a reputation based on the area or *terroir* where they are produced and their intrinsic qualities. As such, they can be considered geographical indications.

From the legal standpoint, geographical indications belong to the realm of intellectual property law. According to the TRIPS Agreement of the World Trade Organisation, they identify a good as originating in a geographical region or area where a given quality, characteristic or reputation is attributable to its geographical origin. They are protected by international treaties and domestic legislation under a vast range of concepts.

With market globalisation, consumers are becoming more and more curious about the provenance of the products they buy. This attitude is generating fast growing demand for traditional regional or local products, and olive oil and table olives are no exception to this trend.

But the IOC realised that no comprehensive review had ever been undertaken of the legal instruments employed around the world to protect olive oils and table olives, nor did any comparative analysis exist of the specifications for the different geographical indications.

And so it decided to undertake such a study. A steering committee met in October 2009 to determine the specifications of this project. A further meeting followed in February 2010 with Insight Consulting, the Brussels-based firm of consultants selected to carry out the study, in order to fine-tune the framework and identify potential assistance from the member organisations of the IOC Advisory Committee and IOC delegations.

This legal and technical review is now underway and its preliminary findings were presented at the extraordinary session of the Council of Members in June of this year. Besides exploring legal aspects and providing a comparative technical review of GI specifications, the final results – to be presented and discussed at an international seminar in autumn 2010 – will address the state of play in the ongoing international negotiations in this field and will provide a list of potential seekers of new geographical indications.

Mohammed Ouhmad Sbitri

Executive Director

The IOC seen through its International Agreements

Last year was a landmark for the International Olive Council, coinciding with the 50th anniversary of its creation, and represented a key date in its existence.

The life of the IOC is closely tied up with the International Agreement it administers. The first multilateral agreement for olive oil dates back to 1955. Concluded under the auspices of the United Nations, it was made possible by broad concerted efforts and laid the foundations of permanent international cooperation.

On being adopted in 1955 after negotiations involving the participation of the International Olive Growing Federation (FIO), the Food and Agriculture Organisation of the United Nations (FAO) and the United Nations Economic and Social Council, the first agreement was open for signature by countries until 1956. Notably it incorporated the general commodity principles embodied in chapter VI of the Havana Charter.

Another three agreements were to follow in its wake in 1963, 1979 and 1986, each of which was renewed or renegotiated or both, until the current agreement was drafted. Officially known as the International Agreement on Olive Oil and Table Olives, 2005, it will remain in force until 2014.

The agreement is the backbone of the Council, its constitutional charter setting out its structure and mandate. The various versions have mirrored the most significant stages in the Council's development, for instance the agreement signed in 1986 – the International Agreement on Olive Oil and Table Olives, 1986 – was the first to expressly mention table olives in its title, thus signalling a more central role for table olives in the world arena.

The inclusion of table olives under the scope of the agreement was an important step. Amongst other things, it meant that promotion, one of the cornerstones of IOC activity together with international technical cooperation and the standardisation of international trade, featured initiatives for table olive production, trade and processing, so pushing out the frontiers of promotion markets.

From their beginnings, the objectives of the agreements were:

- To achieve regular international trading
- To promote the products of the olive and to broadcast their beneficial properties in order to consolidate traditional consumption markets and to identify new potential outlets
- To champion quality in olive oil and to stimulate the transfer of technology
- To encourage international cooperation to strengthen the position of olive products

But it was the 2005 Agreement that was to herald noteworthy innovative features in product promotion and international trade that marked a significant step forward in the thinking behind IOC action, now aimed at:

- promoting any activities conducive to the harmonious and sustainable expansion of the world products economy in the fields of production, consumption and international trade by every means in the IOC's power, given the ways in which these fields are interrelated; and
- maintaining and amplifying the IOC's role as a meeting point for all the stakeholders in the sector and as a world documentation and information centre on the olive tree and its products.

These two key concepts are very important to the IOC.

In the first instance, by positioning promotion and international trade in a context of **sustainable development**, the agreement echoes an issue of major concern. It requires the IOC to be committed to achieving sustainable expansion all along the commodity chain, amongst other things by streamlining olive and olive oil technology to make it environmentally friendly, so contributing to the welfare and recovery of the environment.

In the second instance, by positioning the IOC as a **meeting point and a world documentation and information centre on the olive tree and its products**, the agreement requires the IOC to be an exhaustive reference source for the member countries and the world in general in the spheres of promotion and information. Its remit is to provide up-to-the-minute documentation and information on each and every branch and stage of the sector, from the time the product is grown in the field until it reaches consumer tables, and on the nutritional properties of the products of the olive.

For this to materialise, it will be necessary to give fresh impetus to scientific research, the mainspring of information activities, and to rethink the concept of IOC documents and publications.

Executive Secretariat meets with Director-General for Agriculture of European Comission

In February of this year the IOC Executive Director travelled to Brussels to meet with the EU Director-General for Agriculture and Rural Development as part of the working relations between the International Olive Council and the European Commission.

The object of the meeting was to discuss issues of joint interest to the two institutions.

The Director-General returned the visit by travelling to the IOC headquarters in March 2010 for a meeting arranged by the Executive Secretariat with the Chairman of the IOC and the ambassadors of the IOC member countries.

The IOC Executive Director and the EU Director-General for Agriculture and Rural Development

Turkey joins the IOC

The Spanish Ministry of Foreign Affairs and Cooperation – the depositary of the Agreement – has notified that the Government of Turkey filed its instrument of accession to the 2005 International Agreement on Olive Oil and Table Olives on 21 February 2010. Turkey thus joined the Agreement on that date.

On behalf of all its Members, the International Olive Council welcomes back Turkey to the membership of the Organisation, which it belonged to under preceding Agreements.

This latest accession brings the membership of the Organisation to 18: Albania, Algeria, Argentina, Croatia, Egypt, Iraq, Israel, Iran, Jordan, Lebanon, Libya, Morocco, Montenegro, Serbia, Syria, Tunisia, Turkey and the European Union (with its 27 Member States).

IOC Executive Director on official mission to India

India was the destination of a mission undertaken by the Executive Director in late November/early December of last year connected with the IOC's generic promotion of olive oil and table olives in non-member countries.

The purpose of the trip was to attend a selection of scheduled promotional events and to interact with local media professionals and members of the scientific community to assess the impact of the IOC's promotional messages. The Executive Director met two journalists from the leading Indian dailies *Hindustan Times* and *Anandabazar Patrika* and reputed cardiologist Dr Soumitra Kumar, known for his talks on the nutritional benefits of olive oil.

During his visit, the Executive Director opened a ***Road Show and Workshop for Women*** in Kolkata by explaining what the IOC is and does, and what it seeks by promoting olive oil and table olives. Dr Kumar participated in this event to speak about a number of ever more frequent health problems in India associated with the spread of certain eating habits and the consumption of certain products. His suggestions for combating these problems included consuming more olive oil as a preventive measure.

The next stop was New Delhi where the Executive Director visited the IOC stand at the IFE trade fair where he had the chance to chat to many of the visitors to the stand who were interested in olive products and in the documentation on display. Highlights of IOC presence also included tastings of traditional Indian dishes made with olive oil, led by a guest chef over three days.

The Director also networked with food service operators and journalists who received copies of ***Best of India – Cooking with Olive oil***, the cookery book published by the IOC during its 2007 promotion and awareness campaign in India. Penned by internationally acclaimed chef and olive oil enthusiast Sanjeev Kapoor, this recipe book reinvents typical Indian cuisine, giving it a contemporary twist by replacing the traditional local fats with olive oil.

IOC Executive Director visits Barcelona for 8th International Congress on the Mediterranean Diet

Since 1996, the International Congress on the Mediterranean Diet has been held every two years to create added awareness of the health benefits of the Mediterranean Diet in which olive oil is a centrepiece. This year marked the 8th edition of the congress, held in Barcelona in March.

Fulfilling the IOC's institutional remit of supporting the olive sector, the IOC Executive Director participated in the congress. The event programme included a full section dedicated to olive oil with papers by renowned academics and institutional representatives who broached olive oil from a historical, cultural and medical angle.

Participation gave the Executive Director a very worthwhile chance to tell participants more about the mission and tasks of the IOC.

Also, as part of IOC efforts to support scientific outreach events held by member countries in line with the objectives of the International Olive Oil and Table Olive Agreement, the Executive Director signed an agreement with the Vice President of the Mediterranean Diet Foundation to make a financial contribution to the congress.

Two highlights of the Executive Director's visit to Barcelona

Right lo left: IOC Executive Director Mohammed Ouhmad Sbitri and Francisco Serrat, Vice Chairman of the Mediterranean Diet Foundation, greet each other

IOC and Mediterranean Diet Foundation sign agreement for the award of a grant for the 8th International Congress on the Mediterranean Diet

International seminar on olive growing and the environment: conclusions

18 November 2009

Topics ranging from soil erosion to rational water use, from carbon storage to the impact of climate change, were addressed in the seventeen papers presented at this seminar, aimed at flagging up the importance of joining forces to propose environmental conservation measures at the same time as higher yields and higher quality are achieved in olive growing, a crop of such great significance in the Mediterranean region.

In his welcome address the Executive Director of the International Olive Council stressed that producing countries needed to adopt measures to design a model of olive production that made careful use of natural resources and protected ecosystems while affording better socio–economic prospects. The achievement of this goal called for interaction between fund providers to carry out joint, interdisciplinary projects.

The seminar was arranged around four working sessions opening with a keynote presentation on environmental ethics by Professor Eugenio Domínguez Vilches from the University of Córdoba. In his address, Professor Domínguez underscored the ethical need to combine human-scale development with respect for the environment and where olive growing is an important example of a sustainable economy. Olive growing should not be approached solely in terms of economism but also in terms of its cultural, social and historical aspects which lend it a part in the heritage of the Mediterranean countries where it is so important.

Soil conservation and desertification control strategies were discussed in the first session. The implementation of a sustainable management model was proposed to protect and conserve soil organic matter in order to prevent the trend towards desertification. This entails synchronising plant nutrient demand and nutrient availability in the soil by tapping the resources directly generated by olive growing and using non-eco-pollutant fertilisers. Soil erosion in olive orchards was reported to depend on the environmental conditions and terrain, the extent to which traditional orchards are abandoned or intensified, and the removal of ground cover. Recommended measures to reduce soil erosion include avoiding the use of steep slopes and increasing ground cover.

The second session explored the topic of the water cycle, with the spotlight on the role of irrigation in olive growing. The papers first presented the olive as a crop that requires less water than other crops and which is capable of using it more efficiently; as a result, it has an insignificant impact on soil erosion and drainage provided it is irrigated properly. The olive is also considered quite resistant to salinity. Consequently, it can be exposed to saline water provided irrigation is performed properly, except in areas where water is scarce. On the other hand, the alkalinisation of water by sodium salts and organic matter can lead to a potential risk of physical blockage of water and potential soil deteroration or erosion, and may even cause soil water repellance in drought conditions. Various technologies enabling higher olive yields in arid and semi-arid environments were presented during this session.

The IOC is carrying out a project focused on rational irrigation management. Known as IRRIGAOLIVO, the project is underway in Syria and Morocco with funding from the Common Fund for Commodities. Owing to the importance of optimising the use of water resources, a proposal was tabled at the seminar to extend this project in the future to other IOC member countries where water is a scarce resource and rational water management is a priority.

The third session focused on the vital role played by olive orchards in the landscape of the Mediterranean countries, which has been fashioned by the climate and influenced by historical developments. Conservation of natural areas and cultural heritage was recommended by attempting to create a mosaic landscape of patches of different agricultural and semi-natural systems featuring biological and landscape diversity. The olive tree should be considered a valuable crop because, when it stops giving adequate yields, it gradually runs wild and becomes an integral part of the Mediterranean landscape. Traditional olive orchards are a cultural heritage that attracts tourism and socio-economic interest.

Olive groves are a modified, diverse ecosystem that makes a special contribution to the biodiversity of southern Europe. They constitute a habitat characterised by the combination of semi-natural elements, such as old trees, flora, invertebrates, small mammals, reptiles and birds, and they offer refuges for specific flora and fauna, thus making for greater biological diversity of the ecosystem.

However, some recent practices are impacting heavily on the biodiversity of these ecosystems. In fact, intensive farming models, particularly super-intensive models, reduce diversity although they generate more economic value. Over time this has transformed a natural ecosystem into a clearly artificial ecosystem featured not only by a loss of biodiversity but also by a heightened risk of wildfires and increased demand for water.

One of the priorities of the European Union is crops with a high natural value (HNV) to protect biodiversity. The European Environmental Agency (EEA) distinguishes between two types of HNV crops, one of which is low-intensity crop systems in a mosaic, with a high presence of semi-natural elements. This is also one of the priorities of the European Biodiversity Strategy. The chief objective should be to identify, maintain and monitor HNV crops. The concrete case of LIFE + CENT.OLI.MED, a project funded under the LIFE Environment programme, was presented as a practical example. This project concerns the identification and conservation of traditional, ancient olive groves in Apulia where a study of the flora and fauna has been undertaken to determine the degree of biodiversity.

