SISSG
SOCIETÀ ITALIANA PER LO STUDIO DELLE SOSTANZE GRASSE

ORGANIC, NEW EMERGING PROCESSING TECHNOLOGIES AND QUALITY CONTROL OF EXTRA VIRGIN OLIVE OIL WITH MULTIVARIATE APPROACH

STUDIUM GENERALE CIVITATIS PERUSII · A.D. MCCCVIII

ÇUKUROVA UNIVERSITY 1973

Associate Prof. Dr. Turkan M. KECELI
The University of Cukurova, Turkey

Congress SISSG 2022, Edible Oils And Fats: Innovation and Sustainability in Production and Control, June 15-17, 2022 Perugia, Italy

PROGRAM

LEGEND OF TOPICS: Seed oil | Olive oil | Volatile compounds in olive oils | Technology | Analytic | "Stefano Fachini Medal" Award | Poster session

SISSG
EDIBLE FATS AND OILS INNOVATION and SUSTAINABILITY
IN PRODUCTION AND CONTROL

June 15 - 17 **2022**

PERUGIA, Complesso monumentale di San Pietro
Borgo XX Giugno n°74. **Dipartimento di Scienze Agrarie Alimentari ed Ambientali** (DSA3)
Università di Perugia

Wednesday 15

13:30 > 14:30 Registration

14:30 > 15:00
Congress Presentation and welcome addresses

15:00 > 15:40 — *Ergonul P.G.*
Valuable Oily seeds/ cold pressed seeds oils market and risk of the contaminants during supply chain

15:40 > 16:10 Coffee Break

16:10 > 16:30 — *Bondioli P. - Calderari I.*
Pressure extracted seed oils: a normative perspective. State of the art

16:30 > 16:50 — *Di Matteo G.*
A multi-methodological approach for the hemp seed oils characterization *

16:50 > 17:10 — *Stilinovi R.*
Avocado oil production by milling technology and oil separation by means of a decanter

17:10 > 17:30 — *Benincasa C. - et al.*
Biochemical composition and antioxidant properties of Algerian date seeds oil (Phoenix dactylifera L)

17:30 > 17:50 — *Cardenia V. - et al.*
Characterization of a "middle age" oil from Occitan Valleys: the "oil of ground hog" (Prunus brigantina Vill)

17:50 > 18:10 — *Caponio F. - et al.*
Durum wheat: a sustainability germ

18:10 > 19:00 SISSG General Assembly

Thursday 16

9:00 > 10:00 — Fachini AWARD *Giovanni Lercker*
The evolution of researches on frauds on edible oils and fats, lipids and other foods

10:00 > 11:00 — Fachini AWARD *Konrad Grob*
My journey through capillary GC

11:00 > 11:30 Coffee Break

11:30 > 11:50 — *Alexandrescu L. - et al.*
Latest developments in EU marketing standards for olive oil

11:50 > 12:10 — *Camin F. - et al.*
NMR spectroscopy in extra virgin olive oil authentication

12:10 > 12:30 — *Di Giovacchino L.*
The modern oil mill: extractive efficiency, oil quality, diversification and environmental sustainability

12:30 > 14:10 Lunch

14:10 > 14:30 — *Aprea E. - et al.*
Sensory and instrumental dynamic methods to investigate perceived quality Italian extra Virgin Olive Oils

14:30 > 14:50 — *Kocoli T.M.*
Organic and new processing technologies and quality control analysis of extra virgin olive oil with multivariate approach

14:50 > [illegible] — [illegible] - et al.
An 1H NMR Chemometric model for the classification of Italian extra virgin olive oils

15:10 > 15:30 — *Clodoveo M.L. - et al.*
Med Index: a food product labelling system to promote adherence to the Mediterranean diet encouraging producers to make healthier and more sustainable food products: the case study of extra virgin olive oil

15:30 > 15:50 — *Casadei E. - et al.*
An harmonized multi analyse SPME GC-FID or GC-MS method for measuring volatile compounds in virgin olive oil: some evidence from the validation process

15:50 > 16:10 — *Giomo A. - et al.*
Flavourspec® Machine Learning the new frontiers in instrumental support for the sensory analysis of virgin olive oils

16:10 > 16:40 Coffee Break

16:40 > 17:00 — *Sarani A.*
Correlation between volatile compounds and the organoleptic characteristics of extra virgin olive oils

17:00 > 17:20 — *Giomo A. - et al.*
Study of a predictive model of the shelf life of extra virgin olive oil in bottles through the evaluation of the odorous molecules of the headspace

17:20 > 17:40 — *Cecchi L. - et al.*
Analysis of volatile compounds: a potent multi faced tool for EVOO quality evaluation

17:40 > 18:00 — *Selvaggini R. - et al.*
Geographycal characterization of extra virgin olive oils through the analysis of head space volatile compounds (HS-SPME-GC-MS)

18:00 > 18:30 Discussion

Dinner

Friday 17

9:00 > 9:20 — *Bernardini M. Bernardini A.*
Contaminants mitigation (3-MCPD and GE) in edible oils

9:20 > 9:40 — *Schulz C.*
Basics of efficient and environmentally friendly vacuum systems

9:40 > 10:00 — *Veneziani G. - et al.*
Vacuum technology applied to mechanical extraction of virgin olive oils

10:00 > 10:20 — *Ciuffarin F. - et al.*
The impact of polyphenol content and gelator type on structure of extra virgin olive oil based oleogels

10:20 > 10:40 — *Tessitori A. et al.*
Innovation in vegetable oils filtration

10:40 > 11:10 Coffee Break

11:10 > 11:30 — *Gallina Toschi T. - et al.*
Comparison of three different methodologies for the quantification of hydroxytyrosol and tyrosol in olive oils, in relation to the health claim

11:30 > 11:50 — *Menegoz-Ursol L. - Moret S.*
Solvent saving sample preparation for high sensitivity determination of MOSH and MOAH in vegetable oils

11:50 > 12:10 — *Carretta A. - Ventro C.*
Automation in olive oils analysis

12:10 > 12:30 — *Peroni D. - et al.*
Improvements of MOSH/MOAH analysis and speciation and identification of contaminants

12:30 > 13:00 Conclusions and farewell

Poster session

Bendini A. - et al.
Flavoured olive oils by co-milling of olives, black pepper and orange fruits or pomace: compositional characterization, sensory properties and sustainability aspects

Benincasa C. - et al.
Characterization of new lipophyl phenolic compounds in olive oil and in byproducts

De Santis A. - et al.
Health claim dealing with polyphenols in extra virgin olive oils: a study on its reliability in time

Sordini B. - et al.
New food ingredients obtained from the olive blackwater

Fiorenza M. - et al.
The definition of analytical markers of the geographical origin of virgin olive oils based on the evaluation of minor constituents with particular reference to volatile compounds

Florio D. - et al.
Functional oils through enrichment of olive oils and refined seed oils treated with waste water

Mercatante D. - et al.
Valorization of olive mill waste waters through the production of phenol-enriched extracts: utilization for the formulation of low-nitrite meat products

Panni F. - et al.
HS-GC-IMS and SPME-GC-FID: screening and targeted methods to classify virgin olive oils, in support to the panel test, by exploiting the volatile fraction

Pellerino M. - et al.
Development of rapid and non-destructive methods for determining the chemical composition and label compliance of extra virgin olive oil

Valli E. - et al.
Olive mill pomace valorization: sustainable methods to extract phenolic compounds

Naviglio D. - et al.
Analysis of triglycerides, cholesterol, wax esters and steryl esters in foods by means of Restek 65 TG-HT Capillary Colum and analysis of fatty acids as phenethyl esters by means of HPLC

Stefanucci A. - et al.
Phenolic analysis and in vitro biological activity of pomace and grape seeds oil derived from Vitis vinifera L. cv Montepulcano d'Abruzzo

Outline of my talk

Introduction

- **Part I:** Olive Oil Processing Technologies
- Organic Olive oil Processing
- New emerging Non thermal Olive Oil Processing Methods
- **Part II.** Quality Control of Olive oil with Chemometric Methods

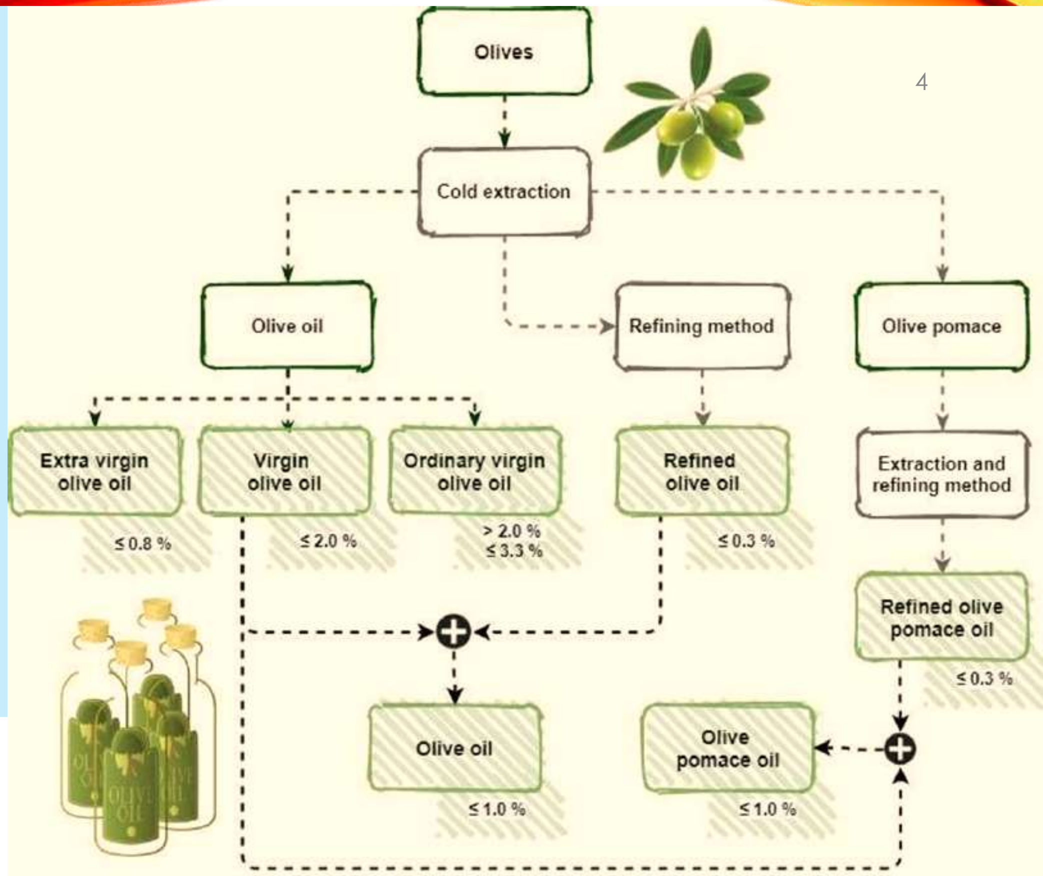
Conclusions

According to the International Olive Council (IOC), VOO is the olive oil "obtained from the fruit of the olive tree (Olea europaea L.) 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".

It has a standardized protocol for commercial classification based on sensory attributes. This protocol is officially regulated by European legislation and, together with 26 chemical parameters, is used for classifying olive and olive pomace oil

Bruna and Marcio, 2021

Olive Oil Classes
Extra virgin olive oil (EVOO)
Virgin olive oil (VOO)
Ordinary virgin olive oil
Lampante virgin olive oil
Refined Olive Oil (ROO)
Olive oil (ROO+VOOs)
Crude olive pomace oil
Refined olive–pomace oil (ROPO)
Olive Pomace Oil (ROPO+VOOs)



	1. Quality Criteria				
	1.1.Organoleptic Characteristics				
Olive Oil Classes	Odour and taste	Median defect	Median fruity	Colour	Aspect at 20 ^{0}C for 24h
Extra virgin olive oil		Me=0	Me>0		
Virgin olive oil		0<Me≤3.5	Me>0		
Ordinary virgin olive oil		3.5<Me≤6.0			
Lampante virgin olive oil		Me>0			
Refined Olive Oil	Acceptable			Light yellow	limpid
Olive oil (ROO+VOOs)	Good			Light yellow to green	limpid
Crude olive pomace oil					
Refined olive–pomace oil	Acceptable			Light yellow to brownish yellow	limpid
Olive Pomace Oil (ROPO+VOOs)	Good			Light yellow to green	limpid

Kritsakis et al., 20202

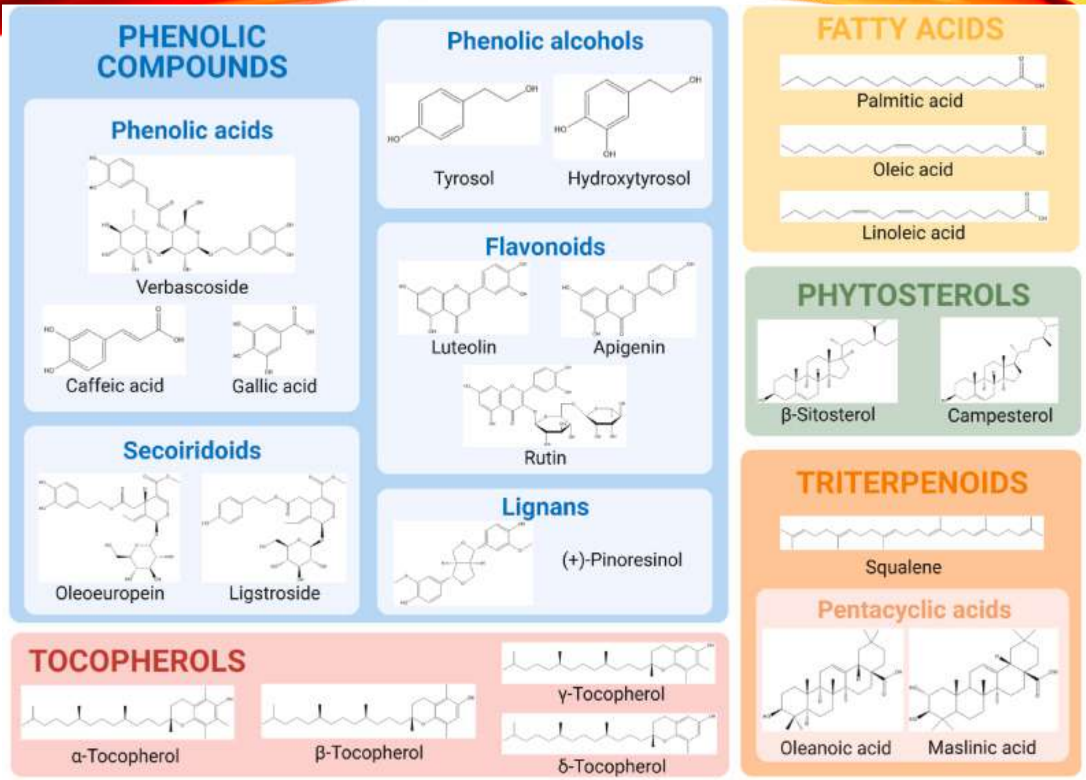
	Quality Criteria (continued)								
Olive Oil Classes	1.2. Free Acidity % m/m expressed in oleic acid	1.3. Peroxide value in milleq. peroxide oxygen per kg/oil	1.4. Absorbance in ultra-violet (270 nm 232 nm*	1.5. Moisture volatile matter	1.6. Insoluble impurities in light petroleum % m/m	1.7. Flash point	1.8. Trace metals mg/kg Iron Copper	1.9. Fatty acid ethyl esters (FAEEs)	1.10. phenol content
Extra virgin olive oil	≤0.8	≤20	≤0.22 ≤0.01 ≤2.5	≤0.2	≤0.1	-	≤3.0 ≤0.1	≤ 35 mg/kg	
Virgin olive oil	≤2.0	≤20	≤0.25 ≤0.01 ≤2.6	≤0.2	≤0.1	-	≤3.0 ≤0.1		
Ordinary virgin olive oil	≤3.3	≤20	≤0.30 ≤0.01	≤0.2	≤0.1	-	≤3.0 ≤0.1		
Lampante virgin olive oil	>3.3	No limit		≤0.3	≤0.2	-	≤3.0 ≤0.1		
Refined olive oil	≤0.3	≤5	≤1.25 ≤0.16	≤0.1	≤0.05	-	≤3.0 ≤0.1		
Olive oil (ROO+VOOs)	≤1.0	≤15	≤1.15 ≤0.15	≤0.1	≤0.05	-	≤3.0 ≤0.1		
Crude olive pomace oil	No limit	No limit		≤1.5		≥120°C			
Refined olive–pomace oil	≤0.3	≤5	≤2.00 ≤0.20	≤0.1	≤0.05	-	≤3.0 ≤0.1		
Olive pomace oil (ROPO+VOOs)	≤1.0	≤15	≤1.70 ≤0.18	≤0.1	≤0.05	-	≤3.0 ≤0.1		