Synergy was proposed between projects financed under the LIFE programme and projects financed by the Common Fund for Commodities to allow all the IOC member countries to participate in the different activities connected with olive growing and the environment.

The last session was devoted to the potential impact of climate change on olive growing. Firstly, findings were presented on the floral phenology of the olive and of other plants of floral or forestry interest, using the air pollen index as a tool for this purpose. Studies based on historical databases reveal a direct influence of temperature increases on earlier flowering in some woody species, including olive. Such earlier flowering can have implications. It may lead to situations where the reproductive organs are at greater risk from the sharp potential drops in temperature that may occur in late winter. Earlier flowering may also lead to lower fruit production while later flowering is related with higher crop production. However, these trends are not observed in herbaceous plants which demonstrate a more direct response to water availability than to temperature. As regards other indirect impacts of climate change related to migration processes, a variation in the spatial distribution of the olive could be observed in the future as well as an expansion of world olive cultivation. A pilot pollen monitoring project conducted in Tunisia under IOC supervision and with funding from the Common Fund for Commodities has produced very interesting results, prompting proposals for its implementation in other member countries in the near future.

Lastly, the seminar focused on the importance of olive growing in fixing atmospheric CO_2. This is a further function of olive groves, which does not detract from their other important functions of fruit production, prevention of soil erosion and soil drainage. According to the figures supplied, a 10% increase in world biomass could fix up to 23% of annual atmospheric CO_2 and each year a 1% increase in world humus could capture the CO_2 released in approximately seven years. This makes it essential to implement a sustainable, more eco-friendly agricultural model.

An overview of IOC promotional campaigns (1959–2010)

For more than twenty years the International Olive Council has been conducting institutional promotion in what are known as “third countries” in official jargon (i.e. outside Europe). Admittedly, there was a halt between 2002 and 2006, but action got off the ground again in 2007 on IOC funding. This promotion has reaped very positive, and in some cases amazing, results.

This success is borne out by the conclusions of campaign evaluation surveys which have analysed the impact of IOC activities on exports and on the consumption of olive oil and table olives in third countries in recent decades.

BACKGROUND

Promotion and education have always been a highlight of IOC activities owing to their international perspective and to their effects at world level in spreading the word about the nutritional features and gastronomic characteristics of olive oil and table olives.

Under the 2005 International Agreement on Olive Oil and Table Olives, the Promotion Division of the IOC Executive Secretariat is responsible for increasing product awareness and knowledgeability. To do so, it is assigned several tasks. It has to:

- support generic international promotion of olive oil and lend assistance for national campaigns
- draw up and implement promotional and educational initiatives on olive oil and table olives in line with the relevant provisions of the Agreement
- disseminate the findings of scientific research into the nutritional properties of olive oil and table olives
- elaborate or commission/coordinate market research on potential target markets for promotion campaigns and evaluations of completed campaigns
- coordinate the drafting, update and production of documentation on IOC activities and produce publications on all aspects of the olive tree, olive oil and table olives (both one-off publications and regular publications like this magazine)
- set up a world documentation and reference centre for the member countries as well as for anyone interested in learning about every step along the olive growing, olive oil production and table olive processing chain

HISTORICAL OVERVIEW

Ever since it first began, IOC promotion has been hinged on making people more aware of the **healthy properties and gastronomic characteristics** of olive oil, which is an integral part of Mediterranean eating patterns.

The fact that IOC promotion is institutional, and therefore has no private or geographical axes to grind, is a guarantee that the information released is correct and balanced and does not give prominence to any type or category of olive oil over another. The longstanding aim of IOC campaigns is to educate consumers about the characteristics of all the grades of product, from extra virgin olive oil to olive-pomace oil. The idea is to supply potential consumers with all the information they need to distinguish between the different grades and to be familiar with their nutritional attributes and uses in the kitchen so that they can plan their shopping basket.

This action fits in with a broader approach of incorporating olive oil into other cuisines by presenting it as a key ingredient of the Mediterranean diet that provides a healthy alternative to other local animal and/or vegetable fats and oils.

The IOC has gone to great lengths to make olive oil an “exportable”, “flexible” food that can be adapted to and worked into other cuisines. The objective is not to impose a foreign element on local cuisines but to offer an option that is worthwhile and healthy.

A few figures will help to illustrate the impact of this approach. In 1991 the IOC embarked on promotion campaigns in Japan, a country where very little was known about olive oil, which was used almost exclusively for beauty purposes. In the 1995/96 crop year Japan imported 16,535.1 tonnes of olive oil from the European Union; by 2000/01, when the IOC campaigns were at their height, imports from the EU had climbed to 29,567.4 tonnes.

Taking another country, the United States imported 99,788 tonnes from the EU in 1995/96; by 2000/01 the figure was 194,218.9 tonnes.

More recently, market research has come up with interesting findings on Russia and China where the IOC will be launching two promotion campaigns in the second half of this year.

IOC PROMOTION THROUGH THE WRITTEN WORD

The IOC brings out three fundamental types of publications; general, economic (on subjects like market research, consumer attitudes and campaign impact) and technical/scientific. In their own different way they are all a backup for promotional activities because they relay information about all the aspects and characteristics of the olive tree and its produce.

Some publications have been brought out for specific promotion events, for instance the cookery book *Best of India: Cooking with Olive Oil* written by chef Sanjeev Kapoor for the launch of the IOC promotion campaign in India, or *Mediterranean Olive Oil in the Cuisines of the World,* the end result of a contest sponsored by the IOC to chose the best international dish made with olive oil.

Scientific booklets like *Frying Food with Olive Oil, Olive Oil Health Notes or Olive Oil and Health* – available in print format and shortly online – report the findings of scientific research on the health and nutritional properties of olive oil and its specific advantages when used for frying at high temperatures.

Frying is in fact a topic of key interest in olive oil promotion in Asian countries where it is a firmly established culinary technique and where olive oil is a significant alternative offering a health bonus compared with other local fats and oils.

Olive oil, extra virgin olive oil particularly, is the best of all the vegetable fats or oils for frying because even when used at high temperatures the food retains its properties intact. The scientific evidence is there to prove it.

The Executive Secretariat realises that information plays a centre part in promotion campaigns. In 2010, it therefore intends to call for tenders to reprint several of its publications – *The Olive Tree, Olives, Olive Oil; Olive and Health* and *Frying with Olive Oil* – in English, French, Italian and Spanish and to release them online at the IOC website.

MARKET RESEARCH

Market research is always carried out in advance of promotional activities to explore whether they would be worthwhile. Similarly, when campaigns are over, evaluations are carried out to check the impact on consumers and consumption habits.

The Executive Secretariat has a wide selection of market research and evaluation studies on all the countries where the IOC promotion campaigns have been implemented or potentially considered, for instance Australia, Canada, China, Japan, India, Mexico, Russia and the United States.

Following in the footsteps of the market research recently published on the Chinese and Russian markets, a call for tenders was issued in May 2010 for the performance of market research in Brazil.

REGULAR PUBLICATIONS

OLIVAE is the single official magazine of the IOC. Published twice yearly in five languages (Arabic, English, French, Italian and Spanish), till now it has been circulated via subscription or on an exchange basis with other institutions.

The magazine is a tool for releasing information to and on the international olive sector. The representatives of the member countries recently approved a battery of editorial innovations for 2010 to keep up with the latest technological advances. It has been decided to consolidate and strengthen the role of the IOC as a forum for business operators and a world documentation and information centre, so putting into practice the provisions of the International Agreement. How is this to be done?

- By amplifying the communications role of the magazine, turning it into an e-publication available on the IOC website free of charge
- By printing a limited number of copies in the language editions concerned for readers whose subscription has not yet expired
- By running off 50 print copies each in English and French for member countries and interested institutions

So, as of this year, no further paid subscriptions will be processed. The Executive Secretariat will deliver all the issues under subscription until it finalises its commitments. From issue No 113 onwards, readers will be able to find the five language editions of *OLIVAE* (Arabic, English, French, Italian and Spanish) on the IOC website at www.internationaloliveoil.org.

IOC organises media tour of Tunisia's olive growing regions

As part of its promotional programme for 2009 the IOC organised an educational trip to Tunisia for a group of twelve specialised journalists from Canada, China, Russia, Serbia and India.

The tour, held in December 2009, aimed to give participants the chance to learn about olive products by visiting one of the major olive producing regions of the world and to gain first-hand experience of olive growing and its cultural, gastronomic and health aspects.

Accompanied by the Head of the IOC Promotion Campaigns Department, the group visited the main producing regions of Tunisia. The programme was organised in conjunction with the National Oil Board (ONH) and the Tunisian authorities and included visits to modern and traditional olive farms, olive oil mills and bottling facilities where they saw all the stages of production, from the harvesting and delivery of the fruit to the mill to the extraction and storage of the olive oil. The journalists savoured genuine, traditional cuisine showcasing Tunisia's top-quality extra virgin olive oil and table olives and met with olive experts and chefs, besides visiting archaeological sites and cultural events and hearing about the history and cultural and artistic expansion of olive growing, all of which gave an added dimension to the technical core of the trip.

The main tour events and visits were:

- Welcome meeting at the Sheraton Hotel organised by the ONH, including an introduction to the olive tree in Tunisia by a Tunisian expert and an overview of the olive oil industry in Tunisia by the Chairman and Managing Director of the ONH
- Field tour to experience the olive harvest and visit olive groves
- Visit to an ONH olive nursery
- Tour of the Ben Yedder olive oil mill
- Visit to the Châal and Enfidia agricultural complex where the journalists met with technical staff to talk about agricultural practices, research and development, product characteristics and quality, tastings,…
- Visit to the Olivebioteq seminar in Sfax where the group toured the exhibition, networked with experts and met the Director of the Sfax Olive Tree Institute to discuss issues including promotion and the outlook for the olive sector
- Visit to the Kalâa Kébira Festival (tourist day) featuring folklore events and tastings
- Fact-finding meeting about social issues, tourism and other subjects with the Tunisian External Communications Agency in Tunis, which was attended by the Agency Director and the Technical Director of the ONH

The tour was an excellent opportunity for IOC representatives to tell the journalists about the mission and activities of the IOC in general and to give them a wide spectrum of technical information about varieties, the grades and chemical and organoleptic characteristics of olive oil, agricultural practices, production, storage, organic farming, protected designations of origin, quality factors, international standards for table olives and olive oil, the IOC method for organoleptic assessment and so forth.

They were told about the significance the sector holds for all the IOC member countries and the importance of IOC generic promotion, which aims to raise awareness of olive products by releasing sound information about their sensory and gastronomic properties and scientifically documented nutritional and health-promoting effects.

The unique taste, premium quality, quality differentiation and health benefits of olive products were the general messages transmitted throughout the tour.

For all the journalists, this was their first visit to Tunisia, where they enjoyed its renowned hospitality, and for some their first chance to visit an olive producing country. Once back home, the mine of information they obtained and their impressions and experiences provided inspiration for numerous articles, thus sealing the success of the tour.

Team of journalists is welcomed by the Kalâa Kebira Festival Committee

Left-right: The Head of the IOC Promotion Campaign Department with the guest journalists at a press conference given by Tunisia's External Communications Agency

Tour of an archaeological site

First call for applications for grants for 2010

The scheduled promotional activities approved by the IOC for 2010 include the issue of grants to finance promotional and scientific programmes aimed at promoting consumption of olive oil and table olives.

The grants will be awarded for events or activities to be implemented in 2010 and will be open to EU and non-EU Members of the IOC.

The objective of the grants is to build up a market culture in the member countries by highlighting the quality of local products and encouraging cooperation amongst all the IOC member countries.

Proposed action and events should be of clear-cut promotional worth and in line with the objectives of the International Agreement on Olive Oil and Table Olives. Such action will take the form of educational and information campaigns showcasing the organoleptic and chemical characteristics and nutritional, therapeutic and other properties of olive products and dealing with international market conditions and trends.

The programmes put forward should include the following types of activities:

- Organisation of seminars, trade fairs, symposiums and workshops
- Information points at food and nutrition fairs
- Promotional material (brochures, CDs, books, etc)
- Invitations for the participation of international specialists
- Scientific events notably on subjects of major interest such as:
  - – Nutritional and health-related properties of olive oil and table olives
  - – Lipid technology and science
  - – Cardiovascular diseases
  - – Antioxidants

The rules for the award of grants are posted in English and French on the IOC website at:

www.internationaoliveoil.org /Web service/Tender
www.internationaoliveoil.org / Areas of activity/Promotion

Promotion activities for 2010–2011

The Beijing-based firm Hill & Knowlton Public Relations Co Ltd. will be responsible for implementing a calendar of IOC promotional activities in China, which got off the ground on 6 May 2010 with a press conference at the Park Hyatt Hotel in Beijing.

Speaking at this launch event was the IOC Deputy Director in charge of the Promotion Division who told the media about what the IOC does and what it aims to achieve through promotion and gave an overview of the world olive oil market now and in the future.

The IOC's debut in China continued with the participation of the Executive Secretariat in the 4th International Healthy and Nutritious Edible Oil Industry Exhibition and a media gathering in Shanghai on 11 May 2010.

Planned campaign activities include a Chinese-language website and newsletter, trips for local journalists to IOC producing member countries, promotion via TV programmes, the publication of cookery books featuring recipes made with olive oil authored by two leading Chinese chefs, tasting seminars led by specialists, and a host of other events.

The contract for carrying out IOC promotion in Russia has gone to the Moscow-based agency Market Group and Marketing Communications ZAO MarCom. Promotional activities will kick off in June and will feature a packed time table of events which readers will hear about soon.

Turning its eyes to Brazil, the Executive Secretariat has published an international call inviting tenders to undertake market research on olive oil and table olive consumption in this country.

The objective of this study is to determine the existing situation and to provide input for a three-year promotional plan in Brazil by identifying the most suitable promotional messages.

Comparative review of the stability of olive oil produced from the Picholine marocaine and Arbequina varieties

W. Terouzi, Z. Ait Yacine & A. Oussama

INTRODUCTION

Consumption of olive oil is destined to increase dramatically, particularly owing to the positive image associated with the monounsaturated fatty acids and natural antioxidants it contains (Food Authenticity, FAIM, 1998).

Olive oil is characterised by its high resistance to oxidation, which is due to its high content of unsaturated fatty acids (72% monoinsaturates and 14% polyinsaturates) (Harwood J. *et al*., 2000), both free and esterified as triacylglycerols. These fatty acids have one or more reactive sites, which are the double bonds.

Light or temperature-induced fatty acid oxidation leads to organoleptic deterioration of the acid-containing matrix and to the emergence of a characteristic "rancid" flavour which alters the organoleptic quality of the product and directly influences its shelf life (Judde, 2004).

Light and temperature are the oxidation parameters of olive oil. The aim of this study was to monitor the effect of specific storage conditions - darkness, exposure to full daylight and exposure to ultraviolet (UV) lamplight - on the stability of the physico-chemical properties of olive oils obtained from two varieties: Arbequina and Picholine marocaine.

MATERIALS AND METHODS

For this study we used olive oil obtained from olives belonging to the Picholine marocaine (P) and Arbequina (A) varieties harvested during the 2008/2009 crop year at Ouled Ziane in Casablanca.

The quality parameters studied in line with the IOC standard were: the acid value (AV), the peroxide value (PV) and the specific extinction at K_{232} and K_{270}.

We proceeded as follows to study the influence of each set of storage conditions on the stability of the characteristics of the olive oils under review:

- One sample lot was kept in an enclosed space away from light and at ambient temperature.
- A second sample lot was left in direct sunlight.
- A third sample lot was exposed to light from a UV lamp (254 nm) placed at a distance of 15 cm.

The analyses were performed at 15-day intervals after exposure to sunlight or dark storage, and after every 30 minutes of exposure to UV light.

The UV specific extinction coefficients at 232 nm (K_{232}), 270 nm (K_{270}) and ΔK were determined with the aid of a Jenway 6715UV/Vis spectrophotometer.

RESULTS AND DISCUSSION

Tables 1, 2 and 3 summarise the test results obtained in the three sets of storage conditions. The oils studied (A and P) were classified as extra virgin olive oils on the basis of the assessment of their initial quality criteria (COI/T.15/NC No 3/Rev. 4).

Determination of the initial characteristics of the olive oils revealed that the Arbequina oil had low acid values, peroxide values and extinction coefficients at

K_{232}/ K_{270} compared with the Picholine marocaine oil (approximately three months after production).

TABLE 1
Changes in olive oil parameters according to duration of dark storage

Samples	t (days)	AV (%)	PV (meq O_2.kg-1)	K232	K270	K
A	0	0.705	5.00	0.0845	0.0110	< 0
	15	0.705	6.25	0.1020	0.0434	< 0
	30	0.705	6.25	0.1650	0.0384	< 0
	45	0.846	10.00	0.2650	0.0820	< 0
	60	0.846	11.25	0.2860	0.0980	< 0
P	0	0.846	6.25	0.103	0.054	0.001
	15	0.846	7.50	0.102	0.0459	< 0
	30	0.846	7.50	0.104	0.0742	< 0
	45	0.846	8.75	0.111	0.0980	< 0
	60	0.846	8.75	0.116	0.1020	< 0

TABLE 2
Changes in olive oil parameters according to duration of exposure to sunlight

Samples	t (days)	AV (%)	PV (meq O_2.kg-1)	K232	K270	K
A	0	0.7050	10.00	0.028	0.0306	< 0
	15	1.0575	10.00	0.066	-	-
	30	1.1280	11.25	0.052	0.0460	0.0045
	45	1.1985	10.00	0.409	0.0620	0.0055
	60	1.2690	10.00	0.420	0.0760	0.0035
P	0	0.7290	7.08	0.068	0.0750	0.002
	15	0.7990	7.70	0.149	-	-
	30	0.8460	10.00	0.180	0.0410	0.0035
	45	0.9870	10.83	0.322	0.0529	0.0025
	60	1.0575	11.25	0.360	0.0746	0.0025

TABLE 3
Changes in olive oil parameters according to duration of exposure to UV light

Samples	t (days)	AV (%)	PV (meq O_2.kg-1)	K232	K270	K
A	0	0.6815	5.00	0.0383	0.0746	0.001
	30	0.9165	9.58	0.0990	0.1321	0.007
	60	0.9870	10.00	0.0976	0.0311	< 0
	90	1.0810	11.25	0.0450	0.0462	0.006
	120	1.1505	11.87	0.4278	0.1660	0
	150	1.2690	8.75	0.4270	0.1531	< 0
P	0	0.7290	8.12	0.0540	0.0880	0.002
	30	0.9870	10.00	0.0675	0.1296	0.006
	60	1.0100	11.25	0.0930	0.0415	< 0
	90	1.1045	10.00	0.0248	0.0443	< 0
	120	1.1985	10.83	0.4460	0.1793	0
	150	1.2690	7.92	0.4280	0.1908	< 0

After storage for two months (darkness, sunlight and UV light), the oils exposed to sunlight had a much higher content of free fatty acids than the oils kept in dark storage, thus pointing to the effect of sunlight on triacylglycerol hydrolysis. Content increased specifically by 0.56% in oil (A) and 0.33% in oil (P).

The oils exposed to UV light had a higher free fatty acid content than the oils exposed to sunlight. The increases recorded were 0.59% in oil (A) and 0.54% in oil (P).

Increases were likewise observed in the other quality criteria (peroxide value, K_{232} and K_{270}) during exposure to sunlight and to UV light.

Figures 1, 2 and 3 plot the results obtained and show the correlations between the different quality parameters according to storage time.

The acid value, expressed as a percentage of oleic acid, is a quality factor (IOC -2009) that indicates olive oil deterioration due to hydrolysis.

Figure 1 shows that the changes in free acidity are linear and of varying degrees of significance, depending on the duration and conditions of storage. Specifically:

- In darkness, the acid value remained constant in oil (P) whereas it rose slowly although not significantly (ρ = 0.0423) in oil (A).
- During exposure to sunlight, the acid value varied in a linear movement to a slightly significant extent according to exposure time, especially in oil (A) [ρ = 0.1269], while ρ = 0.0845 for oil (P).
- During exposure to UV light, the acid value again varied in a linear movement to a slightly significant extent according to exposure time, especially in oil (A) [ρ = 0.1067], while ρ = 0.098 for oil (P).

The peroxide value is an important quality parameter in edible oils (IOC, 2009). The results obtained after analysing the oils under review are reported in Figure 2.

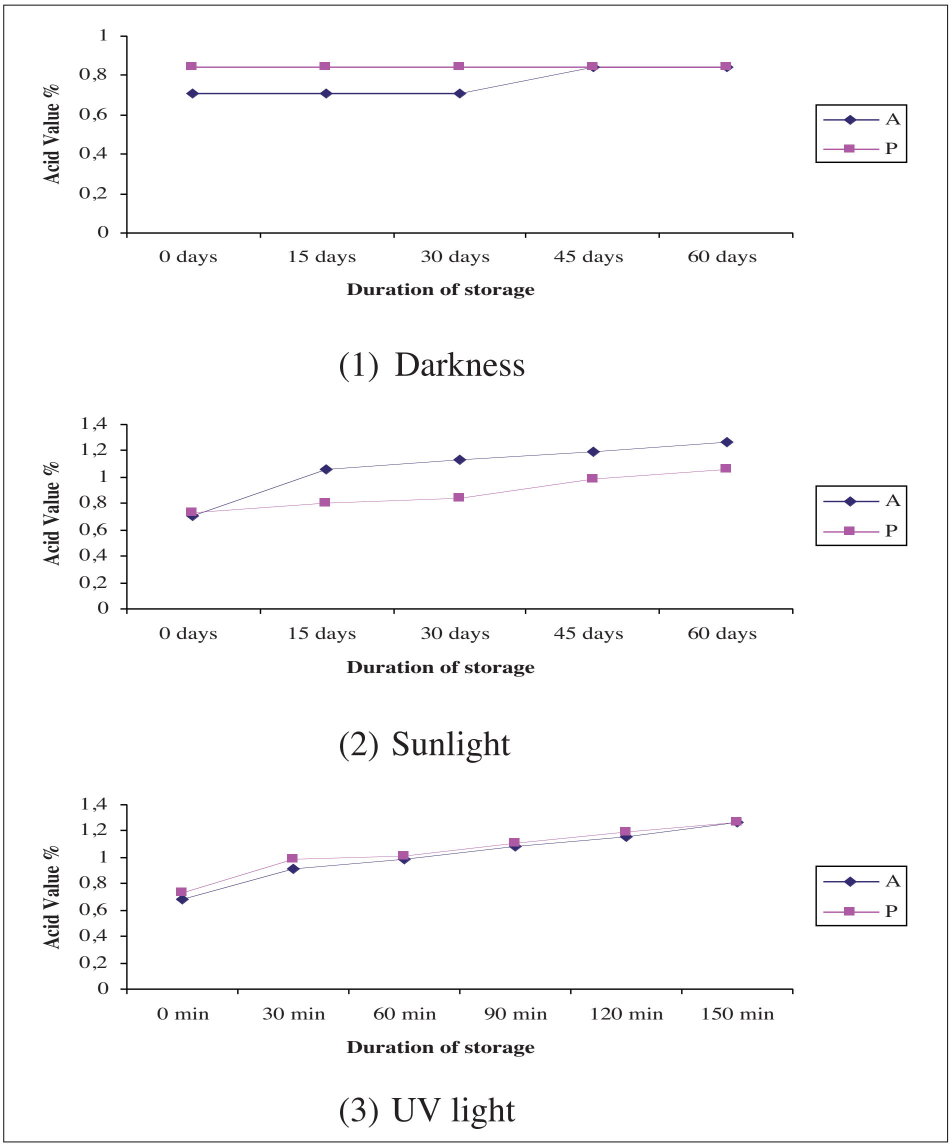


Figure 1: Effect of the different storage conditions on the acid value of olive oil

Scrutiny of the changes noted in the peroxide value during storage reveals the following:

- In darkness, the peroxide value recorded a small increase after 30 days in oil (P) and after only 15 days in oil (A). When a correlation is established between peroxide value and storage time, ρ = 1.625 for (A) and ρ = 0.625 for (P).
- During the exposure to sunlight, a general increase in the peroxide value was observed [ρ = 1.147 for (P)], thus showing the negative effect of light on olive oil in which it raises this parameter.

These results have been confirmed by Rahmani (2007) who reported that autoxidation of fresh fats (olive oil) goes through three periods (induction, active oxidation and acceleration of secondary reactions) which are influenced by pro-oxidants (light, temperature, metal traces).

- During exposure to UV light, the peroxide value increased to a more pronounced extent in oil (A) than in oil (P), showing a correlation with storage time of 0.768 and 0.0061 respectively.