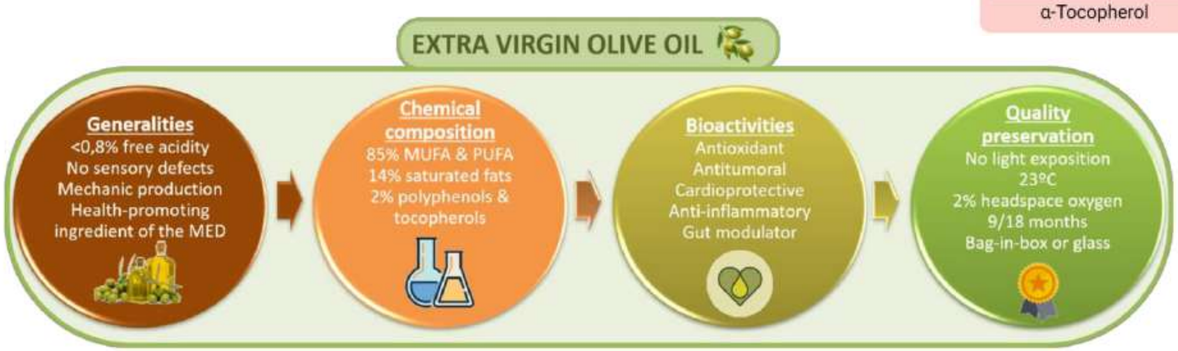
	Other requirements							
		Contaminants						
Olive Oil Classes	Food Additives	Heavy metals Lead (Pb) Arsenic (As)	Pesticide residues	Halojenated solvents	Hygiene	Packaging	Container tolerance	Labelling
Extra virgin olive oil	None	≤0.1 mg/kg ≤0.1 mg/kg	maximum residue limits established by the Codex Alimentarius Commission	each halogenated solvent ≤ 0.1 mg/kg sum of all halogenated solvents ≤ 0.2 mg/kg	General Principles of Food Hygiene (CAC/RP 1-1969), and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice. Microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria (CAC/GL 21-1997).	Olive oils and olive pomace oils shall be packed in containers complying with the General Principles of Food Hygiene recommended by the Codex Alimentarius Commission (CAC/RCP 1 - 1969), and other relevant texts such as Codes of Hygienic Practice and Codes of Practice. The containers used may be: 1. tanks, containers, vats, which permit the transportation in bulk of olive oils and olive pomace oils; 2. metal drums, in good condition, hermetically-sealed, 3. metal tins and cans, lithographed, new, hermetically-sealed, 4. demi-johns, glass bottles	The volume occupied by the contents shall under no circumstances be less than 90% of the capacity.	Codex General Standard for the Labelling of Pre-packaged Foods (CODEX STAN 1-1985) On containers intended for direct sale to consumers Name of the product Designations of olive oils Net contents Name and address Country of origin Geographical indications designations of origin Lot identification Date marketing and storage conditions
Virgin olive oil	None							
Ordinary virgin olive oil	None							
Lampante virgin olive oil	None							
Refined Olive Oil	a-tocopherol ≤ 200 mg/kg							
Olive oil (ROO+VOOs)	a-tocopherol ≤ 200 mg/kg							
Crude olive pomace oil	None							
Refined olive–pomace oil	a-tocopherol ≤ 200 mg/kg							
Olive Pomace Oil (ROPO+VOOs)	a-tocopherol ≤ 200 mg/kg							

Olive oil

As a natural product that is produced using 'only mechanical means' from olive drupes, olive oil quality and purity parameters and saftey issues are set by various regulations and institutions such as the EU Regulations

Authenticity of olive oil is described adequately in the legislations. The top two qualities of olive oil are the extra-virgin and the virgin olive oil on their unique physical, chemical and sensorial parameters.





(Commission Regulation EEC, 2016, Regulation UE, 2011, Regulation UE, 2016), International olive Council and Codex Alimentarius (Codex Stan, 2015).

According to the FAO 2017 data, although only 5% of the oil produced in the world is olive oil, its consumption has doubled in the last two decades Öner, 2021.

Although Spain is the biggest oil – producing country,

Greece (20 l per capita) is the biggest oil–consuming country.

Other countries are

Spain (14.2 l per capita),

Italy (11.3 l per capita),

Portugal (8 l per capita),

Syria (4.9 l per capita), Morocco (4.7 l per capita), Tunisia (3.8 l per capita) and Turkey (2.2 l per capita)

Olive oil could be an item wh created and consumed ancient times. It has been obse that there has been an incre interest in this oil, which has identified with the Mediterra diet, in recent years Turkey pos among the world's greatest m of olive oil like other lea Mediterranean nations (Olive Times, 2019).

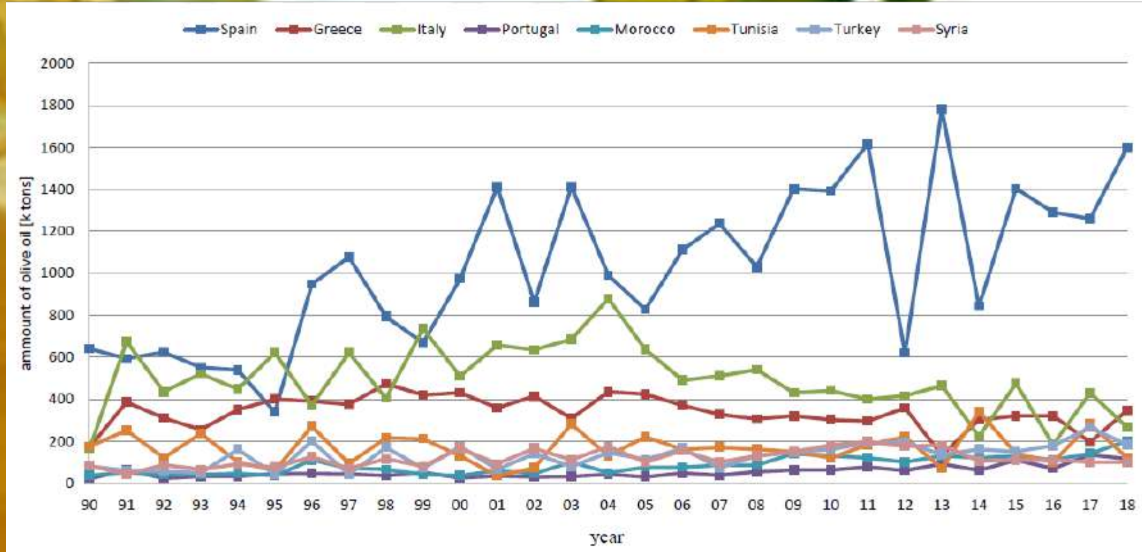
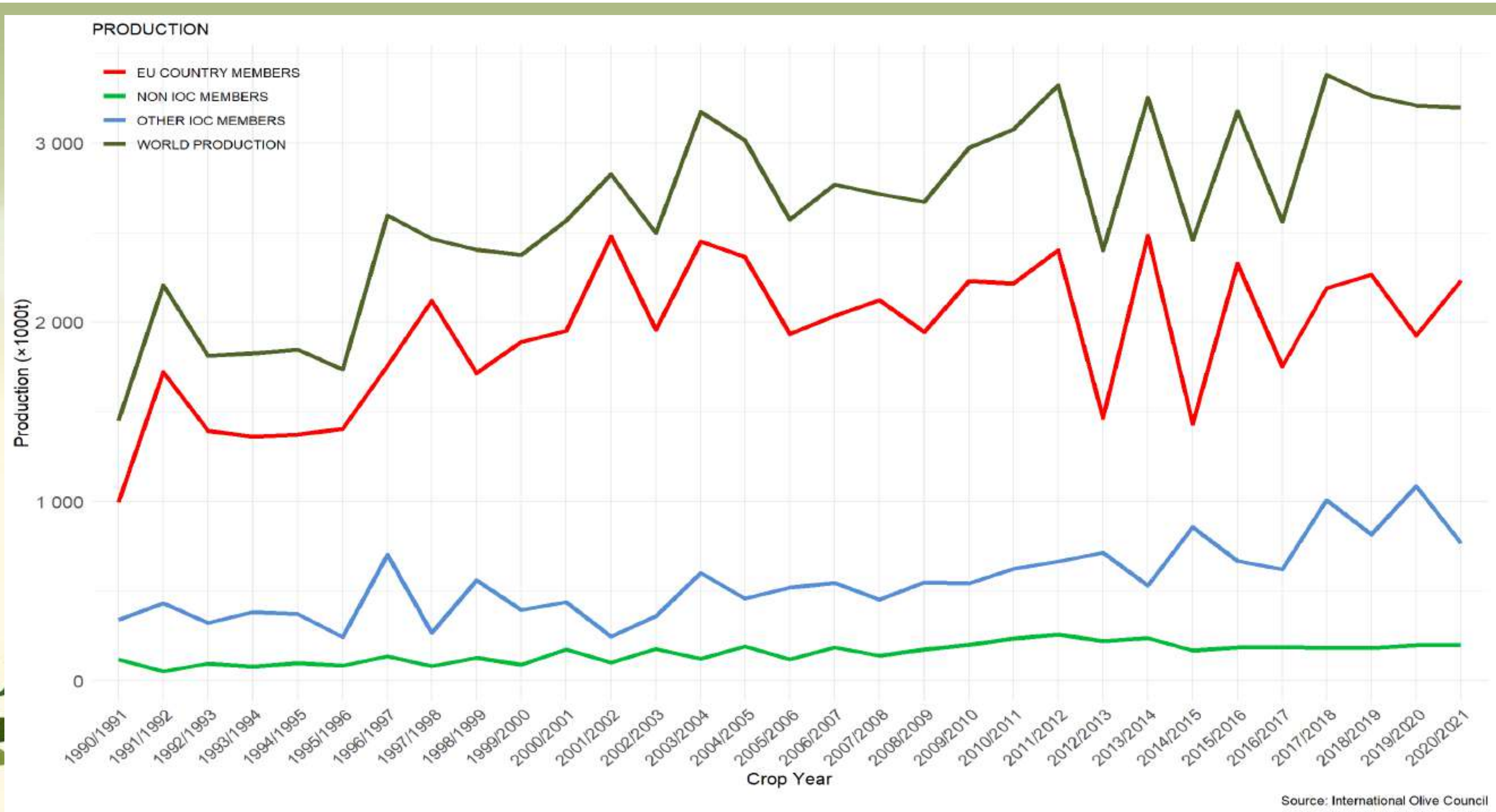


Figure 1. Olive oil production leaders by years (Olive Oil Times, 2019).

Production (×1000tn)	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021(p.)	Average	2021/2022(e.)	%variation rates
EU, of which:	**1 752**	**2 188**	**2 264**	**1 920**	**2 051**	**2 035**	**1 974**	↓ -3.8%
SPAIN	1 291	1 262	1 790	1 125	1 389	1 371	1 300	↓ -6.4%
GREECE	195	346	185	275	275	255	225	↓ -18.2%
ITALY	182	429	174	366	274	285	315	↑ 15.2%
PORTUGAL	69	135	100	140	100	109	120	↑ 20.0%
Other IOC countries, of which:	**620**	**1 007**	**808**	**1 158**	**758**	**870**	**936**	↑ 23.5%
TUNISIA	100	325	140	440	140	229	240	↑ 71.4%
TURKEY	178	263	194	230	210	215	228	↑ 8.3%
MOROCCO	110	140	200	145	160	151	200	↑ 25.0%
ALGERIA	63	82	97	126	70	88	98	↑ 39.0%
EGYPT	30	40	41	40	30	36	20	↓ -33.3%
ARGENTINA	24	45	28	30	30	31	30	↓ 0.0%
Non-IOC producers:	**190**	**184**	**233**	**188**	**200**	**199**	**188**	↓ -6.2%
TOTAL	**2 561**	**3 379**	**3 305**	**3 266**	**3 010**	**3 104**	**3 099**	↑ 2.9%

IOC, 2022



World production of olive oil at 3 010 000t, for the 2020/21 crop year which is 8 % less than the previous year.

IOC, 2022

Tableau 2: IMPORTATION

		2017/18 (28)	2018/19 (29)	2019/20 (30)	2020/21 (prov.) (31)	2021/22 (prev.) (32)
Albanie	Albania	1,5	1,0	1,5	1,5	1,5
Algérie	Algeria	0,0	0,0	0,0	0,0	0,0
Argentine	Argentina	0,0	1,5	0,5	1,0	0,5
Chypre	Cyprus					
Croatie	Croatia					
Egypte	Egypt	2,5	3,5	4,5	0,0	0,0
Géorgie	Georgia		0,5	0,5	0,5	0,5
Iran	Iran	3,5	3,0	3,0	1,0	2,0
Irak	Iraq	1,5	1,5	1,5	1,5	1,5
Israël	Israel	4,0	10,5	12,5	10,0	12,0
Jordanie	Jordan	0,0	0,0	0,0	0,0	0,0
Liban	Lebanon	5,5	0,0	0,0	0,0	0,0
Libye	Libya	0,0	0,0	0,0	0,0	0,0
Maroc	Morocco	12,0	5,5	6,5	8,0	4,0
Montenegro	Montenegro	0,0	0,0	0,0	0,0	0,0
Ouzbékistan	Uzbekistan			0,5	0,5	0,5
Palestine	Palestine	0,0	0,0	0,0	0,0	0,0
Tunisie	Tunisia	0,0	0,0	0,0	0,0	0,0
Turquie	Turkey	0,0	0,0	0,0	0,0	0,0
UE *	EU *	180,0	145,0	250,5	167,5	210,5
Uruguay	Uruguay	1,0	1,0	1,0	1,0	0,0
TOTAL A		**211,6**	**173,0**	**282,6**	**182,6**	**233,0**
A. Saoudite	Saudi Arabia	33,5	34,5	38,5	28,0	30,0
Australie	Australia	31,0	32,0	36,0	36,0	35,5
Brésil	Brazil	76,5	86,0	104,0	106,5	109,5
Canada	Canada	47,0	46,5	57,5	58,0	65,0
Chili	Chile	2,5	1,5	1,5	2,0	1,5
China	China	38,0	46,0	50,5	45,5	52,5
Etats-Unis	USA	310,5	346,5	391,0	379,5	401,0
Japon	Japan	55,5	69,0	69,5	59,0	60,0
Mexique	Mexico	15,0	16,5	20,5	19,0	14,5
Norvège	Norway	4,0	4,0	4,5	4,0	4,0
Russie	Russia	20,5	24,0	27,0	32,0	35,0
Syrie	Syria	0,0	0,0	0,5	0,0	0,0
Suisse	Switzerland	14,5	15,0	18,0	15,5	15,0
Taiwan	Taiwan	7,5	8,0	9,5	8,0	8,0
Autres P.prod.	Other pr.coun.	2,0	2,0	2,0	2,0	2,0
Autr.P.un.imp.	Oth.non-prod.	73,5	70,5	127,0	135,0	145,0
TOTAL B		**731,6**	**802,0**	**957,6**	**930,0**	**978,6**
TOTAL MONDIAL WORLD		**943,0**	**976,0**	**1.240,0**	**1.122,6**	**1.211,6**

IOC, 2022

Tableau 3: EXPORTATION

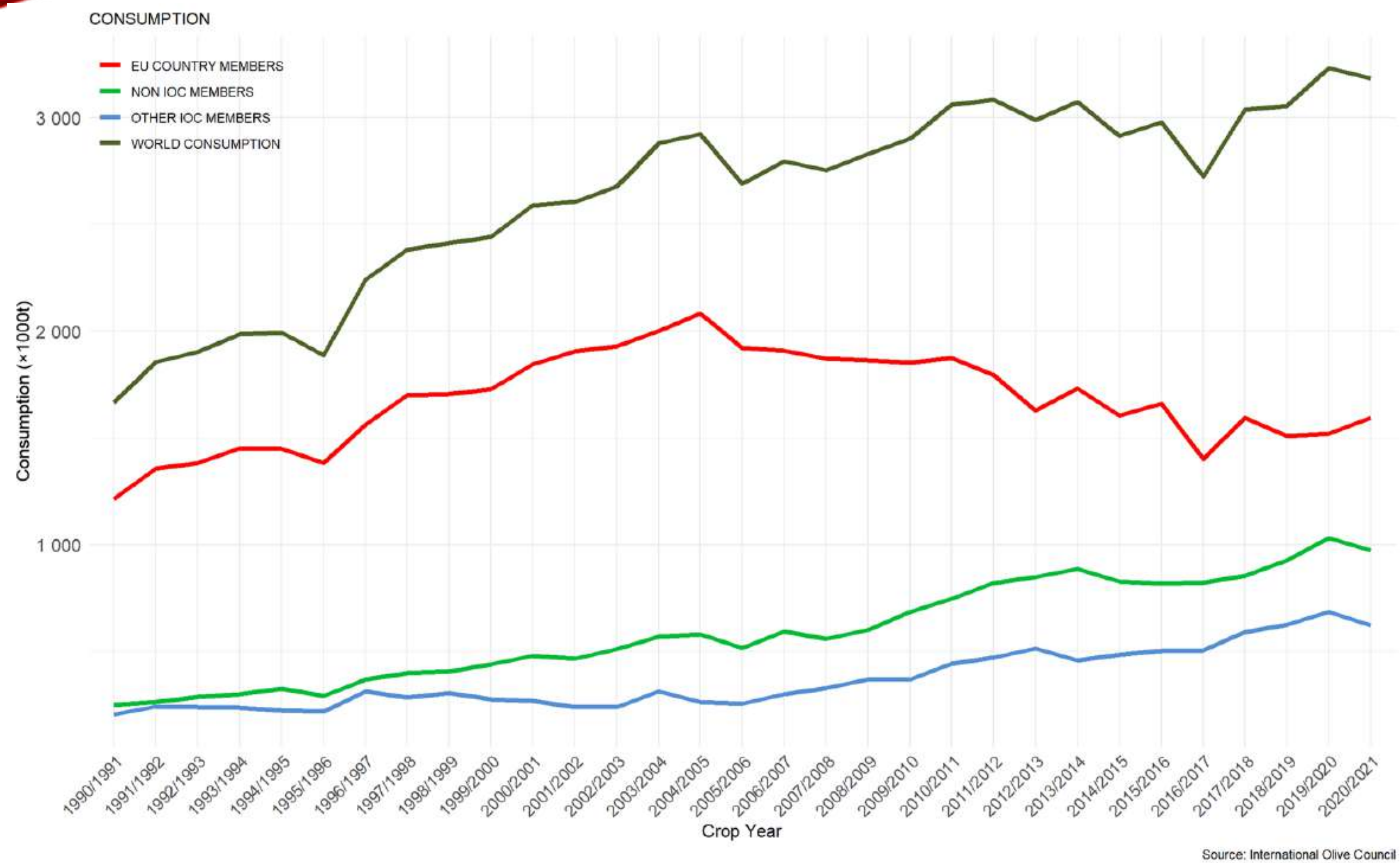
		2017/18 (28)	2018/19 (29)	2019/20 (30)	2020/21 (prov.) (31)	2021/22 (prev.) (32)
Albanie	Albania	0,0	0,0	0,0	0,0	0,0
Algérie	Algeria	0,0	0,0	0,0	0,5	0,0
Argentine	Argentina	37,5	21,5	23,0	23,0	23,0
Chypre	Cyprus					
Croatie	Croatia					
Egypte	Egypt	2,5	0,5	1,0	0,0	0,0
Géorgie	Georgia		0,0	0,0	0,0	0,0
Iran	Iran	0,0	0,0	0,0	0,0	0,0
Irak	Iraq	0,0	0,0	0,0	0,0	0,0
Israël	Israel	0,0	0,0	0,0	0,0	0,0
Jordanie	Jordan	0,0	0,5	0,5	3,5	3,0
Liban	Lebanon	3,0	6,5	6,5	6,0	6,0
Libye	Libya	0,0	0,0	0,0	0,0	0,0
Maroc	Morocco	11,0	28,0	10,5	10,0	28,0
Montenegro	Montenegro	0,0	0,0	0,0	0,0	0,0
Ouzbékistan	Uzbekistan			0,0	0,0	0,0
Palestine	Palestine	4,5	2,5	8,0	6,0	5,5
Tunisie	Tunisia	205,0	160,0	355,0	170,0	200,0
Turquie	Turkey	66,0	55,0	45,0	40,0	46,0
UE *	EU *	563,5	648,0	746,5	804,0	830,0
Uruguay	Uruguay	0,0	0,0	1,0	0,5	0,0
TOTAL A		**893,0**	**822,6**	**1.197,0**	**1.063,5**	**1.141,6**
A. Saoudite	Saudi Arabia	0,5	0,5	0,0	0,5	0,5
Australie	Australia	3,0	3,0	2,5	4,0	4,0
Brésil	Brazil	0,0	0,0	0,0	0,0	0,0
Canada	Canada					
Chili	Chile	14,5	12,0	15,5	13,0	14,0
China	China					
Etats-Unis	USA	8,5	6,5	3,5	4,0	9,0
Japon	Japan					
Mexique	Mexico	0,0	1,5	1,5	3,5	0,0
Norvège	Norway					
Russie	Russia					
Syrie	Syria	20,0	18,0	15,0	15,0	15,0
Suisse	Switzerland					
Taiwan	Taiwan					
Autres P.prod.	Other pr.coun.	5,0	5,0	5,0	5,0	5,0
Autr.P.un.imp.	Oth.non-prod.					
TOTAL B		**51,6**	**48,6**	**43,0**	**45,0**	**47,6**
TOTAL MONDIAL WORLD		**944,6**	**969,0**	**1.240,0**	**1.108,6**	**1.189,0**

* sans les échanges intracomm

Tableau 4: CONSOMMATI

		2017/18 (28)	2018/19 (29)	2019/20 (30)	2020/21 (prov.) (31)	2021/22 (prev.) (32)
Albanie	Albania	12,5	13,5	13,0	14,5	13,0
Algérie	Algeria	82,5	92,0	115,0	80,0	97,0
Argentine	Argentina	8,0	7,5	7,5	7,5	7,5
Chypre	Cyprus					
Croatie	Croatia					
Egypte	Egypt	40,0	45,0	43,0	30,0	20,5
Géorgie	Georgia		0,5	0,5	0,5	0,5
Iran	Iran	10,5	14,5	11,0	12,5	12,0
Irak	Iraq	1,5	1,5	1,5	1,5	1,5
Israël	Israel	21,0	25,0	28,0	25,0	23,0
Jordanie	Jordan	22,0	21,0	34,0	21,5	19,0
Liban	Lebanon	20,0	11,0	7,5	20,0	15,5
Libye	Libya	18,0	16,5	17,0	16,0	16,0
Maroc	Morocco	120,0	150,0	140,0	140,0	150,0
Montenegro	Montenegro	0,5	0,5	0,5	0,5	0,5
Ouzbékistan	Uzbekistan			0,5	0,5	0,5
Palestine	Palestine	15,0	12,5	17,0	16,0	16,5
Tunisie	Tunisia	40,0	40,0	38,0	30,0	30,0
Turquie	Turkey	176,5	163,0	170,0	160,0	170,0
UE	EU	1.595,0	1.508,5	1.520,0	1.476,5	1.505,0
Uruguay	Uruguay	1,5	2,0	2,0	1,5	1,5
TOTAL A		**2.184,5**	**2.124,5**	**2.166,0**	**2.054,0**	**2.098,5**
A. Saoudite	Saudi Arabia	33,5	37,5	41,5	33,0	33,5
Australie	Australia	48,0	50,0	42,5	53,0	50,0
Brésil	Brazil	76,5	86,0	104,0	106,5	109,5
Canada	Canada	47,0	46,5	57,5	58,0	65,0
Chili	Chile	7,5	9,0	8,5	9,0	8,0
China	China	44,0	51,5	57,5	53,0	60,5
Etats-Unis	USA	315,0	351,0	402,5	389,0	401,0
Japon	Japan	55,5	69,0	69,5	59,0	60,0
Mexique	Mexico	15,0	15,0	17,0	17,5	14,5
Norvège	Norway	4,0	4,0	4,5	4,0	4,0
Russie	Russia	20,5	24,0	27,0	32,0	35,0
Syrie	Syria	80,0	136,0	103,5	86,0	93,5
Suisse	Switzerland	14,5	15,0	18,0	15,5	15,0
Taiwan	Taiwan	7,5	8,0	9,5	8,0	8,0
Autres P.prod.	Other pr.coun.	12,5	12,5	12,5	12,5	12,5
Autr.P.un.imp.	Oth.non-prod.	73,5	70,5	127,0	135,0	145,0
TOTAL B		**854,5**	**985,5**	**1.102,5**	**1.071,0**	**1.116,0**
TOTAL MONDIAL WORLD		**3.039,0**	**3.110,0**	**3.268,5**	**3.125,0**	**3.214,5**

IOC, 2022



Consumption reached 2 054 000t in IOC member countries and 1 071 000t in non-member countries. Total consumption is expected at around 3 125 000t (-4.4%)

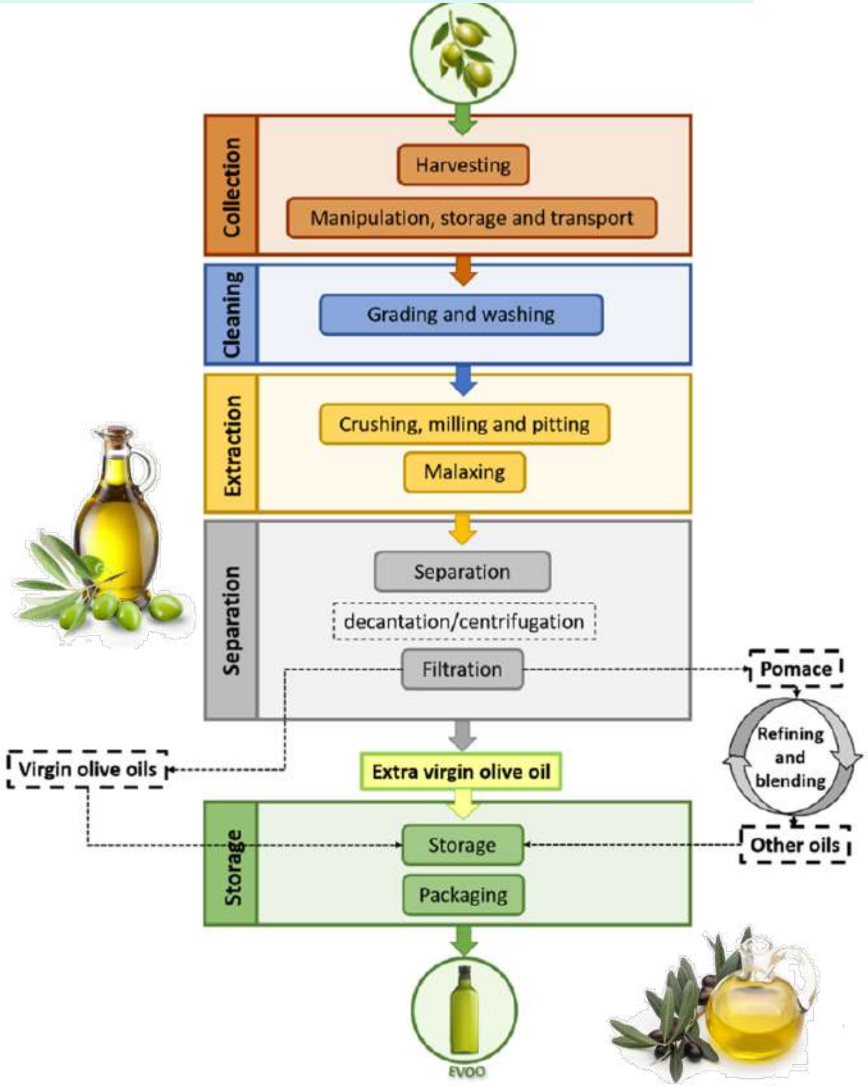
Part Ia. Olive Oil Procesing Technologies

Olive oil processing steps

1. Harvest, transport, storage
2. Washing olive crushing, milling
3. Mixing of the olive paste (malaxation)
4. Oil separation from the paste