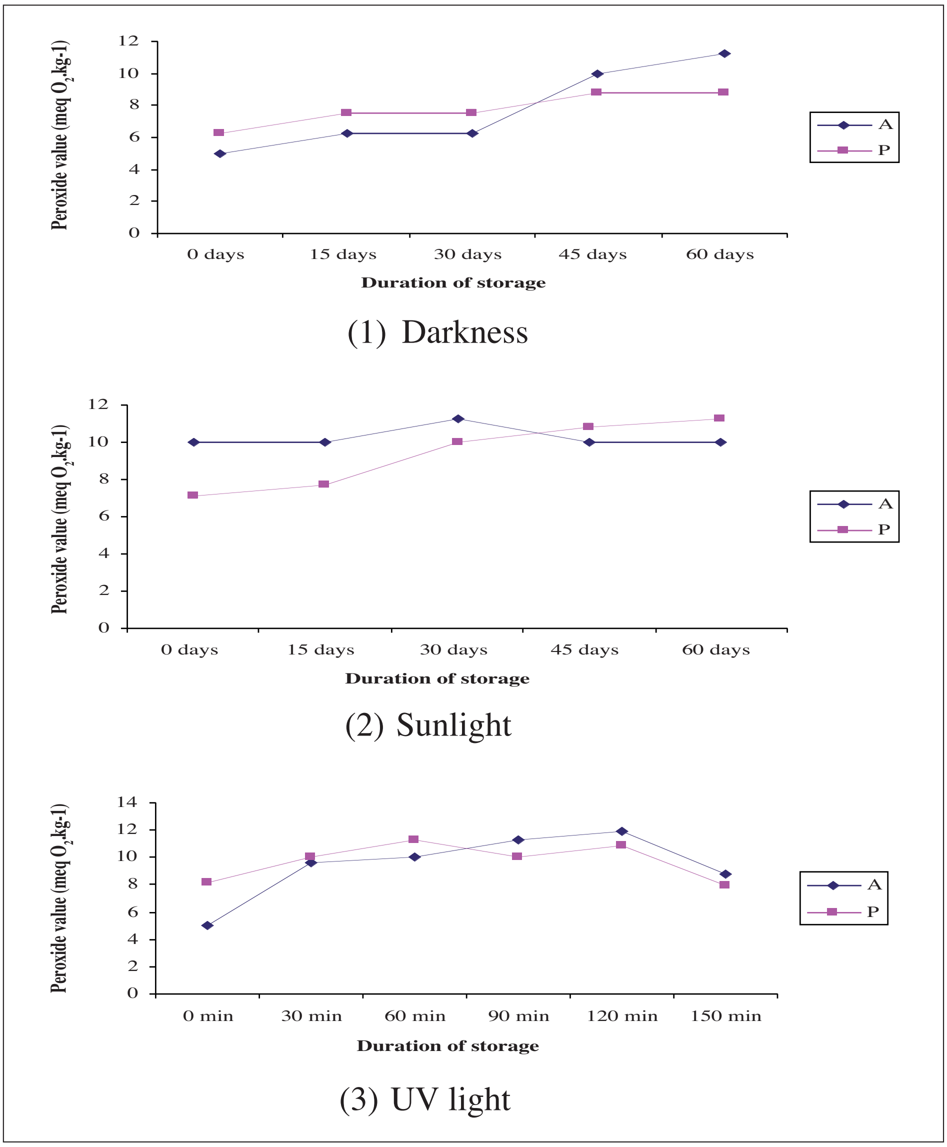


Figure 2: Effect of the different storage conditions on the peroxide value of olive oil

Figure 3 gives the results obtained for the specific extinction values.

The specific UV extinction coefficients are an important quality parameter of olive oils. At 232 nm, they permit evaluation of the presence of the primary oxidation products of fatty acids (linoleic hydroperoxides, oxidised fatty acids) while at 270 nm they permit detection of the secondary products of fatty acid oxidation (alcohols, ketones,…) (Tchiégang *et al*. 2005).

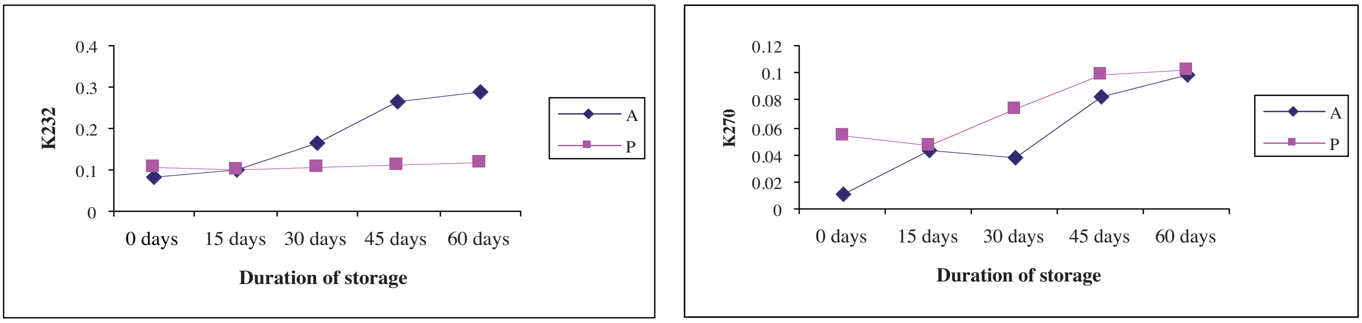
It can be seen from these curves that the specific extinction coefficients at 232 nm and 270 nm remained below the limit fixed in the IOC standard ($K_{232} \leq 2.6$ and $K_{270} \leq 0.25$) and that they increased only slightly through the storage period. The correlation coefficients remained low and did not exceed 0.1127 for oil (A) and 0.0839 for oil (P).

CONCLUSIONS

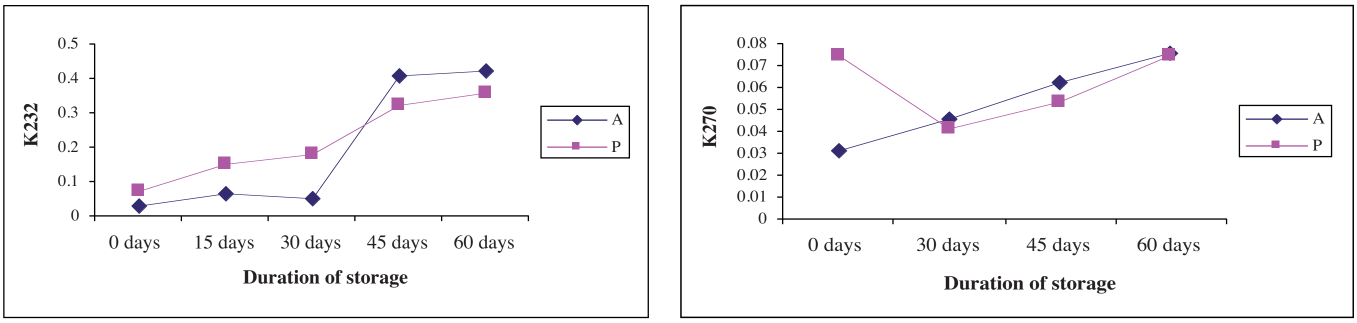
In the light of the findings of this study, we have demonstrated that storage conditions affect the quality of olive oil to varying degrees of significance. Specifically, we have observed that:

- In darkness, the stability of the oils obtained from the two varieties was good in terms of the quality parameters studied, although it was better in the Picholine marocaine oil.
- During exposure to sunlight, the stability of the oil obtained from the Picholine marocaine variety was good in terms of the characteristics studied.
- During exposure to UV light, a slight increase was noted in both varieties.

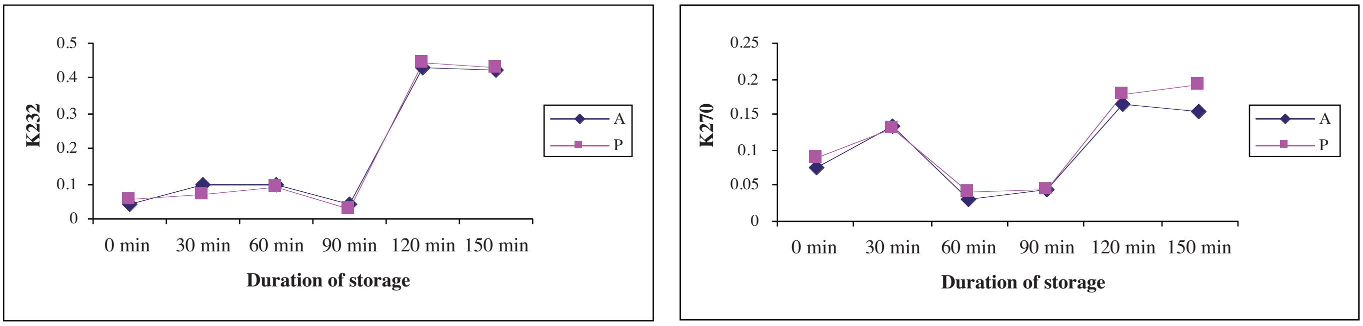
The olive oil obtained from the Arbequina variety initially displayed the best characteristics. However, during storage in natural conditions (darkness and daylight), it demonstrated less resistance to deterioration than the Picholine marocaine variety. These findings provide confirmation of the good oxidative stability of olive oil obtained from Picholine marocaine olives



(1) Darkness



(2) Sunlight



(3) UV light

Figure 3: Effect of the different storage conditions on the specific extinction coefficients of olive oil

compared with that produced from Arbequina olives.

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Olive growing and the olive and table olive industry in Extremadura

J. L. Llerena & I. Garrido

1. INTRODUCTION

Olive growing is the main oil-producing agricultural activity in the Mediterranean region. In Extremadura it is a mainstay of the rural economy and it is the crop accounting for the largest share of the region's arable land.

The olives grown in Extremadura are primarily for oil extraction. Extremadura lies fourth in the olive oil production ranking of Spain's regions, coming behind Andalusia, Castile-La Mancha and Catalonia, (the oils produced are of varying quality). Table olive production is also important in Extremadura, which accounts for 21% of the treated olives produced in Spain. This places it in second position after Andalusia for the production of this highly regarded product.

This paper reviews the situation of olive growing and olive oil mills and table olive processing facilities in the various olive growing districts of Extremadura.

2. MATERIALS AND METHODS

2.1. Characteristics of olive orchards

This article is based on information supplied by the Regional Government of Extremadura from the databases used for managing European Union (EU) aid. According to Royal Decree No 286 of 22 March 2002 regulating **aid for olive oil production**, olive growers who wish to be admitted to the aid scheme must submit a crop declaration specifying the number of crop-bearing olive trees and the status of the olive orchards farmed at 1 November of the year for which the declaration is filed, itemised by the municipalities where the growers farm the olives. They are also required to declare the kilograms of olives delivered to authorised facilities for oil and table olive production.

The characteristics of olive growing in Extremadura have been determined by analysing all the declarations filed for the 2004/05 crop year with the *Servicio de Ayudas Sectoriales* (Sector Aid Office of the Department of Agricultural and Environmental Affairs of the Regional Government of Extremadura). This is the last year for which these data are available because with the introduction of the single payment scheme in 2005/2006, olive growers are no longer required to lodge declarations because the authorities assign them a "single payment" based on their recorded olive production in recent years. The data were furnished by the *Servicio de Ayudas Sectoriales* (Sector Aid Office, Directorate-General for Common Agricultural Policy, Department of Agricultural and Environmental Affairs, Regional Government of Extremadura) in September 2006.

Olive growing districts

Twelve olive growing districts have been demarcated in Extremadura according to the criterion of homogenous olive oil production zones. These districts are laid down in Commission Regulation (EC) No 2138/97 and listed in Table 1 and Figure 1.

TABLE 1
Olive growing districts of Extremadura: surface area (SA), number of municipalities and usable agricultural area (UAA)

Olive growing district	SA (ha)	% SA	Nr municipalities	UAA (ha)	% UAA/SA
Gata-Hurdes	247,559	6.08	39	133,121	53.77
Vera-Ambroz-Jerte	225,102	5.53	42	181,661	80.70
Ibores	169,727	4.17	23	125,715	74.07
Logrosán-Guadalupe	307,683	7.56	19	197,124	64.07
Montánchez	117,243	2.88	21	81,765	69.74
Tierras de Cáceres	834,909	20.52	70	722,247	86.51
Alburquerque	143,612	3.53	12	127,661	88.89
Vegas del Guadiana	510,567	12.55	36	436,722	85.54
Tierra de Barros	285,570	7.02	31	262,852	92.04
Siberia	297,689	7.32	20	197,685	66.41
Serena	219,024	5.38	9	202,042	92.25
Jeréz-Llerena	710,440	17.46	51	610,061	85.87
Extremadura	4,069,125	100.00	373	3,278,656	80.57

Source: Created by the authors from MAPA 1982 (a) and 1982 (b).