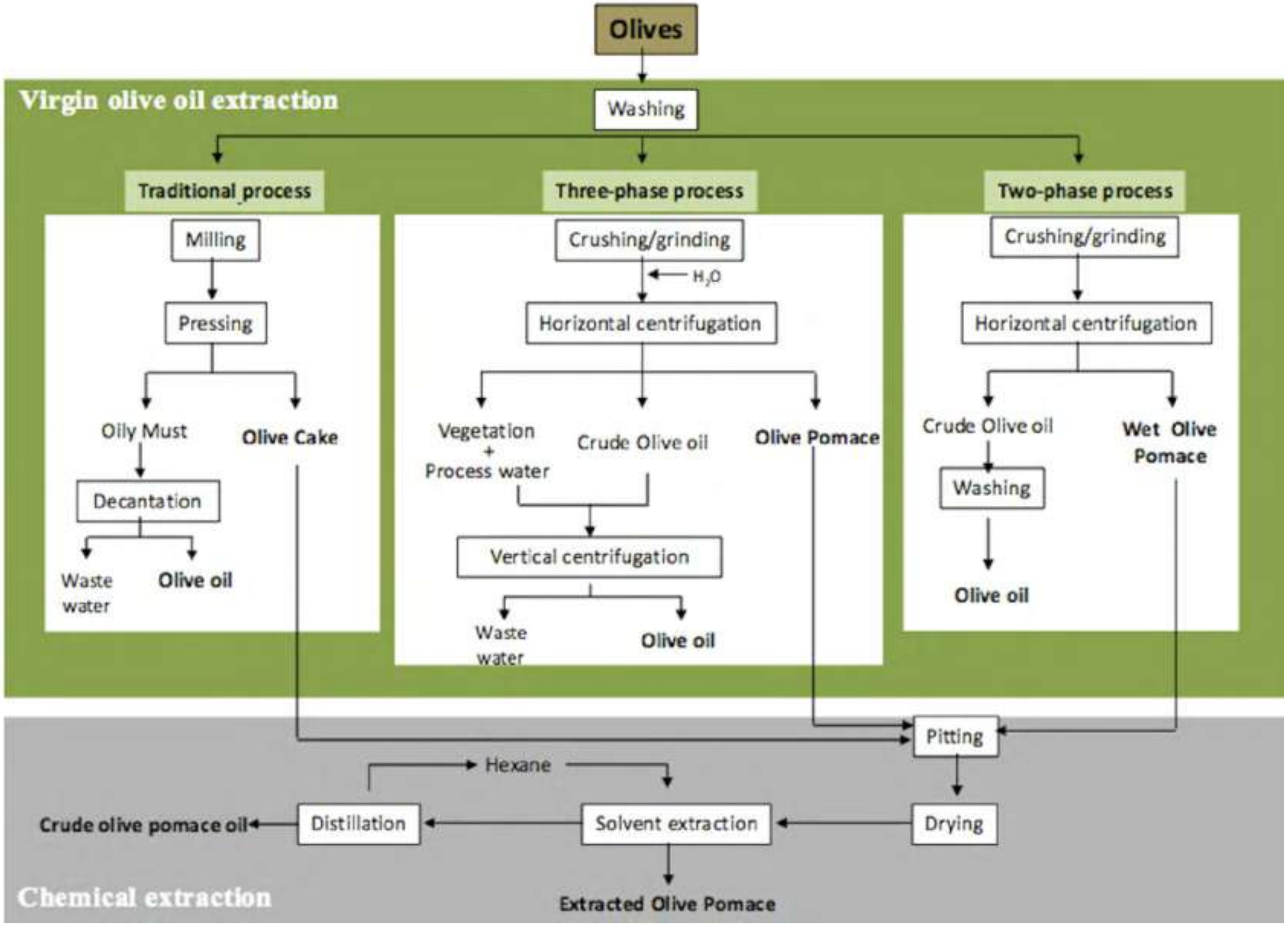
4.1. Pressure (Traditional systems)
4.2. Centrifugation (three-phase or two-phase decanter)
4.3. Selective filtration

5. Oil filtration, storage and packaging

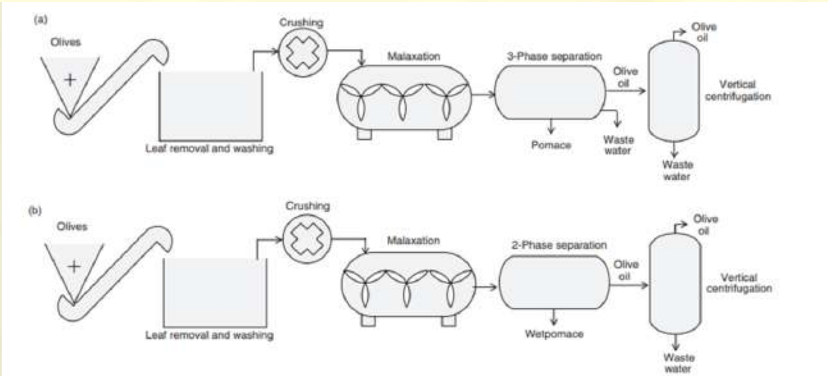


Vossen, 2020; Kritsakis et al., 2020

Usually, olive oil is obtained mechanically by pressure or by two or three-phase centrifugation systems or by selective filtration. There are approximately 12 000 olive oil mills in the world, more than 80 per cent of which are centrifugal shown in Figure .



Fernandes et al., 2016, Kritsakis et al., 2020, Jimenez-Lopez et al., 2021



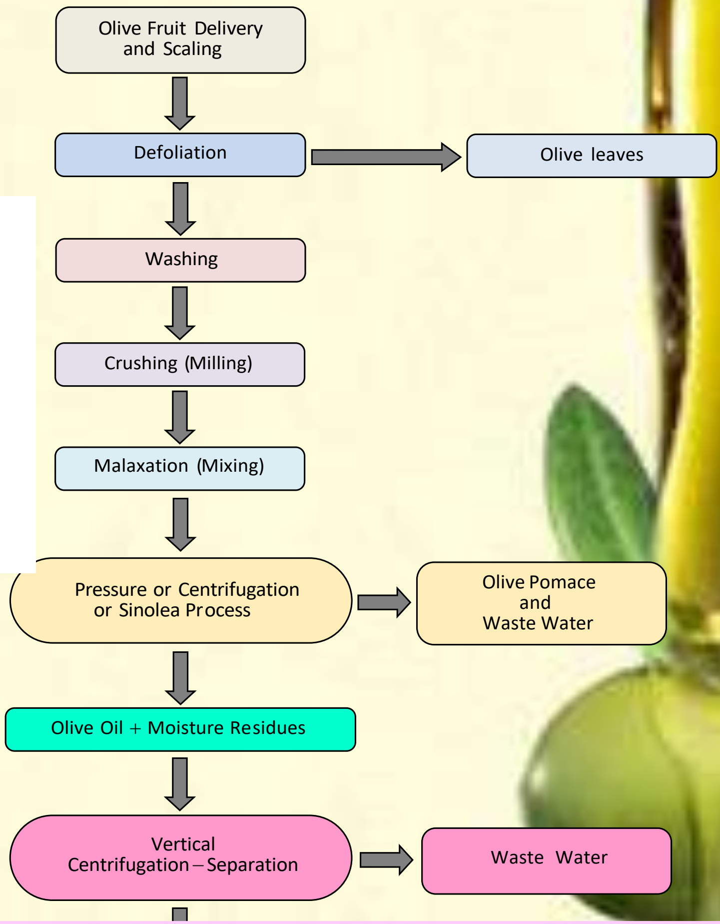


Figure 1. Flow chart of the olive oil extraction process in systems using 3-phase (a) and 2-phase (b) decanters (Centrifugal systems)

Factors Affecting Olive Oil properties

Olive oil quality depends on several factors related to the production

- in the primary sector (Geographic region, the climate, the crop season, the tree age, the operations and treatments in the field, and the time and operations applied for olive harvesting),
- to the processing technology and
- process variables as well as to
- the storage conditions.

primary sector variables that affect the olive oil characteristics such as the fatty acid profile, the composition of phenolic compounds and the sensory attributes. Unfortunately, many of the variables related to the primary sector cannot be controlled (e.g. weather, climate).

On the other hand, olive oil-processing variables can be controlled. A fine control of these variables can lead into an optimization of oil quality production yield, economy, and environmental impact

MILLING MACHINERY EFFECT ON OLIVE OIL QUALITY

MACHINE	*POSITIVE EFFECT*	*NEGATIVE EFFECT*
Hammermill	+ Fruity + Green	- Sweetness + Pungent + Bitter
Stone mill	+ Sweetness - Pungent - Bitter	- Fruity - Green
Disc mill	+ - Sweetness + - Pungent + - Bitter	+ - Fruity + - Green
Pitter mill	+ Sweetness - Pungent - Bitter	- Fruity - Green

PRINCIPLE ADVANTAGES and DISADVANTAGES of the PRESS, SELECTIVE FILTRATION, 2-PHASE, and 3-PHASE SYSTEMS

SYSTEM	*ADVANTAGES*	*DISADVANTAGES*
Press	*The old way romance factor, uses less energy, less cost to establish, produces relatively dry pomace*	*Less capacity, requires more labor, difficult to maintain cleanliness of mats, more paste and oil contact with oxygen*
Selective Filtration	*Extracts more oil in conjunction with decanter systems than decanter system alone, produces unique quality oil*	*Difficult to keep clean, greater maintenance, extracts only half of the oil, greater quality may not be worth the extra effort*
3-phase Decanter	*Produces relatively dry pomace, easier to monitor extraction efficiency than the 2-phase system, continuous flow*	*Uses more water, needs more power to heat extra water, washes out too many polyphenols in some oils, produces a lot of waste water, needs 2 vertical centrifuges*
2-phase Decanter	*No fruit-water effluent, oil has higher polyphenol content, uses less water, needs only one vertical centrifuge, continuous flow*	*Produces very wet pomace, more difficult to determine extraction efficiency*

CONTAINER CHARACTERISTICS FOR OLIVE OIL BOTTLING

ITEM	*ADVANTAGES*	*DISADVANTAGES*
Clear Glass	Customer can see the oil color, image of high quality	Greatest light exposure, can see sediments, breaks easily, size limitations, heavy
Colored Glass	Excludes some light, image of high quality, and can't see sediments	Customer can't see product, breaks easily, size limitations, heavy
Tin	Excludes all light, does not break, can't see sediments, can be used for larger containers	Customer can't see product, cheap image, can impart off flavors during long term storage
Plastic	Light weight, unbreakable, customer can see color, can be used for larger containers	Does not exclude light, cheap image, can see sediments, some oxygen passage, possible migration of pvc's into oil
Paper laminated (tetra-brik)	Excludes all light, can be used for frozen oil, unbreakable, can't see sediments, light weight	Unknown in the marketplace, can't see the oil color, may be cheap image, size limitations
Ceramic	Image of high quality, excludes light, can't see sediments	Fewer closure choices, breakable, heavy
Cork – wine type	Image of high quality	Difficult to open, drips, leaks, and poor oxygen exclusion
Cork with wide top	Image of quality	Drips, leaks, and poor oxygen exclusion
Screw- top w/plastic no drip	Easy to open, drip less, excludes oxygen, no leaks	Cheap image
Spout or spigot	Image of quality	Leaks, difficult to package
Tall narrow shape	Elegance and image of quality	Difficult to package and store in the kitchen
Short wide shape	Elegance and image	Difficult to handle
Round shape	Same	Same
Angular shape	Same	Same
Box enclosure	Image of high quality	Can't see the product without opening
Cylinder enclosure	Image of high quality	Can't see the product without opening

Factors affecting olive oil quality (milling, system used and packaging), Vossen, 2020

Part 1b. Organic Olive oil Processing

"Organic farming is an agricultural method that aims to produce food using natural substances and processes" (EC, 2020). EU introduced the organic logo and a strict system of control and enforcement in order to guarantee that organics rules and regulations.

EC, 2020

The organic logo gives a coherent visual identity to EU produced organic products sold in the EU, and since it can only be used on products that have been certified as organic by an authorised control agency or body, it represents a useful tool for consumers to recognise certified organic products and for farmers interested in marked them across all EU countries (EC, 2020).

National and regional products with PDO certification are preferred mainly for their higher perceived quality and respondents' interest.

Businesses do not have to drop their prices to compete with non-organic products, because the information on the product label is becoming increasingly important, influencing the quality perception and the social consciousness.

Consumers will increase their willingness to pay (WTP) a price premium, as well their purchase frequency of organic products.

Consumers perceive organic farming as an effective way to improve environmental quality and they prefer organic food, because it presumably contains fewer chemical residues and veterinary drugs compared to conventional food. Most of them express more and more anxiety on agrochemicals, hormones and medicine in animal production and GMO and artificial additives in fruits and vegetables.

There has been a growing concern for human health and safety, which is a key factor that influences consumer preference for organic food, which is motivating consumers to buy organic food as insurance and/or investment in health.

It was highlighted that the fundamental role of the health attribute to generate consumers' preferences for organic EVOO.

20% of organic agricultural lands in the world are used for olive cultivation.

According to 2017 data, 8.3% of olive production was provided from organic production. 70% of organic olive production is made in Europe and 30% in Africa (Tunisia).

The world leader in organic olive production is Tunisia (629000 acres). Other countries are Italy (570000 acres), Spain (480000 acres), Turkey (202 000 acres) and Greece (124,000 acres). The organic field used in olive cultivation has increased almost three times

Öner, 2021

Organic farming is of importance in the agricultural sector of many countries. **Organic olive** is one of the most important products in the world as well as in Turkey. **8%** of the olive orchards are managed organically in Turkey.
Organic cultivation in Turkey is being validated by Control and Certification private bodies according to the Organic Farming Regulation no. 5262/2004). The Turkish Ministry of Food, Agriculture and Livestock accredited control and Certification private bodies.

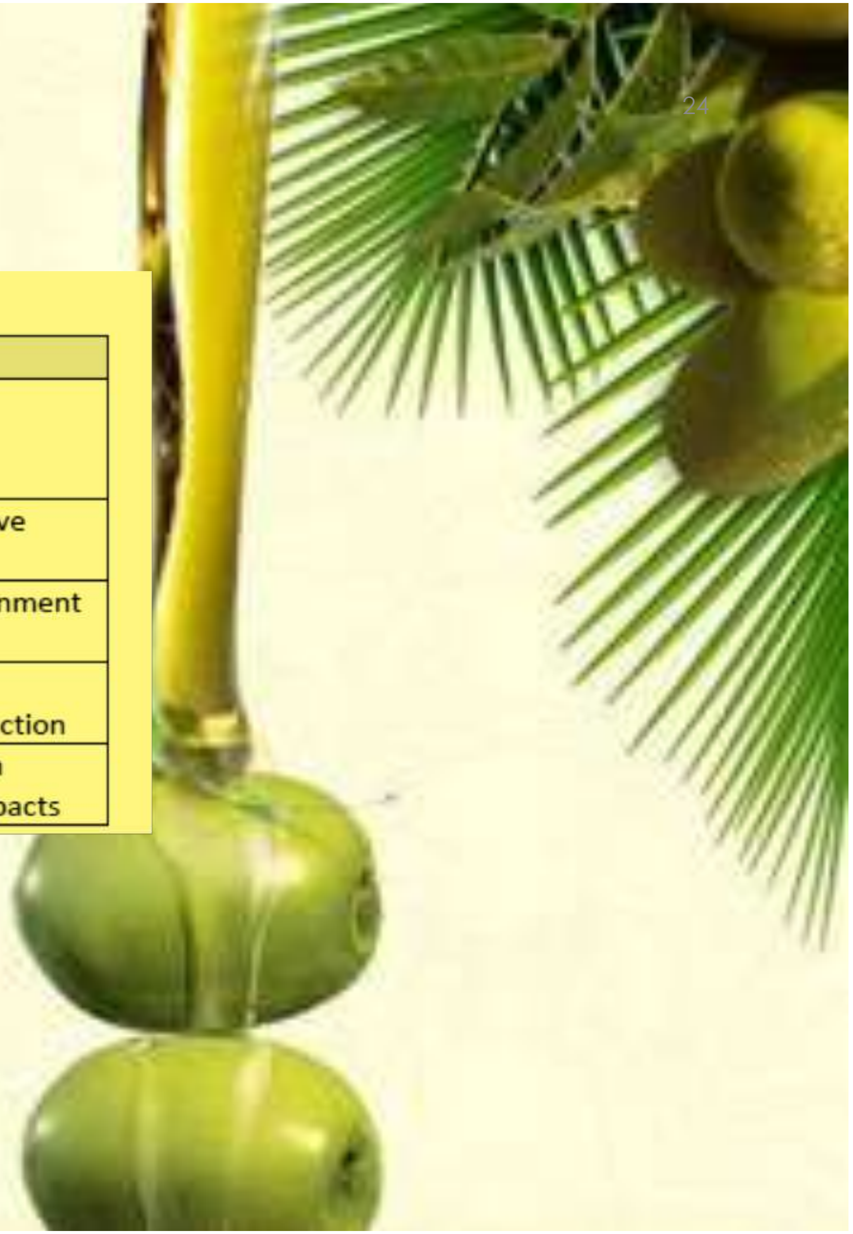
Many advantages, both from an environmental and social-economic point of view, are offered through the organic cultivations of olive trees.

- protection of the environment,
- protection of the health of producers and consumers and
- economic advantages.

In addition, both cooperatives entered in the organic olive and olive oil market. Tariş has already been producing organic virgin olive oil and Marmarabirlik introduced organic table olives in the market starting from 2015.

Some projects of Cooperatives and Unions for Organic Olive in Turkey

Union/Cooperative	Supporter	Project
Marmarabirlik	TÜBİTAK TEYDEB	Process development for olive by-product management and energy production using by-products
Marmarabirlik/ iznik Coop.	BEBKA Development Agency	Sustainable clean production in olive sector
Marmarabirlik/ Orhangazi Coop.	BEBKA Development Agency	Table olive production with environment friendly clean technologies
Marmarabirlik/ Orhangazi Coop.	GMKA Development Agency	Application of clean production technologies in pickled olive production
Tariş/ Ayvalık Coop.	GMKA Development Agency	Treatment of olive oil bagasse with minimization of environmental impacts



Öner, 2021

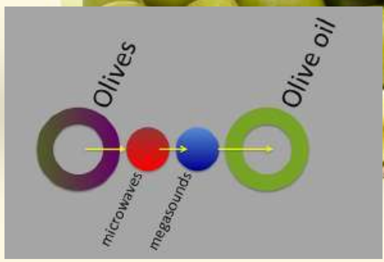
Part I c. New emerging Non thermal Olive Oil Processing Methods

Researchers working on the development of food technology are making great efforts to develop and implement "**minimal processing**" strategies to remove the negative effects of traditional food processing methods.

In the production of EVOO, these techniques are based on rupturing the cell walls and membranes of the olive fruit and promoting pore formation and membrane permeability, which leads to water influx, swelling, and deflation. A variety of methods have been explored to enhance the oil extraction including

- enzymatic pretreatment to degrade cell walls coadjuvants to avoid oil–water emulsions and
- new emerging technologies.

As a result, oil extraction during malaxation is improved and higher yields are obtained.



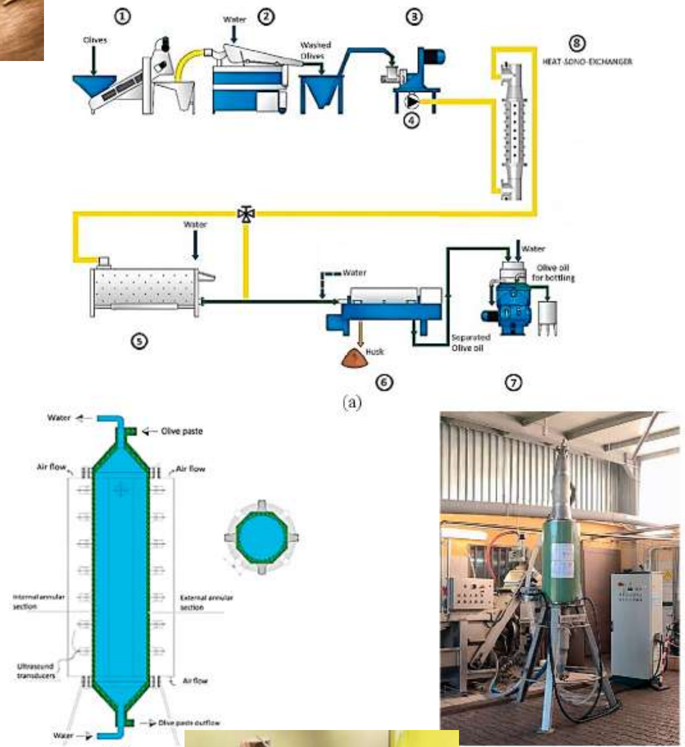
Baydar, 2018; Kritsakis et al., 2020

Considerable efforts have been dedicated to finding alternative processes that can reduce malaxation time, preserve the quality attributes of foods, while being environmentally friendly and low in cost In recent years, novel emerging technologies such as

- **microwave energy (from 300 MHz to 300 GHz),**
- **mechanical vibrations (under 200 Hz),**
- **pulsed electric field (PEF),**
- **ultrasounds (US),**
- **heat exchangers and flash thermal conditioning**.

have been adopted in olive oil extraction because of their positive effects including

- enhanced extraction efficiency,
- reduced extraction time,
- increased yield, and
- low energy consumption,
- satisfying the growing consumer demand for more natural products with fewer additives and preservatives
- offer convenience, freshness, and safety.



(a)

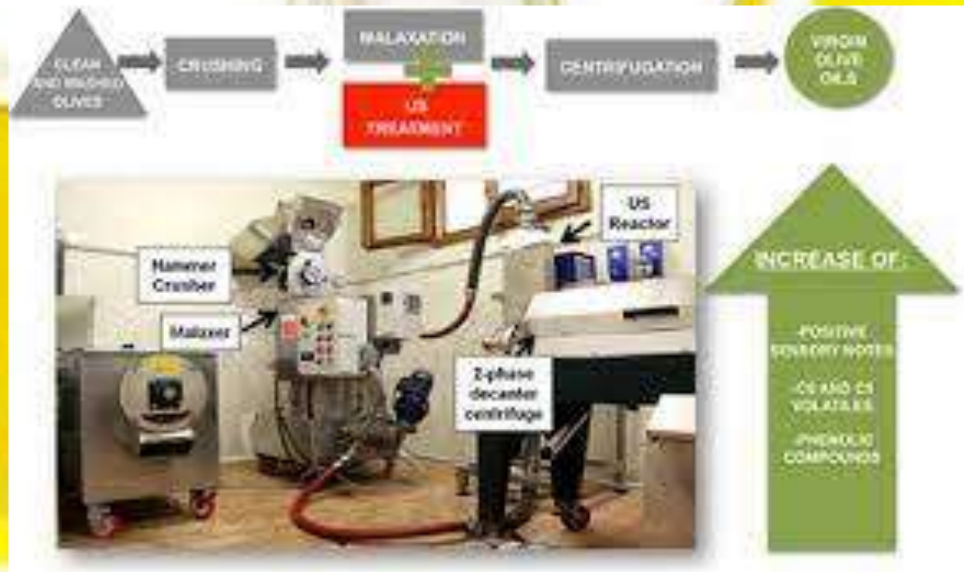
(b)

(c)

Perez et al., 2021

This new emerging technology could give more flavor and aroma, lower bitterness, higher yield, higher antioxidant content and longer shelf life. The extraction process assisted by PEF, HPP, US, and MW technologies has proved tobe very efficient on olive pastes, leading to a significant increase of the oil yield.

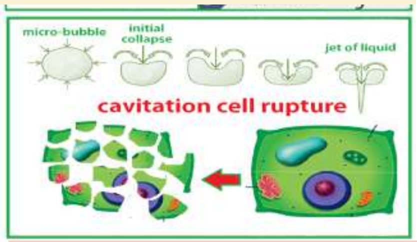
The oil yield as well as the quantity and quality of the oil produced can also be improved by using enzymes with pectinolytic and cellulolytic activity mineral talc and use of microorganisms. All these may significantly increase oil yields. However the use of coadjuvants is not in accordance with the legal definition of virgin olive oil



(Kritsakis et al., 2020)

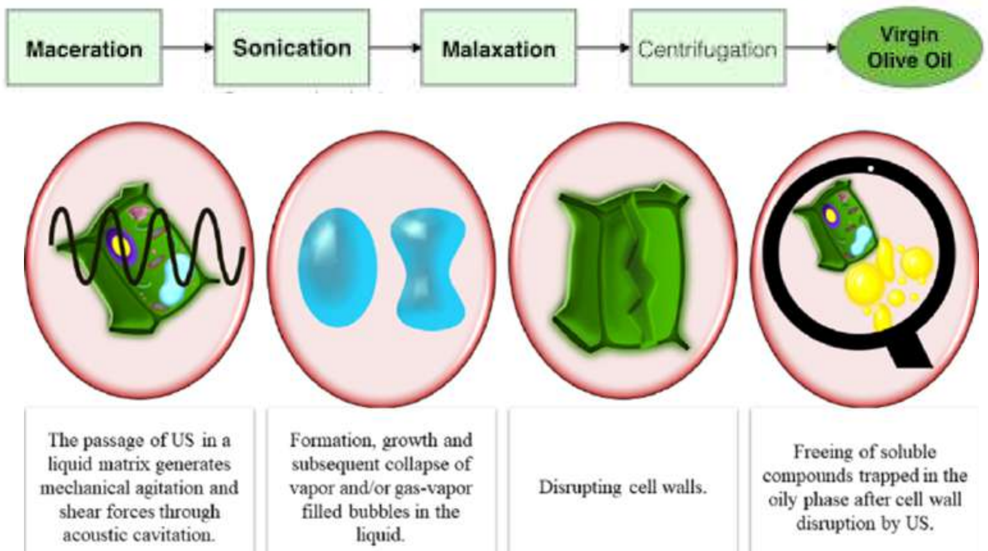
Ultrasound can be applied to the olive paste due to its mechanic effect on the cell membranes, which induces them to

- When applied before malaxation, US release oil easily from vacuoles with a lower malaxation time, production cost and higher oil quality and yield.

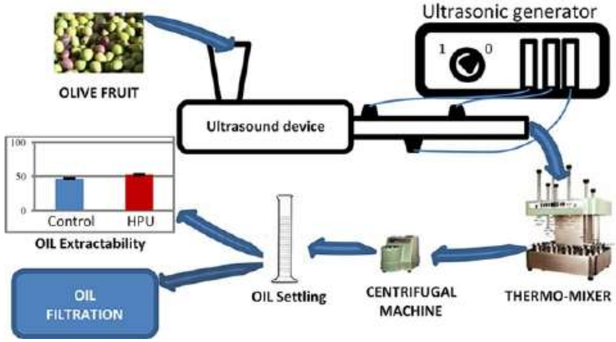


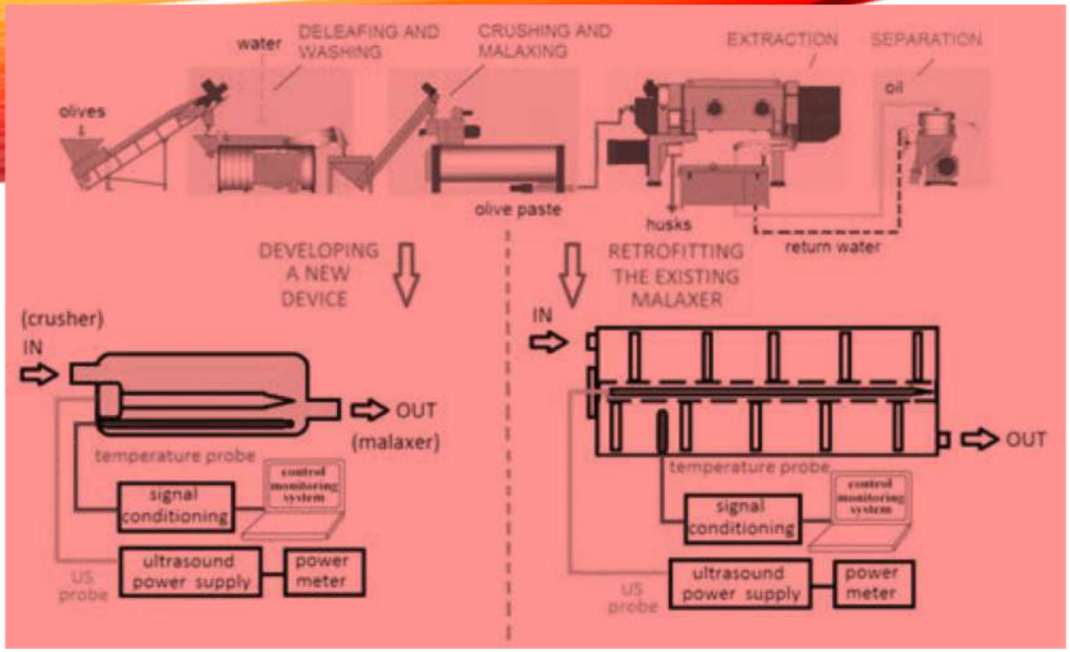
HPU improved oil extraction yield, shorter malaxation time

Baydar , 2018



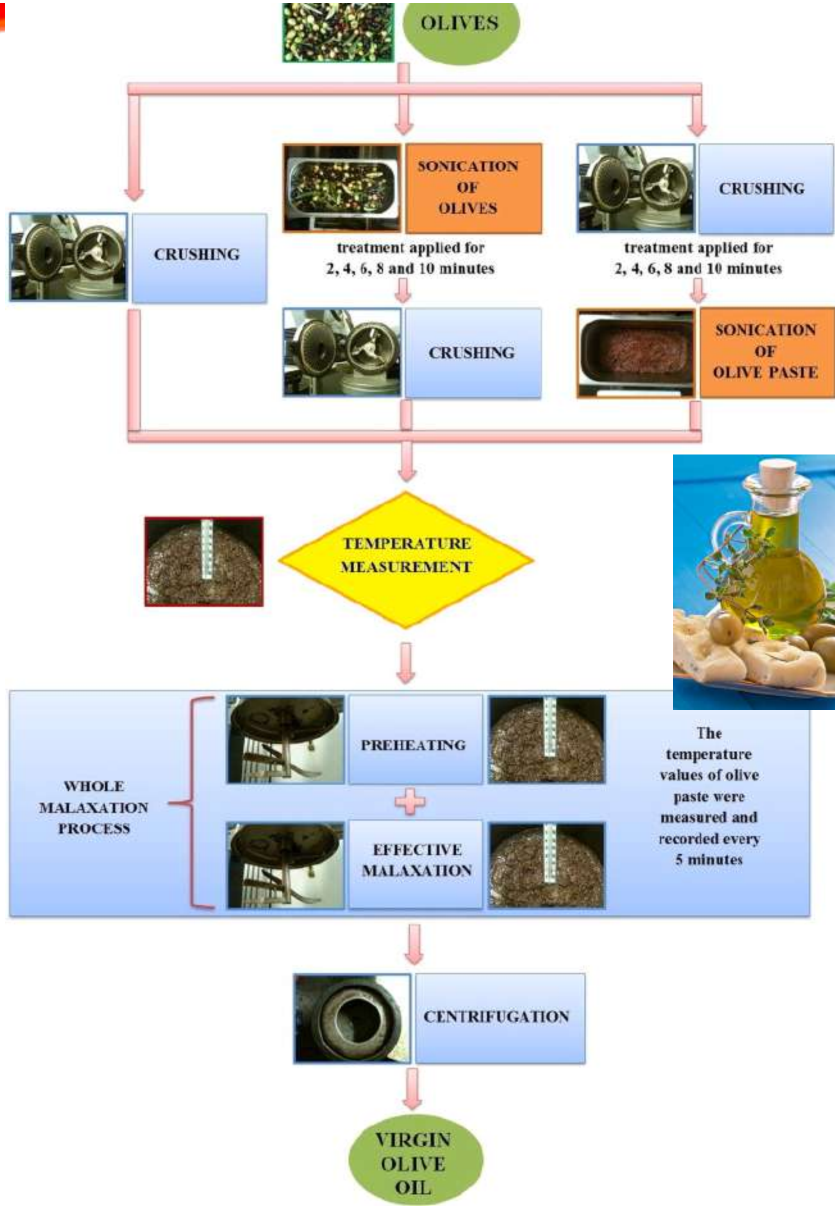
Freeing of soluble compounds trapped in the oily phase after cell wall disruption by ultrasound. US, ultrasound