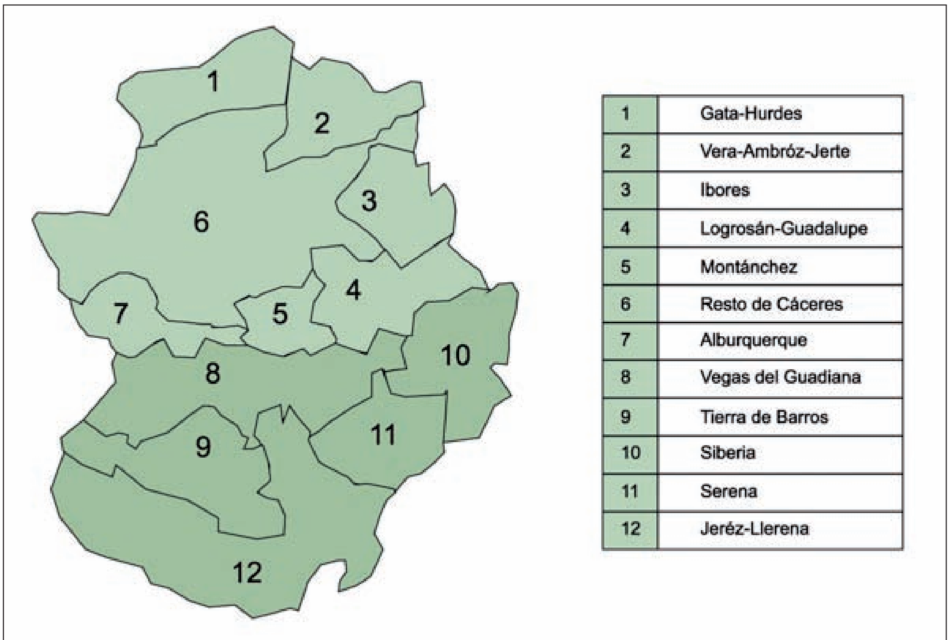

Figure 1: Olive growing districts of Extremadura

2.2. Olive oil mills and table olive processing plants

The olive oil mills and table olive processing plants in the Autonomous Community of Extremadura were identified in May 2005 and classified into groups by olive oil producing zone, i.e. by district. The total number of olive oil and table olive facilities located in Extremadura (119 and 84, respectively) served as the **sampling framework.** The mills are spread across all the districts whereas table olive processing facilities are only found in some of the districts. The data for this study were obtained in interviews, for which a representative sample of 84 was selected for mills (70.59% of the total) and 50 for table olive plants (59.52% of the total). The premise of the study was that at least 50% of the mills or table olive facilities in each district would be represented.

3. RESULTS AND DISCUSSION

3.1. Characteristics of olive orchards in Extremadura

The **cropping intensity** declared for each olive growing district in the 2004/2005 crop year (Table 2) was sampled first. As explained in the Materials and Methods section, this was the last crop year for which data were available. The area under olives was stable, having barely changed since the 2000/01 season (Llerena and Garrido, 2007). The district of Tierra de Barros had the biggest olive acreage, followed by Vegas del Guadiana and Jerez-Llerena, all in the province of Badajoz, and then by Gata–Hurdes in the province of Cáceres. Table 2 also gives the total number of olive trees and the number of crop-bearing trees in each district and the planting densities (these data are for 1997). The district of Gata–Hurdes has the highest number of total and crop-bearing olive trees, as well as the highest planting density (224.52 trees/ha). Tierra de Barros has the lowest density (70.52 trees/ha), but the largest crop area. Consequently, its olive orchards are more widely spread out.

TABLE 2
Area under olives in the olive growing districts of Extremadura, bearing/non-bearing distribution of trees and planting density

District	Olive orchards (ha) (1)	Nr olive trees	Nr crop-bearing trees (2)	Density (trees/ha) (2)
Gata-Hurdes	24,482	4,166,183	4,148,170	224.52
Vera-Ambroz-Jerte	5,626	642,806	639,082	90.33
Ibores	12,447	959,146	953,048	76.95
Logrosán-Guadalupe	8,196	1,015,945	1,008,340	123.32
Montánchez	7,629	626,940	621,536	74.81
Tierras de Cáceres	18,207	1,313,673	1,300,811	92.03
Alburquerque	8,177	807,765	783,204	114.04
Vegas del Guadiana	39,798	3,380,586	2,792,970	96.33
Tierra de Barros	54,338	3,490,939	2,808,721	70.52
La Siberia	15,360	2,165,837	2,120,535	158.29
La Serena	18,744	1,915,219	1,684,163	127.00
Jerez-Llerena	37,290	3,447,241	3,208,844	102.85
Extremadura	250,294	23,932,280	22,069,424	107.33

Source: Created by the authors from: (1) Servicio de Ayudas Sectoriales 2006; (2) Servicio de Estadística y Análisis Sectorial 1997.

The European Regulation on oils and fats classifies olive orchards as traditional or intensive according to their planting density. Orchards are considered to be intensive when they have more than 150 trees per hectare compared with traditional olive orchards, which are considered to have a much wider layout, i.e. the olives are at a distance from each other, sometimes more than 13 m (García-Brenes, 2004). According to these criteria, olive growing in Extremadura is intensive in the districts of Gata-Hurdes and La Siberia whereas the rest of the districts are clearly characterised by traditional olive cultivation. Intensive olive orchards aim to achieve higher yields and favour harvest mechanisation, which lowers labour costs (García-Brenes, 2004). However, it places greater pressure on the soil and water resources because it requires larger quantities of fertilisers and water. Traditional olive orchards, on the contrary, are environmentally sustainable but, while they create jobs and are profitable, they also cause social concern owing to the dreadful working conditions (García-Brenes, 2006). Intensive growing breaks with the traditional image of the olive as a dry farmed crop that is less demanding on soil and water resources than the more usual annual crops, converting it into a crop that requires more water and chemicals (Naredo, 1983).

Olive trees have a juvenile and mature stage; reproductive capacity only occurs in the mature stage, which means that new, juvenile orchards are considered to be non-bearing. The transition from the juvenile to the adult stage is temporal, occurring from the ages of 5–8 in trees grown from seed, and spatial in that the parts of the tree closest to the ground are more juvenile (Rapoport, 2004). The bulk of Extremadura's olive orchards (92.20%) are crop-bearing (Table 2). The only districts with a striking proliferation of new orchards are Tierra de Barros, where 19.5% of the trees do not produce fruit, followed by Vegas del Guadiana with 17.4% and La Serena with 12.1%.

The breakdown of **olive production by district** (Table 3) reveals that the province of Badajoz produces 75.15% of Extremadura's olives. The biggest producers in the province are the districts of Tierra de Barros and Vegas del Guadiana, which have the largest number of olive orchards. In the

TABLE 3
Olive production and yield by district

District	Olives (kg)	[%/total]	kg/ha
Gata-Hurdes	52,254,326	[14.63]	2134.40
Vera-Ambroz-Jerte	5,328,964	[1.49]	947.20
Ibores	9,158,523	[2.56]	735.80
Logrosán-Guadalupe	6,752,414	[1.89]	823.87
Montánchez	7,766,010	[2.17]	1017.96
Tierras de Cáceres	7,490,248	[2.10]	411.39
CACERES	88,750,485	[24.85]	1158.82
Alburquerque	7,636,809	[2.14]	933.94
Vegas del Guadiana	75,202,854	[21.06]	1889.61
Tierra de Barros	94,804,530	[26.55]	1744.72
La Siberia	21,929,410	[6.14]	1427.70
La Serena	29,588,128	[8.28]	2093.09
Jerez-Llerena	39,232,893	[10.99]	1052.10
BADAJOZ	268,394,624	[75.15]	1545.10
EXTREMADURA	357,145,109	[100]	1426.90

Source: Created by the authors from Servicio de Ayudas Sectoriales 2006.

province of Cáceres the biggest producing district is Gata–Hurdes (15% of regional production). In terms of yields the leader is La Serena with 2,093.09 kg/ha, followed by Vegas del Guadiana (1,889.61 kg/ha). At the lower end of the scale, the districts with the lowest yields are Tierras de Cáceres (411.39 kg/ha), Ibores (735.80 kg/ha) and Logrosán-Guadalupe (823.87 kg/ha).

García Brenes (2006) distinguishes between four very different productive systems: (1) rainfed olive orchards with low yields usually averaging below 1,000 kg of olives per hectare; (2) rainfed olive orchards with middling yields averaging between 1,000 and 2,500 kg/ha; (3) rainfed olive orchards with high yields averaging between 2,500 and 4,000 kg/ha; and (4) irrigated olive trees with average yields of more than 4,000 kg/ha. According to this breakdown, the olive orchards of Extremadura would belong to the first two productive systems: rainfed olive orchards with low and medium yields. System 1 – low yields – tends to be found in olive orchards established on soils that are unfavourable for any agricultural crop in general, including the olive. System 2 – middling yields – is found on soils where olive trees are traditionally grown but which do not give particularly high yields. However, the productivity of olive growing in Extremadura does not appear to be influenced by soil and climatic parameters, but rather by the varieties grown in each region as well as by crop management, social and economic factors (Llerena *et al.*, 2008).

An analysis of the **olive oil yields** obtained in Extremadura reveals that the bulk of its olive orchards have a low productivity, averaging out at 198 kg of oil per hectare, compared with averages of 610 kg in Andalusia, 234 kg in Castile-La Mancha or 290 kg/ha in the Autonomous Community of Valencia. A high percentage of the olive trees in the region grow in mountain orchards, which give low yields although the oils are of very good organoleptic quality. Nevertheless, thanks to new plantings and improved cultural practices, including drip irrigation, Extremadura's olive orchards have managed to double their olive oil production in recent decades. While the region produced 23,000 t on average during the 1980s, production has risen to close to 50,000 t of olive oil in the last three years, without taking into account olive production for pickling (López Sánchez, 2006). Extremadura's olive orchards produced a total of 49,697 t of oil in the 2004/2005 crop year, 82% of which in the province of Badajoz and 18% in the province of Cáceres (Table 4). When broken down by district, Vegas del Guadiana stands out with its 24% share of production, followed by Tierra de Barros (18%); however, the districts with the highest yields (more kg of oil per ha) were La Serena, Tierra de Barros and La Siberia.

3.2. Processing facilities

Olive oil mills

There are currently 1,773 olive oil mills in Spain. These are concentrated in the South, chiefly in Andalusia (*Agencia del Aceite de Oliva*, 2005). Extremadura is fifth in terms of the number of olive oil mills, with 119 in all spread across all the olive growing districts as can be seen from Table 5. This table also reports the tonnage of olives crushed, the average oil extraction yields, the volume of waste generated and the amount of oil that is packed. The districts that crush the largest quantity of olives are Vegas del Guadiana and La Serena. Average oil extraction yields in Extremadura work out at 18.09%: yields vary to a greater extent in the districts of Cáceres while they are more uniform in the districts of Badajoz (around 19.5%).

A review of waste generation shows that the districts of Cáceres generate much less waste than those of Badajoz in absolute terms (36,816 t versus 107,630 t), but when expressed in terms of the amount of oil obtained (Table 4) Cáceres generates proportionally more than Badajoz: 4.17 t compared with 2.63 t of waste/t of oil produced. The average volume of waste generated by the olive oil mills (Table 5) oscillates widely between 475 t in Ibores and 2,822.22 t in La Serena.

TABLE 4
Olive oil production by district

District	Olives (kg)	[%/total]	kg/ha
Gata-Hurdes	2,679,444	[5.39]	109.44
Vera-Ambroz-Jerte	564,362	[1.14]	100.31
Ibores	1,842,324	[3.71]	148.01
Logrosán-Guadalupe	1,145,407	[2.30]	139.75
Montánchez	1,526,008	[3.07]	200.03
Tierras de Cáceres	1,072,358	[2.16]	58.90
CACERES	8,829,903	[17.77]	115.29
Alburquerque	1,597,815	[3.22]	195.40
Vegas del Guadiana	11,862,358	[23.87]	298.06
Tierra de Barros	9,187,798	[18.49]	169.09
La Siberia	4,481,075	[9.02]	291.74
La Serena	6,214,216	[12.50]	331.53
Jerez-Llerena	7,524,079	[15.14]	201.77
BADAJOZ	40,867,341	[82.23]	235.27
EXTREMADURA	49,697,244	[100]	198.55

Source: Created by authors from Servicio de Ayudas Sectoriales 2006.

TABLE 5
Distribution of olive oil mills by district, average tonnage crushed per mill, average oil extraction yield, percentage of oil packed and tonnes of waste generated

District	NR	Crushed (t)	Oil extraction yield (%)	Waste (t)	% oil packed
Gata-Hurdes	10	2,771.43	14.36	2,453.14	81.43
Vera-Ambroz-Jerte	7	1,190.00	14.00	711.00	80.00
Ibores	5	967.50	20.75	475.00	82.50
Logrosán-Guadalupe	6	1,382.50	14.25	1,138.75	57.50
Montánchez	3	1250.00	19.50	1,100.00	40.00
Tierras de Cáceres	14	1,100.00	15.44	826.00	80.00
CACERES	45	1,520.97	15.76	1,187.61	75.16
Alburquerque	5	1,195.00	19.50	1,062.00	48.75
Vegas del Guadiana	13	3,733.33	19.61	2,753.33	37.56
Tierra de Barros	22	2,302.94	19.28	1,755.24	46.29
La Siberia	9	2,700.00	19.33	2,145.00	25.83
La Serena	13	3,700.00	19.89	2,822.22	32.78
Jerez-Llerena	12	1,554.50	19.18	1,311.63	32.13
BADAJOZ	74	2,631.43	19.45	2,030.75	38.25
EXTREMADURA	119	2,221.62	18.09	1,719.60	51.87

Extremadura packs 51.87% of the oil it produces (Table 5). Packing is concentrated primarily in the province of Cáceres. Itemised by district, Ibores packs the biggest volume of oil (82.50%) while La Siberia packs the smallest (25.83%).

Table olive processing plants

Extremadura has 84 of the 449 table olive processing plants in Spain, placing it in second position behind Andalusia (241 facilities) (*Agencia del Aceite de Oliva*, 2005). Not all the districts have table olive facilities, as can be seen from Table 6 which shows the distribution and output of such facilities in the region. There are 21 table olive factories in the province of Cáceres, most of which (14) are concentrated in the district of Gata–Hurdes. Badajoz has 63 facilities, mostly concentrated in the district of Tierra de Barros (54). The facilities with the highest output are located in the province of Cáceres, which produces more than twice the amount produced in Badajoz. Inside the province of Cáceres, the districts of Vera–Ambroz–Jerte and Gata–Hurdes stand out.

TABLE 6
Distribution of table olive processing plants by district and average production by facility

District	Nº	Average production by facility (t)
Gata-Hurdes	14	5,143.75
Vera-Ambroz-Jerte	6	6,187.50
Tierras Cáceres	1	2,500.00
CACERES	21	5,261.53
Vegas del Guadiana	5	1,216.66
Tierra de Barros	54	2,705.93
Jerez-Llerena	4	1,183.33
BADAJOZ	63	2,461.73
EXTREMADURA	84	3,189.68

4. CONCLUSIONS

The conclusion that can be drawn from these data is that olive growing in Extremadura is fundamentally traditional and can only be considered intensive in two districts (Gata–Hurdes and La Siberia). The olive orchards are crop bearing although Tierra de Barros and Vegas del Guadiana have more non-crop-bearing trees owing to the proliferation of new orchards. Olive and oil yields are low-to-medium. The olive oil mills in the districts of Badajoz record higher oil extraction yields than those in Cáceres; however, the table olive industry is more productive in the districts of Cáceres.

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Trade standard applying to olive oils and olive-pomace oils

1. SCOPE

This standard applies to olive oils and olive-pomace oils that are the object of international trade or of concessional or food aid transactions.

2. DESIGNATIONS AND DEFINITIONS

2.1. **Olive oil** is the oil obtained solely from the fruit of the olive tree *(Olea europaea* L.), to the exclusion of oils obtained using solvents or re-esterification processes and of any mixture with oils of other kinds. It is marketed in accordance with the following designations and definitions:

2.1.1. Virgin olive oils are the oils obtained from the fruit of the olive tree solely by mechanical or other physical means under conditions, particularly thermal conditions, that do not lead to alterations in the oil, and which have not undergone any treatment other than washing, decantation, centrifugation and filtration.

2.1.1.1. Virgin olive oils fit for consumption as they are include:

(i) Extra virgin olive oil: virgin olive oil which has a free acidity, expressed as oleic acid, of not more than 0.8 grams per 100 grams, and the other characteristics of which correspond to those fixed for this category in this standard.

(ii) Virgin olive oil: virgin olive oil which has a free acidity, expressed as oleic acid, of not more than 2 grams per 100 grams and the other characteristics of which correspond to those fixed for this category in this standard.

(iii) Ordinary virgin olive oil: virgin olive oil which has a free acidity, expressed as oleic acid, of not more than 3.3 grams per 100 grams and the other characteristics of which correspond to those fixed for this category in this standard.[1]

2.1.1.2. Virgin olive oil not fit for consumption as it is, designated lampante virgin olive oil, is virgin olive oil which has a free acidity, expressed as oleic acid, of more than 3.3 grams per 100 grams and/or the organoleptic characteristics and other characteristics of which correspond to those fixed for this category in this standard. It is intended for refining or for technical use.

2.1.2. Refined olive oil is the olive oil obtained from virgin olive oils by refining methods which do not lead to alterations in the initial glyceridic structure. It has a free acidity, expressed as oleic acid, of not more than 0.3 grams per 100 grams and its other characteristics correspond to those fixed for this category in this standard.[2]

2.1.3. Olive oil is the oil consisting of a blend of refined olive oil and virgin olive oils fit for consumption as they are. It has a free acidity, expressed as oleic acid, of not more than 1 gram per 100 grams and its other characteristics correspond to those fixed for this category in this standard.[3]

[1] This designation may only be sold direct to the consumer if permitted in the country of retail sale. If not permitted, the designation of this product shall comply with the legal provisions of the country concerned.
[2] This designation may only be sold direct to the consumer if permitted in the country of retail sale.
[3] The country of retail sale may require a more specific designation.

2.2. Olive-pomace oil is the oil obtained by treating olive pomace with solvents or other physical treatments, to the exclusion of oils obtained by re-esterification processes and of any mixture with oils of other kinds. It is marketed in accordance with the following designations and definitions:

2.2.1. Crude olive-pomace oil is olive-pomace oil whose characteristics correspond to those fixed for this category in this standard. It is intended for refining for use for human consumption, or it is intended for technical use.

2.2.2. Refined olive-pomace oil is the oil obtained from crude olive-pomace oil by refining methods which do not lead to alterations in the initial glyceridic structure. It has a free acidity, expressed as oleic acid, of not more than 0.3 grams per 100 grams and its other characteristics correspond to those fixed for this category in this standard.[1]

2.2.3. Olive-pomace oil is the oil comprising the blend of refined olive-pomace oil and virgin olive oils fit for consumption as they are. It has a free acidity of not more than 1 gram per 100 grams and its other characteristics correspond to those fixed for this category in this standard.[2] In no case shall this blend be called "olive oil".

3. PURITY CRITERIA

The identity characteristics comprising the purity criteria shall be applicable to olive oils and olive-pomace oils.

The limits established for each criterion include the precision values of the attendant recommended method.

3.1. Fatty acid composition as determined by gas chromatography (% m/m methyl esters):

- Myristic acid	≤ 0.05
- Palmitic acid	7.5 - 20.0
- Palmitoleic acid	0.3 - 3.5
- Heptadecanoic acid	≤ 0.3
- Heptadecenoic acid	≤ 0.3
- Stearic acid	0.5 - 5.0
- Oleic acid	55.0 - 83.0
- Linoleic acid	3.5 - 21.0
- Linolenic acid	≤ 1.0
- Arachidic acid	≤ 0.6
- Gadoleic acid (eicosenoic)	≤ 0.4
- Behenic acid	≤ 0.2*
- Lignoceric acid	≤ 0.2

* Limit raised to ≤ 0.3 for olive-pomace oils.

3.2. *Trans* fatty acid content (% *trans* fatty acids)

	C18:1 T %	C18:2 T + C18:3 T %
- Edible virgin olive oils	≤ 0.05	≤ 0.05
- Lampante virgin olive oil	≤ 0.10	≤ 0.10
- Refined olive oil	≤ 0.20	≤ 0.30
- Olive oil	≤ 0.20	≤ 0.30
- Crude olive-pomace oil	≤ 0.20	≤ 0.10
- Refined olive-pomace oil	≤ 0.40	≤ 0.35
- Olive-pomace oil	≤ 0.40	≤ 0.35

[1] This product may only be sold direct to the consumer if permitted in the country of retail sale.
[2] The country of retail sale may require a more specific designation.

3.3. Sterol and triterpene dialcohol composition

3.3.1. Desmethylsterol composition (% total sterols)

- Cholesterol	≤ 0.5
- Brassicasterol	≤ 0.1*
- Campesterol	≤ 4.0
- Stigmasterol	< campesterol in edible oils
- Delta-7-stigmastenol	≤ 0.5
- Beta-sitosterol + delta-5-avenasterol + delta-5-23-stigmastadienol + clerosterol + sitostanol + delta-5-24-stigmastadienol	≥ 93

* Limit raised to ≤ 0.3 for olive-pomace oils.

3.3.2. Total sterol content (mg/kg)

- Virgin olive oils - Refined olive oil - Olive oil	≥ 1000
- Crude olive-pomace oil	≥ 2500
- Refined olive-pomace oil	≥ 1800
- Olive-pomace oil	≥ 1600

3.3.3. Erythrodiol and uvaol content (% total sterols)

- Edible virgin olive oils	≤ 4.5
- Lampante virgin olive oil	≤ 4.5[1]
- Refined olive oil	≤ 4.5
- Olive oil	≤ 4.5
- Crude olive-pomace oil	> 4.5[2]
- Refined olive-pomace oil	> 4.5
- Olive-pomace oil	> 4.5

3.4. Wax content C40 + C42 + C44 + C46 (mg/kg)

- Edible virgin olive oils	≤ 250
- Lampante virgin olive oil	≤ 300[1]
- Refined olive oil	≤ 350
- Olive oil	≤ 350
- Crude olive-pomace oil	> 350[2]
- Refined olive-pomace oil	> 350
- Olive-pomace oil	> 350

[1] When the oil has a wax content between 300 mg/kg and 350 mg/kg it is considered a lampante virgin olive oil if the total aliphatic alcohol content is ≤ 350 mg/kg or the erythrodiol + uvaol content is ≤ 3.5%.
[2] When the oil has a wax content between 300 mg/kg and 350 mg/kg it is considered a crude olive-pomace oil if the total aliphatic alcohol content is > 350 mg/kg and the erythrodiol + uvaol content is > 3.5%.

3.5. Maximum difference between the actual and theoretical ECN 42 triacylglycerol content

- Edible virgin olive oils	0.2
- Lampante virgin olive oil	0.3
- Refined olive oil	0.3
- Olive oil	0.3
- Crude olive-pomace oil	0.6
- Refined olive-pomace oil	0.5
- Olive-pomace oil	0.5

3.6. Stigmastadiene content (mg/kg)

- Edible virgin olive oils	≤ 0.10
- Lampante virgin olive oil	≤ 0.50

3.7. Content of 2-glyceryl monopalmitate

- Edible virgin olive oils and olive oil:

C16:0 ≤ 14.0% ; 2P ≤ 0.9%
C16:0 > 14.0% ; 2P ≤ 1.0%

- Non-edible virgin olive oils and refined olive oils:

C16:0 ≤ 14.0% ; 2P ≤ 0.9%
C16:0 > 14.0% ; 2P ≤ 1.1%

- Olive-pomace oils	≤ 1.2%
- Crude and refined olive-pomace oils	≤ 1.4%

3.8. Unsaponificable matter (g/kg)

- Olive oils	≤ 15
- Olive-pomace oils	≤ 30

4. QUALITY CRITERIA

The limits established for each criterion and designation include the precision values of the attendant recommended method.

	Extra virgin olive oil	Virgin olive oil	Ordinary virgin olive oil	Lampante virgin olive oil*	Refined olive oil	Olive oil	Crude olive-pomace oil	Refined olive-pomace oil	Olive-pomace oil
4.1. <u>Organoleptic characteristics</u>									
- odour and taste					acceptable	good		acceptable	good
- odour and taste (on a continuous scale)									
. median of defect	Me = 0	0 < Me ≤ 3.5	3.5 < Me ≤ 6.00**	Me > 6.0					
. median of the fruity attribute	Me > 0	Me > 0							
- colour					light yellow	light, yellow to green		light, yellow to brownish yellow	light, yellow to green
- aspect at 20ºC for 24 hours					limpid	limpid		limpid	limpid
4.2. <u>Free acidity</u> % m/m expressed in oleic acid	≤ 0.8	≤ 2.0	≤ 3.3	> 3.3	≤ 0.3	≤ 1.0	no limit	≤ 0.3	≤ 1.0
4.3. <u>Peroxide value</u> in milleq. peroxide oxygen per kg/oil	≤ 20	≤ 20	≤ 20	no limit	≤ 5	≤ 15	no limit	≤ 5	≤ 15

* It is not obligatory for the criteria in 4.1, 4,2 and 4.3 to be concurrent; one is sufficient.

** Or when the median of the defect is less than or equal to 3.5 and the median of the fruity attribute is equal to 0.

4. QUALITY CRITERIA (contd.)

	Extra virgin olive oil	Virgin olive oil	Ordinary virgin olive oil	Lampante virgin olive oil*	Refined olive oil	Olive oil	Crude olive-pomace oil	Refined olive-pomace oil	Olive-pomace oil
4.4. Absorbency in ultra violet $(K^{1\%}_{1cm})$									
270 nm	≤ 0.22	≤ 0.25	≤ 0.30**		≤ 1.10	≤ 0.90		≤ 2.00	≤ 1.70
Δ K	≤ 0.01	≤ 0.01	≤ 0.01		≤ 0.16	≤ 0.15		≤ 0.20	≤ 0.18
232 nm*	≤ 2.50**	≤ 2.60**							
4.5. Moisture and volatile matter % m/m	≤ 0.2	≤ 0.2	≤ 0.2	≤ 0.3	≤ 0.1	≤ 0.1	≤ 1.5	≤ 0.1	≤ 0.1
4.6. Insoluble impurities in light petroleum % m/m	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.2	≤ 0.05	≤ 0.05		≤ 0.05	≤ 0.05
4.7. Flash point	-	-	-	-	-	-	≥ 120°C	-	-
4.8. Trace metals mg/kg									
Iron	≤ 3.0	≤ 3.0	≤ 3.0	≤ 3.0	≤ 3.0	≤ 3.0		≤ 3.0	≤ 3.0
Copper	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1		≤ 0.1	≤ 0.1
4.9. Fatty acid methyl esters (FAMEs) and fatty acid ethyl esters (FAEEs)	- Σ FAME + FAEE ≤ 75 mg/kg or - Σ FAME + FAEE > 75 mg/kg and ≤ 150 mg/kg and FAEE/FAME ratio ≤ 1.5								
4.10. Phenols content	See point 11.25								

* This determination is solely for application by commercial partners on an optional basis.