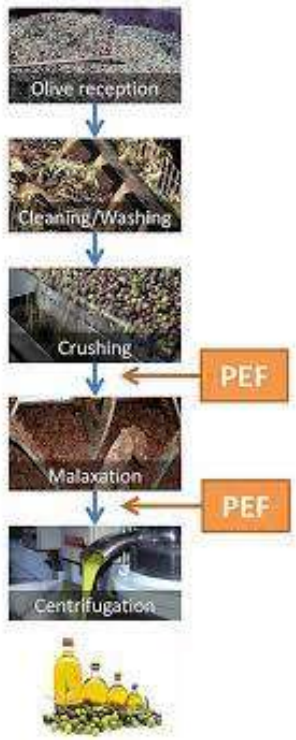
Scaling up of ultrasounds application in VOO industry

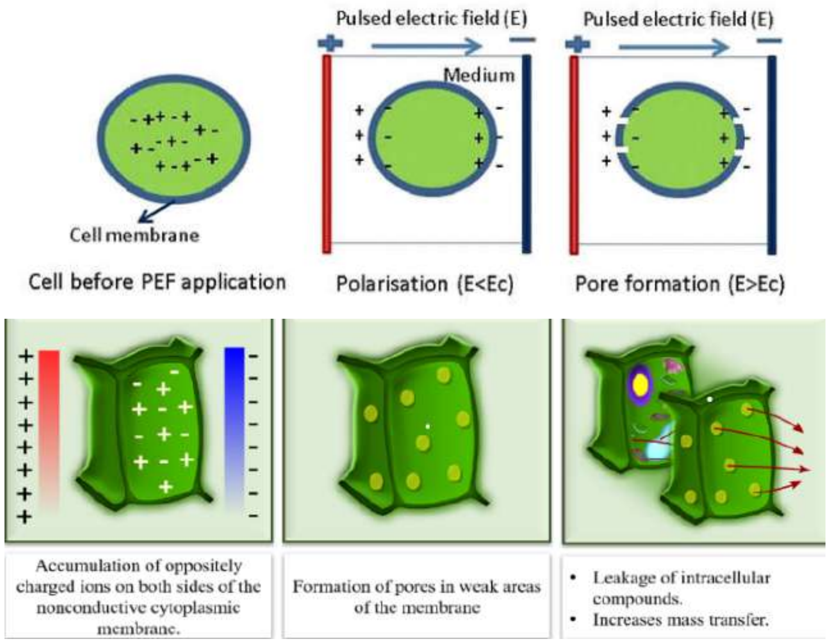
Clovedo, 2013



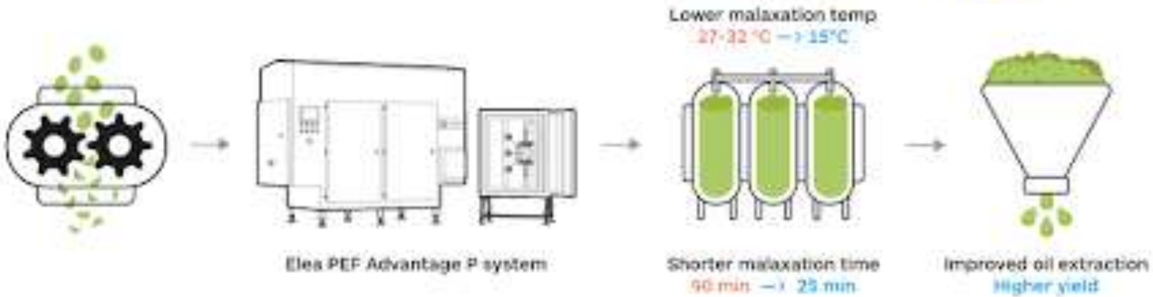
Pulsed electric field (PEF), another non-thermal technology, is effective for reversible or irreversible permeabilization of cell membranes without significant temperature increase. PEF technology is based on exposing olive paste to an electric field causing pores in cell membranes. PEF applications have the potential

- to increase extraction yield and lower malaxation time
- EVOO phytonutrient content such as bioactive and antioxidant compounds and health-giving properties.



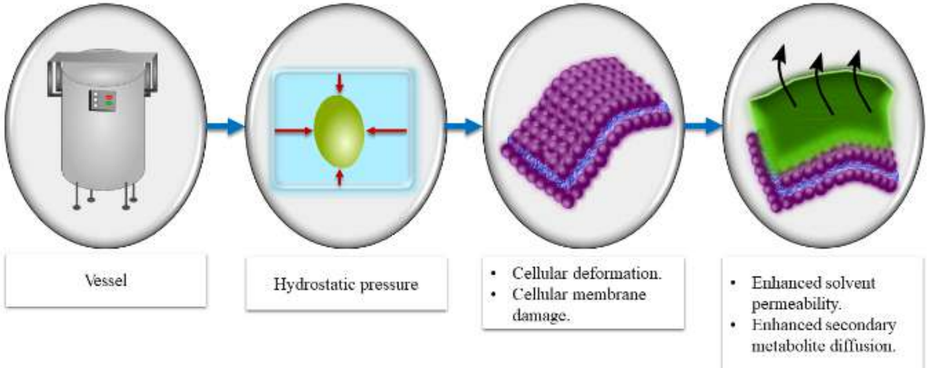


ffect of pulsed electric fields (PEF) treatment
ın cell membrane



Perez et al., 2021

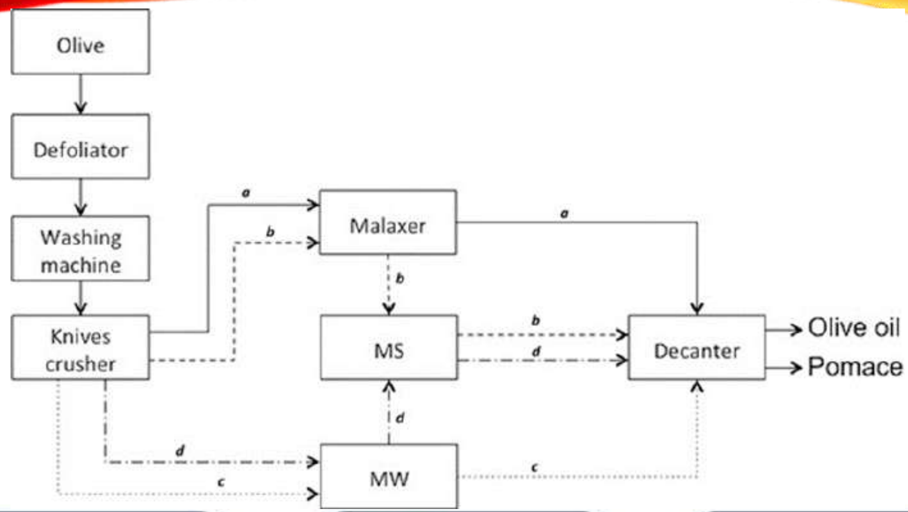
High pressure processing (HPP) and pulsed electric fields (PEF) can disintegrate the cell membranes, enhancing the mass transport thus improving the extractability of intracellular bioactive compounds from olive paste. HPP treatment when applied to improve EVOO extraction. The process increased the oxidative stability of olive oils without any negative impact on their flavor, color, and consistency.

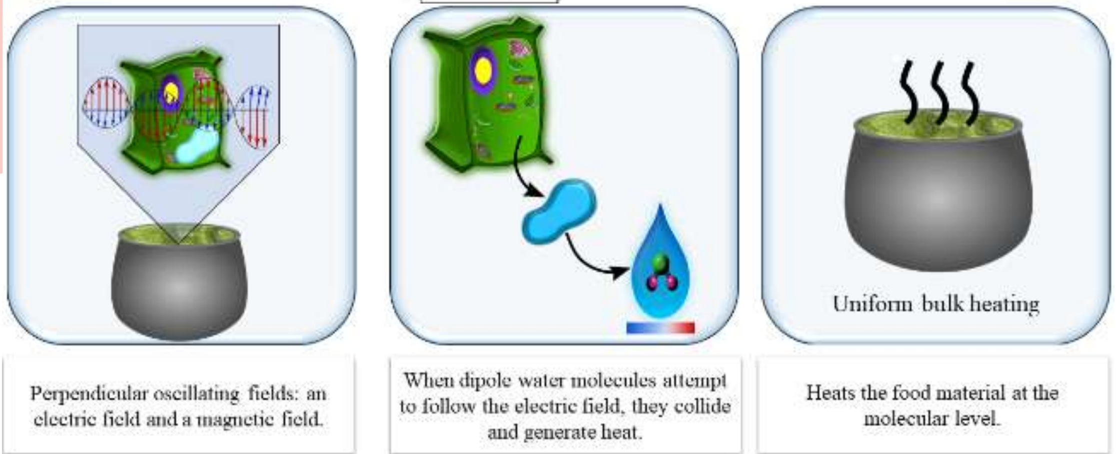


Cellular membrane deformation and damage caused by HPP (High pressure processing)

Microwave-assisted extraction (MAE) is an alternative oil extraction method in recent years. Microwave localised heating causes the rupture of cell wall materials through the formation of internal vapour pressure flow, facilitating the release of cell wall components.

- it is a more efficient extraction method than conventional processes.
- high-quality oil and low energy requirement, which cause a significant reduction in environmental impact and financial costs.

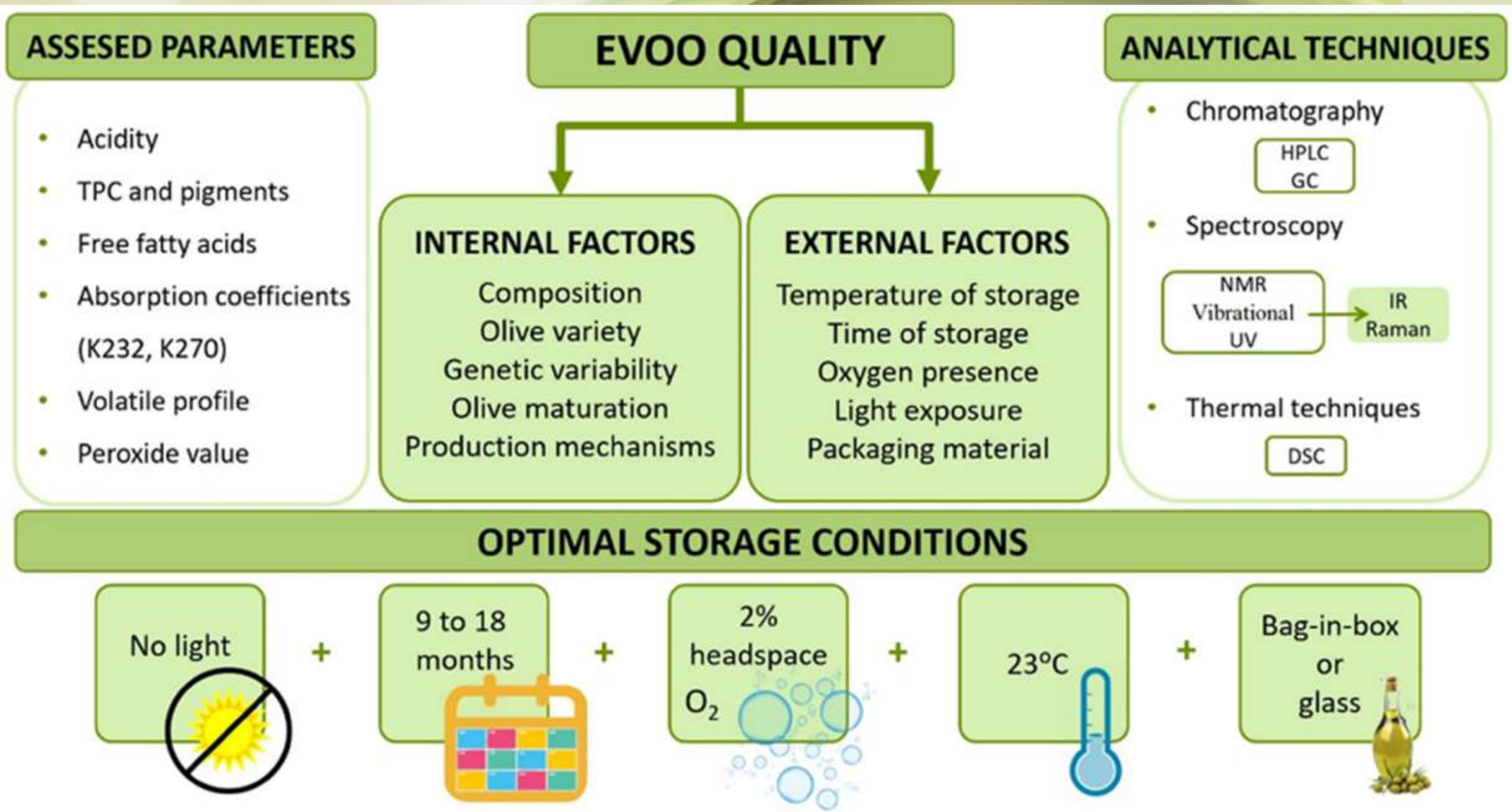




Effect of microwave heating (MW) at the cellular level.

Perez et al., 2021

Part II. Quality Control of Olive oil with Chemometric Methods



EVOO marketing is more demanding in terms of quality assurance. The olive oil sector is subject to compliance with regulations that affect its commercialization. Regulations establish the categorization of the olive oil according to numerous physico-chemical characteristics that are analyzed in accredited laboratories, as well as to organoleptic evaluation by accredited tasting panels.

The quality of olive oil is defined on the basis of the free acidity, the peroxide value, the absorption in the ultraviolet region (K232,K270, and Δκ), and sensory analysis.

Besides these parameters, which constitute the basis for olive oil quality grading, other attributes such as the concentration of bioactive compounds and specific sensory characteristics define olive oil quality.