** Commercial partners in the country of retail sale may require compliance with these limits when the oil is made available to the end consumer.

*** After passage of the sample through activated alumina, absorbency at 270 nm shall be equal to or less than 0.11.

5. FOOD ADDITIVES

5.1. Virgin olive oils and crude olive-pomace oil: none permitted

5.2. Refined olive oil, olive oil, refined olive-pomace oil and olive-pomace oil: alpha-tocopherol permitted to restore natural tocopherol lost in the refining process.

Maximum level: 200 mg/kg of total alpha-tocopherol in the final product.

6. CONTAMINANTS

6.1. Heavy metals

The products covered by this standard shall comply with maximum limits being established by the Codex Alimentarius Commission but in the meantime the following limits will apply:

	Maximum permissible concentration
Lead (Pb)	0.1 mg/kg
Arsenic (As)	0.1 mg/kg

6.2. Pesticide residues

The products covered by this standard shall comply with those maximum residue limits established by the Codex Alimentarius Commission for these commodities.

6.3. Halogenated solvents

- Maximum content of each halogenated solvent 0.1 mg/kg
- Maximum content of the sum of all halogenated solvents 0.2 mg/kg

7. HYGIENE

7.1. It is recommended that the products intended for human consumption covered by the provisions of this standard be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RP 1-1969, Rev. 3 – 1997), and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.

7.2. The products intended for human consumption should comply with any microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria (CAC/GL 21-1997).

8. PACKING

Olive oils and olive-pomace oils intended for international trade shall be packed in containers complying with the General Principles of Food Hygiene recommended by the Codex Alimentarius Commission (CAC/RCP 1 1969, Rev. 3 - 1997), and other relevant texts such as Codes of Hygienic Practice and Codes of Practice.

The containers used may be:

8.1. tanks, containers, vats, which permit the transportation in bulk of olive oils and olivepomace oils;

8.2. metal drums, in good condition, hermetically-sealed, which should be internally covered with a suitable varnish;

8.3. metal tins and cans, lithographed, new, hermetically-sealed, which should be internally covered with a suitable varnish;

8.4. demi-johns, glass bottles or bottles made of suitable macromolecular material.

9. CONTAINER FILLING TOLERANCE

The volume occupied by the contents shall under no circumstances be less than 90% of the capacity of the container, except in the case of tin containers with a capacity of, or less than, 1 litre in which the volume occupied shall under no circumstances be less than 80% of the capacity of the container; this capacity is equal to the volume of distilled water at 20ºC which the container can hold when full.

10. LABELLING

In addition to sections 2, 3, 7 and 8 of the Codex General Standard for the Labelling of Pre-packaged Foods (CODEX STAN 1-1985, Rev.1 - 1991) and the guidelines applying to food not intended for direct sale to consumers, the specific provisions providing the following information shall be applied:

10.1. On containers intended for direct sale to consumers

10.1.1. Name of the product

The labelling on each container shall indicate the specific designation of the product contained, complying in every way with the relevant provisions of this standard.

10.1.1.1. Designations of olive oils:

- Extra virgin olive oil
- Virgin olive oil
- Ordinary virgin olive oil[1]
- Refined olive oil[1]
- Olive oil[2]

10.1.1.2. Designations of olive-pomace oils:

- Refined olive-pomace oil[1]
- Olive-pomace oil[2]

10.1.2. Net contents

The net contents shall be declared by volume in the metric system ("Système International" units).

10.1.3. Name and address

The name and address of the manufacturer, packer, distributor, importer, exporter or seller shall be declared.

10.1.4. Country of origin

The name of the country of origin shall be declared. When the product undergoes substantial processing in a second country, the country in which such processing is carried out shall be considered as the country of origin for labelling purposes.

10.1.5. Indications of source and appellations of origin

10.1.5.1. Indications of source

The labels of virgin olive oils may indicate their source (country, region or locality) when they have been empowered to do so by their country of origin and when such virgin olive oils have been produced, packed and originate exclusively in the country, region or locality mentioned.

10.1.5.2. Appellations of origin

The labels of extra virgin olive oils may indicate their appellation of origin (country, region or locality) when they have been awarded such an appellation, in accordance with the terms provided under the regulations of their country of origin and when such extra virgin olive oil has been produced, packed and originates exclusively in the country, region or locality mentioned.

10.1.6. Lot identification

Each container shall be embossed or otherwise permanently marked in code or in clear to identify the producing factory and the lot.

10.1.7. Date marking and storage conditions

10.1.7.1. Date of minimum durability

In the case of pre-packaged products intended for the end consumer, the date of minimum durability (preceded by the words "best before end") shall be declared by the month and year in uncoded numerical sequence. The month may be indicated by letters in those countries where such use will not confuse the consumer; if the shelf life of the product is valid to

[1] This product may only be sold direct to the consumer if permitted in the country of retail sale.
[2] The country of retail sale may require a more specific designation.

December, the expression "end (stated year)" may be used as an alternative.

10.1.7.2. Storage instructions

Any special conditions for storage shall be declared on the label if the validity of the date of minimum durability depends thereon.

10.2. On forwarding packs of oils intended for human consumption

In addition to the details noted under section 10.1., the following inscription shall appear:

- number and type of containers held in pack.

10.3. On containers allowing the transportation in bulk of olive oils and olive-pomace oils

The labelling on each container shall include:

10.3.1. Name of the product

The name shall indicate the specific designation of the product contained, complying in every way with the provisions of this standard.

10.3.2. Net contents

The net contents shall be declared by weight or volume in the metric system ("Système International" units).

10.3.3. Name and address

The name and address of the manufacturer, distributor or exporter shall be declared.

10.3.4. Country of origin

The name of the exporting country shall be declared.

11. METHODS OF ANALYSIS AND SAMPLING

The methods of analysis and sampling given below are international referee methods. The latest version of these methods should be used.

11.1. Sampling

According to ISO 5555, "Animal and vegetable fats and oils - Sampling".

11.2. Preparation of the test sample

According to ISO 661, "Animal and vegetable fats and oils - Preparation of the test sample".

11.3. Determination of the fatty acid composition

According to COI/T.20/Doc. No 24, "Preparation of the fatty acid methyl esters from olive oil and olive-pomace oil", and ISO 5508, "Analysis by gas chromatography of methyl esters of fatty acids" or AOCS Ch 2–91.

11.4. Determination of the *trans* fatty acid content

According to COI/T.20/Doc. No 17/Rev. 1, "Determination of *trans* unsaturated fatty acids by capillary column gas chromatography", or ISO 15304 or AOCS Ce 1f–96.

11.5. Determination of the sterol composition and total sterol content

According to COI/T.20/Doc. No 10/Rev. 1, "Determination of the composition and content of sterols by capillary-column gas chromatography", or AOCS Ch 6-91.

11.6. Determination of the content of erythrodiol + uvaol

According to IUPAC no. 2.431, "Determination of the erythrodiol content". Capillary columns are recommended.

11.7. Determination of the wax content

According to COI/T.20/Doc. No 18/Rev. 2 "Determination of wax content by capillary-column gas chromatography" or AOCS Ch 8-02.

11.8. Determination of the aliphatic alcohol content

According to COI/T.20/Doc. No 26 "Determination of aliphatic alcohols content by capillary gas chromatography".

11.9. Determination of the difference between the actual and theoretical ECN 42 triacylglycerol content

According to COI/T.20/ Doc. No 20/Rev. 2, “Determination of the difference between actual and theoretical content of triacylglycerols with ECN 42”, or AOCS 5b-89.

11.10. Determination of the stigmastadiene content

According to COI/T.20/ Doc. No 11/Rev. 2, “Determination of stigmastadienes in vegetable oils”, or COI/ T.20/Doc. no. 16/Rev. 1, “Determination of sterenes in refined vegetable oils”, or ISO 15788-1 or AOCS Cd 26-96.

11.11. Determination of the content of 2-glyceryl monopalmitate

According to COI/T.20/ Doc. No 23, “Determination of the percentage of 2-glyceryl monopalmitate”.

11.12. Determination of the unsaponifiable matter

According to ISO 3596, “Determination of the unsaponifiable matter – Method using diethyl ether extraction”, or AOCS Ca 6b-53 or ISO 18609.

The results should be expressed in g/unsaponifiable matter per kg/oil.

11.13. Determination of the organoleptic characteristics

According to COI/T.20/ Doc. No 15/Rev. 2, “Organoleptic assessment of virgin olive oil”.

11.14. Determination of the free acidity

According to ISO 660, “Determination of acid value and acidity”, or AOCS Cd 3d-63.

11.15. Determination of the peroxide value

According to ISO 3960, “Determination of the peroxide value”, or AOCS Cd 8b-90.

11.16. Determination of the absorbency in ultraviolet

According to COI/T.20/ Doc. No 19/Rev. 2, “Spectrophotometric investigation in the ultraviolet”, or ISO 3656 or AOCS Ch 5-91.

11.17. Determination of the moisture and volatile matter

According to ISO 662, “Determination of the moisture and volatile matter”.

11.18. Determination of the insoluble impurities in light petroleum

According to ISO 663, “Determination of the insoluble impurities”.

11.19. Determination of the flash point

According to the FOSFA International method.

11.20. Detection of trace metals

According to ISO 8294, “Determination of copper, iron and nickel by direct graphite furnace atomic absorption spectrometry”.

11.21. Determination of the alphatocopherol

According to ISO 9936, “Determination of tocopherols and tocotrienols contents – Method using high-performance liquid chromatography”.

11.22. Determination of traces of heavy metals

- Determination of lead: according to ISO 12193 or AOCS Ca 18c-91 or AOAC 994.02.
- Determination of arsenic: according to AOAC 952.13 or AOAC 942.17 or AOAC 985.16.

11.23. Detection of traces of halogenated solvents

According to COI/T.20/ Doc. No 8/Corr. 1 “Determination of tetrachloroethylene in olive oils by gas-liquid chromatography”.

11.24. Determination of the content of waxes and alkyl esters

According to COI/T.20/ Doc. No 28 “Determination of the content of waxes, fatty acid methyl esters and fatty acid ethyl esters by capillary gas chromatography”.

11.25. Determination of biophenols

According to COI/T.20/ Doc. No 29 “Determination of biophenols in olive oils by HPLC”.

Determination of biophenols in olive oils by HPLC

1. PURPOSE

This method describes a procedure for the extraction and HPLC quantification of the biophenolic minor polar (BMP) compounds in olive oils, such as the natural and oxidised derivatives of oleuropein and ligstroside, lignans, flavonoids and phenolic acids. The range of measurement is from 30 mg/kg to 800 mg/kg.

WARNING: This method may require the use of dangerous apparatus and chemicals or the performance of dangerous operations. It does not specify all the safety issues connected with its use. Users are therefore responsible for taking all appropriate safety measures beforehand and for observing any legal requirements.

2. PRINCIPLE

The method is based on direct extraction of the biophenolic minor polar compounds from olive oil by means of a methanol solution and subsequent quantification by HPLC with the aid of a UV detector at 280 nm. Syringic acid is used as the internal standard.

The content of the natural and oxidised oleuropein and ligstroside derivatives, lignans, flavonoids and phenolic acids is expressed in mg/kg of tyrosol.

3. EQUIPMENT

3.1. High-performance ternary gradient liquid chromatograph (HPLC), equipped with C18 reverse-phase column (4.6 mm x 25 cm), type Spherisorb ODS-2 5µm, 100 A°, with spectrophotometric UV detector at 280 nm and integrator. Room temperature.

Spectral recording for identification purposes is facilitated by using a photodiode detector with a spectral range from 200 nm to 400 nm.

3.2. Flasks, 10 ml and 100 ml, Class A.

3.3. Pipette, 100 µl, 1000 µl and 5000 µl.

3.4. Test tubes, with screw cap, 10 ml.

3.5. Agitator for test tubes[1]

3.6. Ultrasonic extraction bath.

3.7. Syringe filters ∅13 mm, PVDF type 0.45 µm.

3.8. Centrifuge capable of working at a speed of 5000 min^{-1}.

3.9. Balance, accurate to ± 0.001 g.

3.10. Plastic syringes, 5 ml.

3.11. Usual laboratory glassware.

4. REAGENTS

Reagents should be pure HPLC chromatography grade.

4.1. Orthophosphoric acid, 85% (*V/V*).

4.2. Methanol, chromatography grade.

4.3. Acetonitrile, chromatography grade.

4.4. Water, chromatography grade.

[1] Vortex type.

4.5. Ternary linear elution gradient: water 0.2 % H_3PO_4 (*V/V*) (A), methanol (B), acetonitrile (C). Elution solvents should be de-gassed.

Gradient elution should be performed as follows:

Gradient elution				
Time min	**Flow ml/min**	**A %**	**B %**	**C %**
0	1.00	96	2	2
40	1.00	50	25	25
45	1.00	40	30	30
60	1.00	0	50	50
70	1.00	0	50	50
72	1.00	96	2	2
82	1.00	96	2	2

4.6. 2- (4- hydroxyphenyl) ethanol (tyrosol) ≥ 98 %.