IOOC, 2018, EU 1991; United States Standards for Grades of Olive Oil and Olive-Pomace Oil, 2010

Determination of Quality Criteria

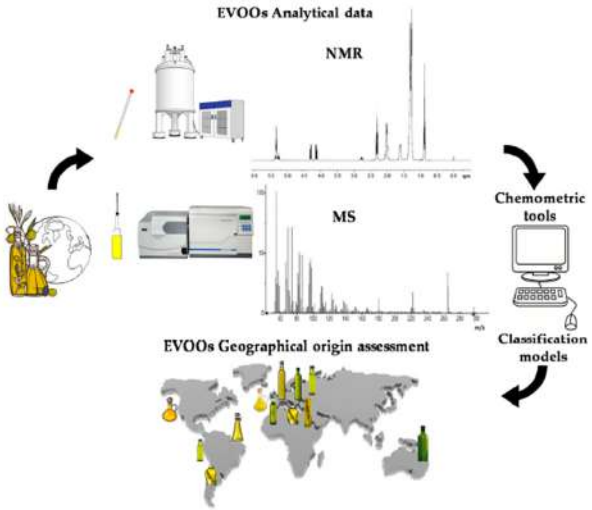
1. Free fatty acids (acidity)
2. Peroxide value
3. UV Specific extinction coefficients of K232, K270 and ΔK
4. Fatty acid methyl and ethyl esters
5. Sensory evaluation

Determination of purity criteria

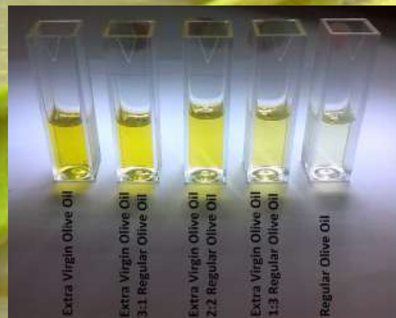
1. Sterols, erythrodiol and uvaol determination
2. Wax content
3. Trans isomers
4. Stigmastadiene content: 3.5-stigmastadiene
5. 2.glycerol monopalmitate

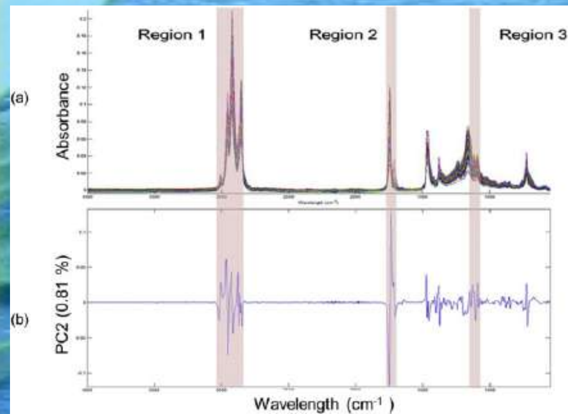
Determination of other constituents of olive oil

1.Unsaponifiable fraction
2.Tocopherols
3. Phenols
4. Volatiles



Extra virgin olive oil (EVOO) is a premium food product requiring a relatively high price, Authenticity covers many aspects, including
adulteration,
mislabeling,
mischaracterization, and
misleading origin.
Therefore, the detection of quality and adulteration is crucial in quality and safety control, and the vegetable oil product trade.





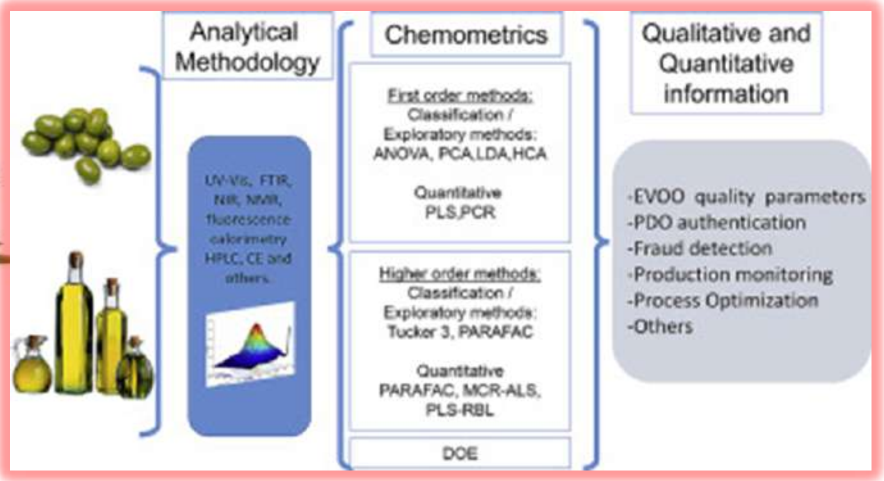
Detection of Quality of Extra Virgin Olive oil

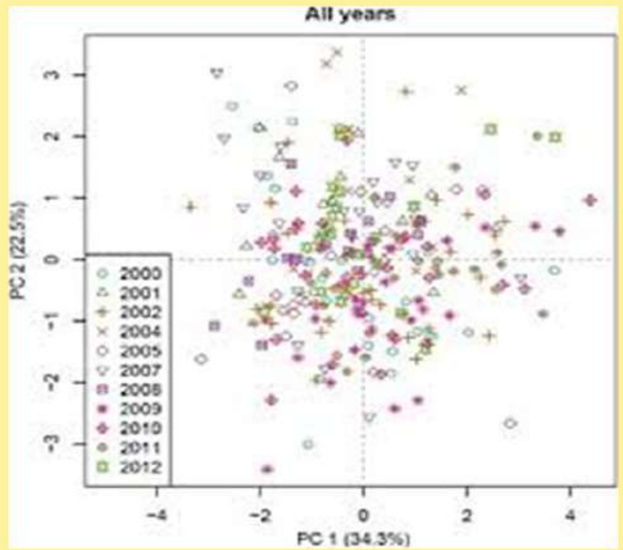
The rapid and reliable detection of quality is a very challenging issue in the field of virgin olive oil authentication and mainly adulteration.

The analytical procedures (including sample preparation, analysis, data acquisition and processing) have been developed and proposed to quality control of virgin olive oil are as follows:

- Vibrational spectroscopic techniques
- Nuclear magnetic resonance (NMR) spectroscopy:
- Mass spectrometry
- Chromatographic techniques:
- Other analytical approaches

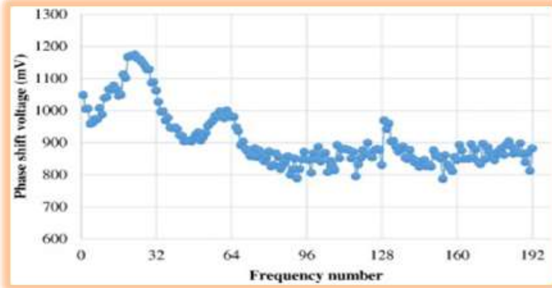
The produced analytical data (spectroscopic, chromatographic, isotopic, sensorial, etc.) are often multivariate data matrices which demand appropriate chemometric analysis. In chemometrics, mathematical and statistical methods are used for processing and capturing the most important and relevant content within the multivariate data.





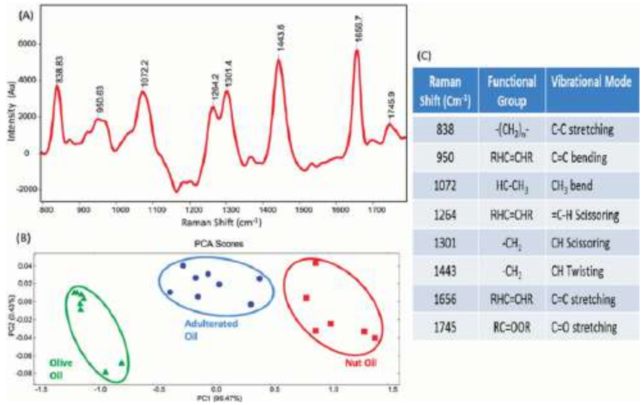
Vibrational spectroscopic techniques

Based on both infrared and midinfrared absorptions (FT-IR, FT-MIR, NIR, and MIR) and Raman scattering have great potential as promising tools to determine quality and olive oil adulteration.



<u>İmportant advantages</u>

- the needed volume of reagents,
- rapid measurements and
- fast data acquisition,
- relatively low cost,
- samples handling and
- their nondestructive nature (analysis is performed directly on intact samples or with only minimal sample preparation).



The application of statistical data evaluation allowed establishing approaches with high capability and great potential to detect EVOO's adulteration and identify the adulterants nature

VIBRATIONAL SPECTROSCOPIC TECHNIQUES

Methods	Determinations	Data Processing	References
FT-IR	firmness, oil content and colour (chroma, hue)	PLS	Kavdir et al., 2009
Near-NIR Vis-NIR	sensory charecteristics	LDA and SIMCA	Sinelli et al., 2010
MIR, Vis NIR	UV Spesific Coeffcient indexes, Fatty acids	PLS	Maggio et al., 2011
FT-NIR	total SFA, monounsaturated FA (MUFA), polyunsaturated FA (PUFA), and trans FA contents	PLS	Mossoba et al., 2013
FT-NIR	the kind and amount of an adulterant in EVOO	PLS	Azazian et al. 2015
FT-MIR ATR and FT-NIR	Oxidation level	PCA	Wojcicki et al., 2015
FT-NIR	evaluating authenticity	SIMCA	Karunathilaka et al., 2016
Raman	Spectral data	PCA	McReynold et al., 2016
FT-NIR	evaluating authenticity	PCA	Mossoba et al., 2017
Vis-NIR	Chlorophylls and carotenoids	PCA, LDA	Ferreiro et al., 2017
NIR, H NMR	Finger prints cultivar classification	Artificial neural netwrks (ANN)	Binetti et al., 2017
FT-NIR	Olive fruit ripenning indices (noisture, oil, sugar, phenolşc compounds)	PLS	Trapani et al., 2017
FT-NIR	Volatiles	OPLS-DA	Jolayemi et al., 2017
FT-NIR	FFA	PLS	Tarhan et al., 2017

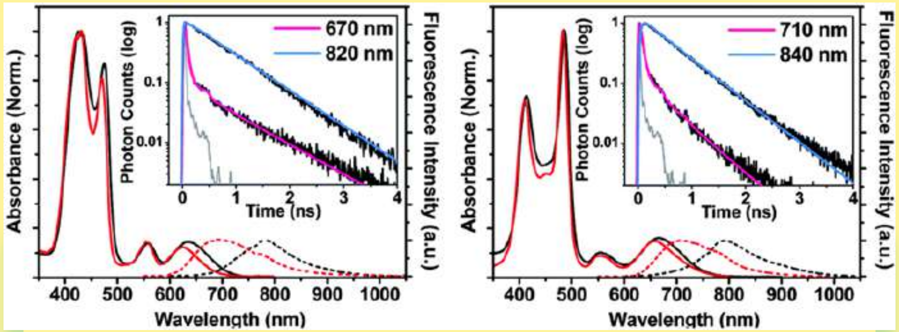
VIBRATIONAL SPECTROSCOPIC TECHNIQUES

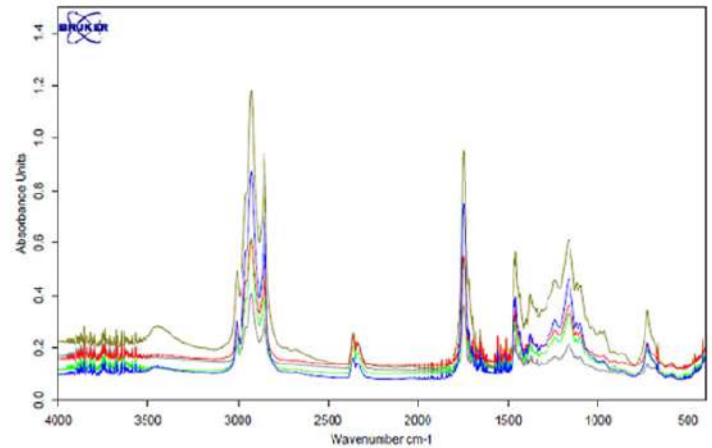
Methods	Determinations	Data Processing	References
FT-MIR	evaluating geographic origin sterols and fatty acids	PLS	Ozdemir et al, 2018
FT-NIR	1,2 DAG and 1,3 DAG	PLS	Azazian et al., 2018
FT-NIR	Adulterant determination	PLS	Jiang and Chen, 2019
NIR	Geographic origin (FA, TAG)	PCA, LDA, k-nearest neighbor tool (kNN)	Gertz et al., 2019
NIR	Moisture content in Oil	PLS, correlation test	Fardin-Kia et al., 2019
NIR	Moisture content in Oil	PLS	Karınathilaka et al., 2020
Vis- NIR	Olive ripeness evaluation	PLS-DA	Tugnolo et al., 2021
FT-NIR	Adulterants in olive oil	PLS-DA	Vieiara et al., 2021
FT-NIR	Olive ripenning degree	PLS-DA	Alemprese et al., 2021
FT-NIR	Authencity (FA, DAG, FFA)	PLS	Azizian et al., 2021
NIRS, Vıs/NIR	Quality Prediction of Intact Olives	PLS	Grassi et al., 2021
FT-NIR	Quality and Authencity of olive oil (FFA, PV, K270, Chlorophyll)	PCA, Factorial- DA, PLS	Zaroual, et al., 2021
fluorescence and FT-Raman	Geographic seperation of PDO olive oils	PCA, PLS-DA	Fort et al., 2021
NMR and MS	Geographic seperation of PDO olive oils	PCA, LDA, KNN	Calo et al., 2021

Chromatographic techniques

Advances of both HPLC and GC
- sample preparation,
- instrumental analysis,
- data processing and
- interpretation for the efficient control of olive oil adulteration.

The use of potent detection systems such as MS for the structural and quantitative analysis of some VOO purity criteria has represent one of the growing areas.