4.7. 3,5 dimethoxy 4- hydroxy benzoic acid (syringic acid) ≥ 97 % .

4.8. Extraction solution: methanol/water 80/20 (*V/V*).

4.9. Solution of external calibration standards (tyrosol and syringic acid). Accurately weigh 0.030 g of tyrosol (4.6) and 0.015 g of syringic acid (4.7) into a 10 ml volumetric flask (3.2). Make up to volume with the solution of methanol/water 80/20 (*V/V*) (4.8).

Transfer 100 µl (3.3) of the solution to a 10 ml volumetric flask. Make up to volume with the solution of methanol/water 80/20 (*V/V*) (4.8).

The concentrations of the external calibration solution are as follows: tyrosol 0.030 mg/ml, syringic acid 0.015 mg/ml.

The solution is stable if kept for three months in the refrigerator at + 4°C.

4.10. Preparation of the internal standard solution (syringic acid). Weigh accurately 0.015 g (4.7) of syringic acid into a 10 ml volumetric flask and make up to volume with the solution of methanol/water 80/20 (*V/V*) (4.8). Transfer 1 ml (3.3) of the solution to a 100 ml volumetric flask (3.2). Make up to volume with the solution of methanol/water 80/20 (*V/V*) (4.8). The final concentration is 0.015 mg/ml.

The solution is stable if kept for three months in the refrigerator at + 4°C.

5. PROCEDURE

5.1. Sample preparation

In a 10 ml screw-cap test tube (3.4) accurately weigh 2.0 g of olive oil.

Transfer 1 ml of the internal standard solution (4.10) to the previously weighed sample.

Seal with the screw cap and shake (3.5) for exactly 30 sec.

Add 5 ml (3.3) of the methanol/water 80/20 (*V/V*) extraction solution (4.8).

Shake (3.5) for exactly 1 min.

Extract in the ultrasonic bath (3.6) for 15 min at room temperature.

Centrifuge at 5000 rev/min for 25 min (3.8).

Take an aliquot of the supernatant phase and filter through a 5 ml plastic syringe (3.10), with a 0.45 µm PVDF filter (3.7).

5.2. HPLC analysis

Switch on the UV spectrophotometer at least 1 hour before analysis.

The chromatography column should be conditioned for at least 15 min with the elution solvent (initial composition) (water 0.2 %

H_3PO_4 (*V/V*) /methanol/acetonitrile 96/2/2 (*V/V/V*)) (gradient elution).

A preliminary empty gradient chromatographic run should always be done (to make sure there are no interfering co-elution peaks) by injecting 20 µl of methanol/water 80/20 (*V/V*) (4.8) into the HPLC system.

Inject 20 µl of the external calibration standard solution (4.9) and record the chromatogram at 280 nm. Calculate the values of the response factors RF for 1 µg of tyrosol and 1 µg of syringic acid (6.1).

Calculate the ratio of the response factor of syringic acid to tyrosol, called $RRF_{syr/tyr}$. Note down the values (6.2).

Inject 20 µl of the final sample solution into the HPLC system and record the chromatogram at 280 nm.

Perform two independent determinations on the same sample and check that the results lie inside the precision values of the method.

Figure 1 shows a typical chromatogram of the biophenols in an extra virgin olive oil characterised by individual component.

The sum of the areas of the individual peaks should be taken into account to calculate the total content.

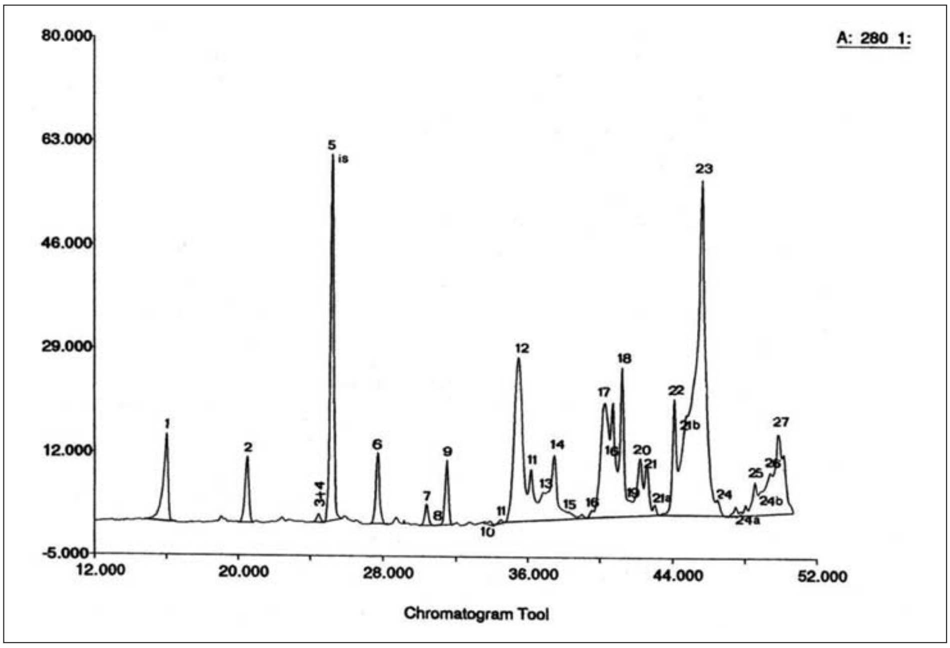

Figure 1: HPLC chromatogram recorded at 280 nm for biophenols profile present in an extra virgin olive oil

At the end of the day flush methanol/acetonitrile 1/1 (*V/V*) through the chromatographic column at a rate of 1.0 ml/min for at least 15 min and store the column in methanol/acetonitrile 1/1 (*V/V*).

6. EXPRESSION OF RESULTS

6.1. Calculation of the response factors of the external calibration standards (RF)

$RF_{1µg}$ (syringic acid) = Area syringic acid/ µg syringic acid injected

$RF_{1µg}$ (tyrosol) = Area tyrosol/ µg tyrosol injected

6.2. Calculation of the ratio between the two response factors (RRF)

$RRF_{syr/tyr}$ = $RF_{1\ µg}$ (syringic acid)/ $RF_{1\ µg}$ (tyrosol)

The value of $RRF_{syr/tyr}$ should be constant and should lie inside the range 5.1 ± 0.4. It enables the final result to be expressed as tyrosol, using syringic acid as the internal standard.

6.3. Calculation of the biophenol content of virgin olive oil

Biophenol content (natural and oxidised oleuropein and ligstroside derivatives, lignans, flavonoids and phenolic acids), expressed in mg/kg, is calculated by measuring the sum of the areas of the related chromatographic peaks (identification in Table 1) according to the following formula; the result is expressed without decimal place.

$$(mg/kg) = \frac{(\Sigma A) \times 1.000 \times RRF_{syr/tyr} \times (W\ syr.\ acid)}{(A\ syr.\ acid) \times (W)}$$

where:

(ΣA) is the sum of the peak areas of the biophenols (hydroxytyrosol, tyrosol, natural and oxidised oleuropein and ligstroside derivatives, lignans, flavonoids and phenolic acids) recorded at 280 nm;

A syr. acid is the area of the syringic acid internal standard recorded at 280 nm;

1000 is the factor used to express the result in mg/kg;

W is the weight of the oil used, in grams;

$RRF_{syr/tyr}$ is the multiplication coefficient for expressing the final results as tyrosol;

W syr. acid is the weight, in mg, of the syringic acid used as internal standard in 1 ml of solution added to the sample.

TABLE 1
Identification of biophenols peaks.
Maximum absorbance (max UV abs) values and relative retention times (RRT)*

Peak No	Biophenols	RRT*	Max. UV abs. nm
1	Hydroxytyrosol	0.62	230-280
2	Tyrosol	0.80	230-275
3	Vanillic acid	0.96	260
4	Caffeic acid	0.99	325
5	Syringic acid (internal standard)	1.00	280
6	Vanillin	1.10	310
7	Para-coumaric acid	1.12	310
8	Hydroxytyrosyl acetate	1.20	232-285
9	Ferulic acid	1.26	325
10	Ortho-coumaric acid	1.31	325
11;11a	Decarboxymethyl oleuropein aglycone, oxidised dialdehyde form	-	235-280
12	Decarboxymethyl oleuropein aglycone, dialdehyde form	1.45	235-280
13	Oleuropein	1.48	230-280
14	Oleuropein aglycone, dialdehyde form	1.52	235-280
15	Tyrosyl acetate	1.54	230-280
16;16a	Decarboxymethyl ligstroside aglycone, oxidised dialdehyde form	1.63	235-275
17	Decarboxymethyl ligstroside aglycone, dialdehyde form	1.65	235-275
18	Pinoresinol, 1 acetoxy-pinoresinol	1.69	232-280
19	Cinnamic acid	1.73	270
20	Ligstroside aglycone, dialdehyde form	1.74	235-275
21;21a;21b	Oleuropein aglycone, oxidised aldehyde and hydroxylic form	-	235-280
22	Luteolin	1.79	255-350
23	Oleuropein aglycone, aldehyde and hydroxylic form	1.87	235-280
24;24a;24b	Ligstroside aglycone, oxidised aldehyde and hydroxylic form	-	235-275
25	Apigenin	1.98	230-270-340
26	Methyl-luteolin	-	255-350
27	Ligstroside aglycone, aldehyde and hydroxylic form	2.03	235-275

(*) The relative retention time is calculated with respect to the retention time of syringic acid. Identification is performed by HPLC-MS.

7. TEST REPORT

The test report should specify the following information:

(a) The reference of this method.

(b) The test results, expressed in mg/kg of oil (no decimal places).

(c) The RRF value used for calculations.

(d) Any departure from this method, made by agreement between the parties concerned or for any other reason.

(e) The identification details of the laboratory, the date on which the test was performed and the signature of the test supervisor.

PRECISION VALUES

1. Analysis of the collaborative test results

The precision values of the method are given in the attached table.

Seventeen laboratories holding IOC recognition at the time took part in the collaborative test arranged by the Executive Secretariat in 2008. The laboratories were from eight different countries.

Sample A – Extra virgin olive oil (Italy)
Sample B – Extra virgin olive oil (Spain)
Sample C – Extra virgin olive oil (Tunisia)
Sample D – Extra virgin olive oil (Slovenia)
Sample E – Extra virgin olive oil (Greece)
Sample R – Extra virgin olive oil (Italy)

The results of the collaborative test organised by the IOC Executive Seecretariat were statistically processed according to the rules laid down in the international standards ISO 5725.

Accuracy (trueness and precision) of measurement methods and results

Outliers were examined by applying the Cochran and Grubbs tests to the laboratory results for all the determinations (replicates a and b).

The table lists:

N number of participating laboratories.

Outliers number of laboratories with outlying values.

Mean mean of the accepted results.

r value below which the absolute difference between two single independent test results obtained with the same method on identical test material in the same laboratory by the same operator using the same equipment within short intervals of time may be expected to lie with a probability of 95%.

Sr repeatability standard deviation.

RSDr (%) repeatability coefficient of variation (Sr x 100 / mean).

R value below which the absolute difference between two single test results obtained with the same method on identical test material in different laboratories with different operators using different equipment may be expected to lie with a probability of 95%.

S_R reproducibility standard deviation.

RSD_R (%) reproducibility coefficient of variation (SR x 100/mean).

Ho_R is the HORRAT value for reproducibility, $[RSD_{R\ actual} / RSD_{R\ theor}] = 2^{(1-0.5\log C)}$ and C is the concentration of the compound expressed to the power 10. (Horwitz equation).

Precision values for total biophenol content, (mg/1000 g)						
	SAMPLE A	SAMPLE B	SAMPLE C	SAMPLE D	SAMPLE E	SAMPLE R
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Mean	694	573	153	343	297	301
N	17	17	17	17	17	17
Outliers	3	3	1	2	2	2
Non-outliers	14	14	16	15	15	15
Test number	28	28	32	30	30	30
R	29	36	18	24	22	17
S_r	10.4	12.7	6.4	8.7	7.7	6.2
RSD_r (%)	2	2	4	3	3	2
R	101	84	60	63	77	32
S_R	36.0	29.9	21.3	22.4	27.5	11.5
RSD_R(%)	5	5	14	7	9	4
HO_R	0.9	0.8	1.9	1.0	1.4	0.6

2. References

ISO 5725-1:1994 Accuracy (trueness and precision) of measurement methods and results Part 1: General principles and definitions.

ISO 5725-2:1994 Accuracy (trueness and precision) of measurement methods and results Part 2: Basic method for the determination of the repeatability and reproducibility of a standard measurement method.

ISO 5725:5:1998 Accuracy (trueness and precision) of measurement methods and results Part 5: Alternative methods for the determination of the precision of a standard measurement method.

ISO 5725:6:1994 Accuracy (trueness and precision) of measurement methods and results Part 6: Use in practice of accuracy values

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