CHROMATOGRAPHY HPLC

Methods	Determinations	Data Processing	References
HPLC-APCI MS/MS	TAGs	PCA	Fasciotti and Pereira Netto, 2010
HPLC UV-Vis	TAGs	LDA	Lerma-Garcia et al., 2011
HTGC (High temperature Gas Chromatography)	TAGs	SIMCA, PLS	Ruiz-Samblas et al., 2012
RP-HPLC	TAGs EC42 therotical value	PCA	Jabeur et al., 2014
HPLC-Quidrapole DAD	Chlophyll	ANOVA	Fang et al., 2015
HPLC, DAD and Fluoerescence (FLD)	Fingerprints phenolic fraction	PCA, PLS-DA, SIMCA and KNN	Bajoub et al., 2017
Flourescence Spectroscopy	Acidity, Peroxide value, K232, 270, ΔK	PLSR	Baltazar et al., 2020
HPLC -DAD	Charecterization of olives (biphenolic profile)	PCA, AHC	Irmak and Dıraman, 2022
Front-Face Flourescence Spectroscopy	Chemical Changes at storage at 60 C	PLS-DA	Botosoa et al., 2021
UHPLC-UV/Vis	polar fraction of different olive oil samples	PLS-DA, SIMCA	Perez-Beltran et al., 2022

CHROMATOGRAPHY GC

Methods	Determinations	Data Processing	References
SPE solid phase extraction GC-FID	FAAEs	ANOVA	Perez-Comino et al., 2008
GC-FID	Fattiy acid methyl esters FAMEs	PCA, target factor analysis [TFA], SIMCA, PLS	Monfread et al., 2014
GC-FID	Fattiy acid methyl esters FAMEs)	ANOVA	Jabeur et al., 2016
GLC	Campasterol stigmastenol	ANOVA	Al-Ismail et al., 2010
GC, TLC	Δ-7-stigmastenol	ANOVA	Mariani & Bellan, 2011
GC	Δ-7-stigmastenol	LDA	Jabeur et al., 2014
Method COI/T.20/Doc. No. 30/Rev. 1 of the IOC, total sterol	desmethylsterols and triterpene dialcohols	ANOVA	Srigley et al., 2016
GC	3,5-stigmastadiene	LDA	Jabeur et al., 2016, 2017
Flash gas chromatography	volatile fraction fingerprints of virgin olive oils	PLS-DA	Barbieri et al., 2020

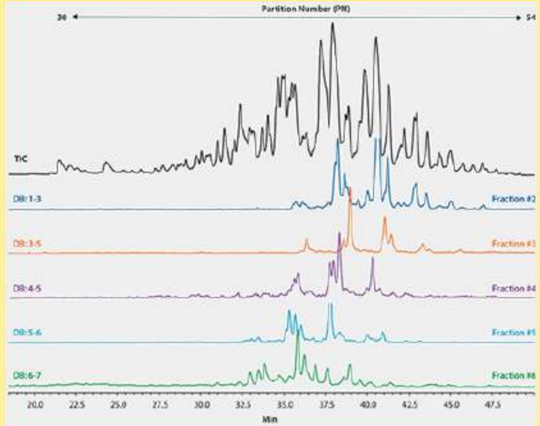


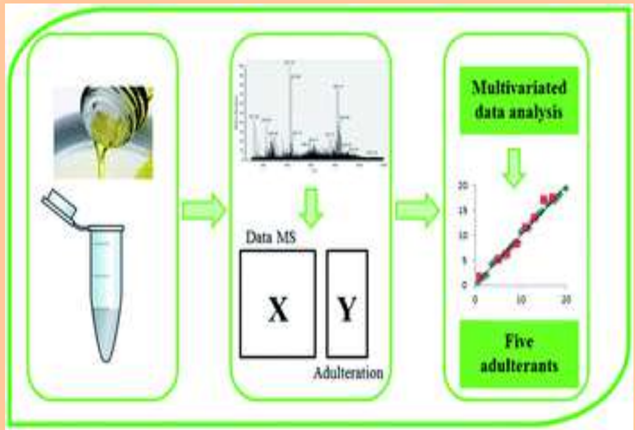
Mass spectrometry

various MS methodologies not requiring prior separation to be applied for virgin olive oils adulteration control be obtained in a short analysis time. In the studies employing direct infusion MS in this field,

- electrospray ionization (ESI),
- atmospheric pressure photoionization ion sources (APPI),
- matrix-assisted laser desorption/ionization (MALDI)
- fingerprinting method based on MALDI-TOF MS

for the effective determination of FAs and TAGs composition in virgin olive oil samples without any required derivatization. The application of chemometric treatments to the obtained data, allowed for the detection of quality and identification of the most common EVOO's adulterant vegetable oils.





GC and GC MASS SPECTROSCOPY

Methods	Determinations	Data Processing	References
GC-MS	PUFAs, MUFAs MUFAs/PUFAs	PLS, DA	Yang et al., 2013
GC-MS	3,5-stigmastadiene	PLS	Crews et al., 2014
GC-MS	3,5-stigmastadiene	PLS	Jabeur et al., 2015
MALDI-TOF/MS	TAG	ANOVA	Jergovic et al., 2017
LC-MS	TAGs	PCA	Pace et al., 2017
Headspace solid-phase (HSSP) microextraction–GC-MS	quantification of the volatile profile	PCA, LDA	Cechi et al., 2019
gas chromatography-ion mobility spectrometry (GC-IMS)	individual signals (markers) from the topographic plots of the olive oil samples	SIMCA, two binaries and a ternary OPLS-DA	Contreras et al., 2019
Headspace solid-phase (HSSP) microextraction–GC-MS	Volatile organic compounds	PCA, AHC, LDA, KNN	Gerhardt et al., 2019
Flow Injection Analysis-Magnetic Resonance Mass Spectrometry FIA-MRMS	Biophenols	SIMCA, PCA	Nikou et al., 2020
GC-MS	Lipid and Sensorial parameters	PCA, Pearson Correlation Coeffcients	Dıraman et al., 2020

Conclusions…

The production and consumption of olive oils have increased in recent years. Olive oil authentication are important not only for consumers, but also for suppliers, retailers, regulatory agencies, and administrative authorities.

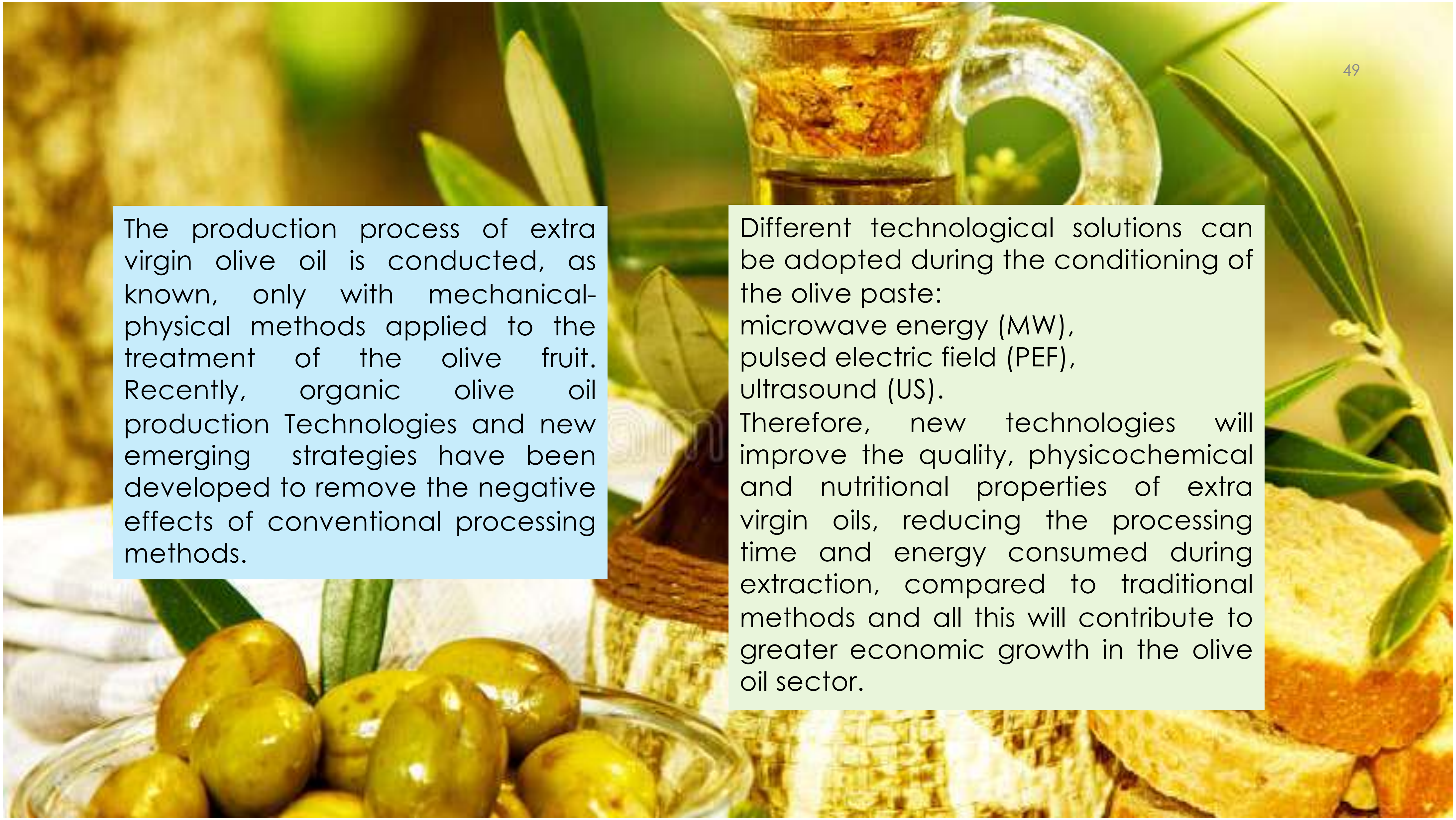
Turkey is the fourth largest olive oil producing nation in the world, with a production of 228.000 tons expected for the agricultural year 2021/22. **8%** of the olive orchards are managed organically in Turkey. 2 % of whole production is organic olive oil.

Olive oil contains a variety of both lipophilic and hydrophilic compounds having a special effect on its quality and its functional properties.

organic extra virgin olive oil is preferred by consumers because it is rich in bioactive components that have a beneficial effect on health.

- Olive oil are strongly related to the presence of large amounts of monounsaturated fatty acids (MUFAs) such as oleic acid and valuable minor components including aliphatic and triterpenic alcohols, sterols, squalene, volatile compounds, tocopherols, chlorophylls, carotenoids and phenolic antioxidants.

- The presence and the amount of these compounds are affected by several factors including cultivar, soil management and agro technical procedures, climatic conditions, health of the fruit, degree of maturity, method of harvesting and transportation of fruit, handling of fruit during storage prior to processing period and processing methods and conditions applied



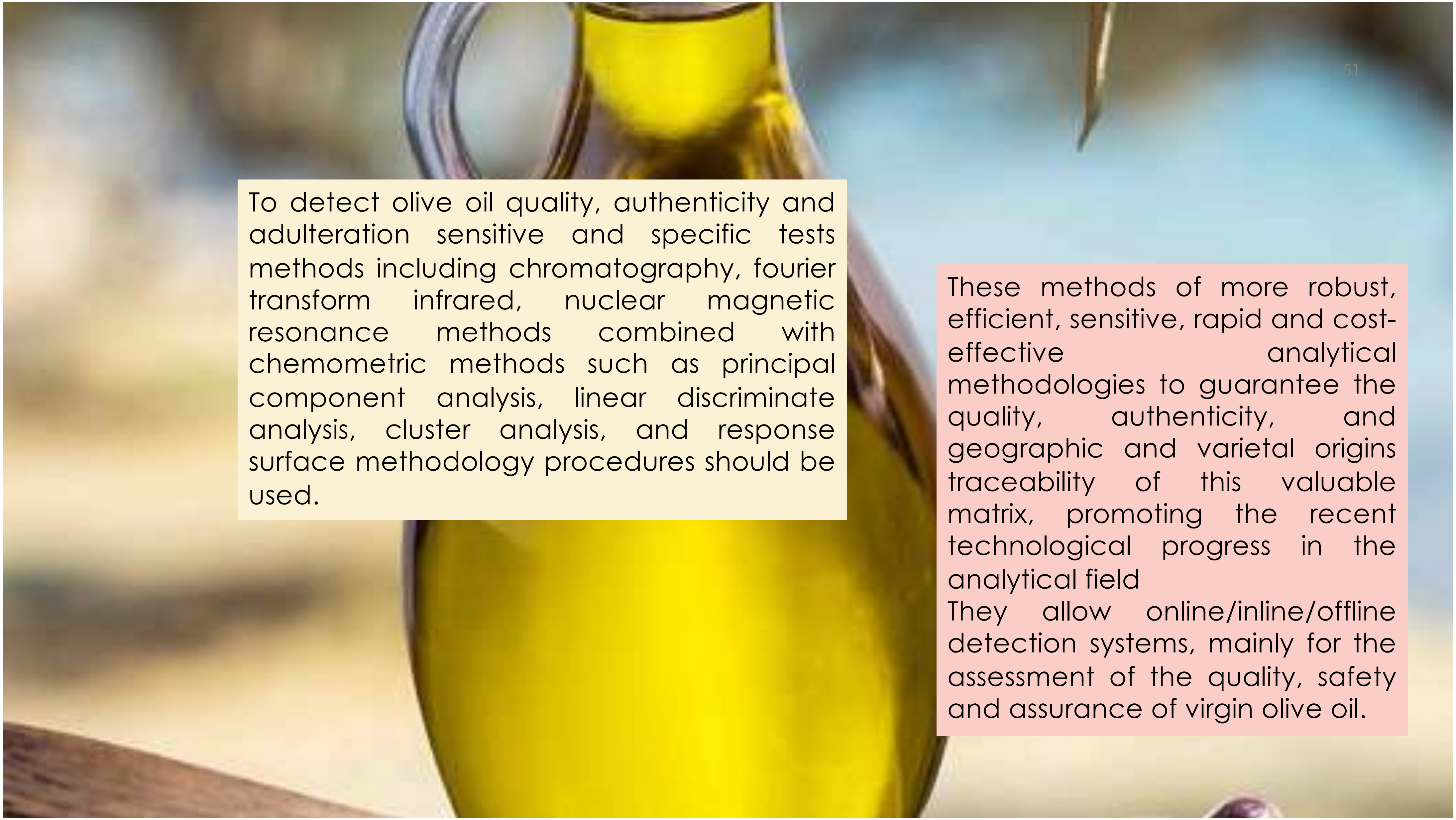
The production process of extra virgin olive oil is conducted, as known, only with mechanical-physical methods applied to the treatment of the olive fruit. Recently, organic olive oil production Technologies and new emerging strategies have been developed to remove the negative effects of conventional processing methods.

Different technological solutions can be adopted during the conditioning of the olive paste:
microwave energy (MW),
pulsed electric field (PEF),
ultrasound (US).
Therefore, new technologies will improve the quality, physicochemical and nutritional properties of extra virgin oils, reducing the processing time and energy consumed during extraction, compared to traditional methods and all this will contribute to greater economic growth in the olive oil sector.

The olive oils are which are regulated, with precise chemical-physical parameters, by regulatory bodies, such as IOC and EU.
Quality criteria of olive oils include: free fatty acids, peroxide value, ultraviolet absorbance. Organoleptic (sensory) properties can also be evaluated under the head of quality criteria including median of defects (negative attributes) and median of fruity (positive attributes)

Purity criteria includes: detection of olive oils adulteration with other vegetable oils, detection of olive oils adulteration with olive-pomace oils, detection of virgin olive oils adulteration with refined oils. In order to ensure purity total sterol, erytrhodiol and uvaol content, wax, trans fatty acid content, maximum difference between the actual and theoritical ECN42, triacylglycerol content, stigmastadiene content, content of 2-glycerryl monopalmitate content (%) and fatty acid methyl esters are measured

Other constituents include: The fractionation of the unsaponifiable components of olive oil , into several groups of constituents (squalene, tocopherols, polyphenols, pigments, volatiles etc.)



To detect olive oil quality, authenticity and adulteration sensitive and specific tests methods including chromatography, fourier transform infrared, nuclear magnetic resonance methods combined with chemometric methods such as principal component analysis, linear discriminate analysis, cluster analysis, and response surface methodology procedures should be used.

These methods of more robust, efficient, sensitive, rapid and cost-effective analytical methodologies to guarantee the quality, authenticity, and geographic and varietal origins traceability of this valuable matrix, promoting the recent technological progress in the analytical field

They allow online/inline/offline detection systems, mainly for the assessment of the quality, safety and assurance of virgin olive oil.

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turkankecelimutlu@gmail.com

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