La riscoperta dell'Officina: l'attività di ricerca sulle Piante Officinali dell'Istituto per i Sistemi Biologici del CNR

Dr. Francesca Mariani

Istituto per i Sistemi Biologici-CNR
Area della Ricerca Roma1
Montelibretti (RM)

in-Vitality 2022. 24 novembre 2022. MiCo_Milano

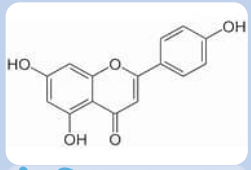
Fitoderivati: le fonti alternative.
Filiere locali, economia circolare, nuove tecnologie: percorsi innovativi per la produzione di estratti vegetali.

Workshop promosso da Innovazione in Botanicals/CEC Editore.

Le Piante Medicinali possono essere studiate da molti angoli visuali

Erbari

Etnobotanica



Botanica

Biochimica

Medicina popolare

Biodiversità

Piante Medicinali

Ambiente

Culinaria

Erboristeria

Prodotti naturali

Risorse genetiche

Fitoterapia

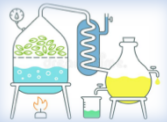
Aromi

Spezie

Principi attivi

Aromaterapia

Piante tintorie



L’Istituto per i Sistemi Biologici ne studia gli usi terapeutici

Etnobotanica

Medicina popolare

Giardini dei Semplici

Erboristeria

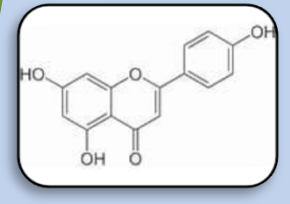
Fitoterapia

Biomolecole

Medicina integrata

Principi attivi

Aromi



Creazione di un “Orto dei Semplici”-Istituto Sistemi Biologici

Collezione di più di 100 specie di Piante Medicinali, raccolte nel periodo balsamico, quando sono più ricche di Principi Attivi.

Particolare cura viene prestata alle condizioni di crescita delle piante selvatiche della tradizione Mediterranea, e la gestione della domesticazione viene ridotta al minimo per simulare al meglio le condizioni degli habitat originari.

Orto selvatico per le specie FITOALIMURGICHE

Agribusiness Paesaggio & Ambiente - Vol. IX (2005) n. 1, Marzo 2006

Il giardino fitoalimurgico per la valorizzazione delle piante spontanee

Maria Clara Zuin* - Giampaolo Zanin** - Giuseppe Zanin**

Phytoalimurgic Garden to Promote Wild Plants. *Wild plants have always been an important food source for people, not only in the distant past but also during more recent times of war. A wealth of knowledge linked to human traditions has been gained on these plants and which is worth preserving. The term phytoalimurgy derives from the Greek word phytŭn = plant, plus the Latin words alimenta = food and urgentia = emergency - hence it means the study of ways to tackle a food crisis (famine, etc.) (Targioni-Tozzetti, 1767). To now create a Phytoalimurgic Garden (PG), as this emergency no longer exists in Europe, means to exploit and spread these plants, promoting popular customs, old flavours and uses. A PG is a place where edible wild plants are grown as if in their natural environment and is planned to produce food all year round. The PG is intended for agri-tourism and teaching purposes, to spread ethnobotanical knowledge and preserve biodiversity. Another advantage is that time and money can be saved by having the plants readily available for harvesting 'close to home' and which are unpolluted.*

MARIA CLARA ZUIN
Istituto Biologia Agroambientale e Forestale, CNR (PD)

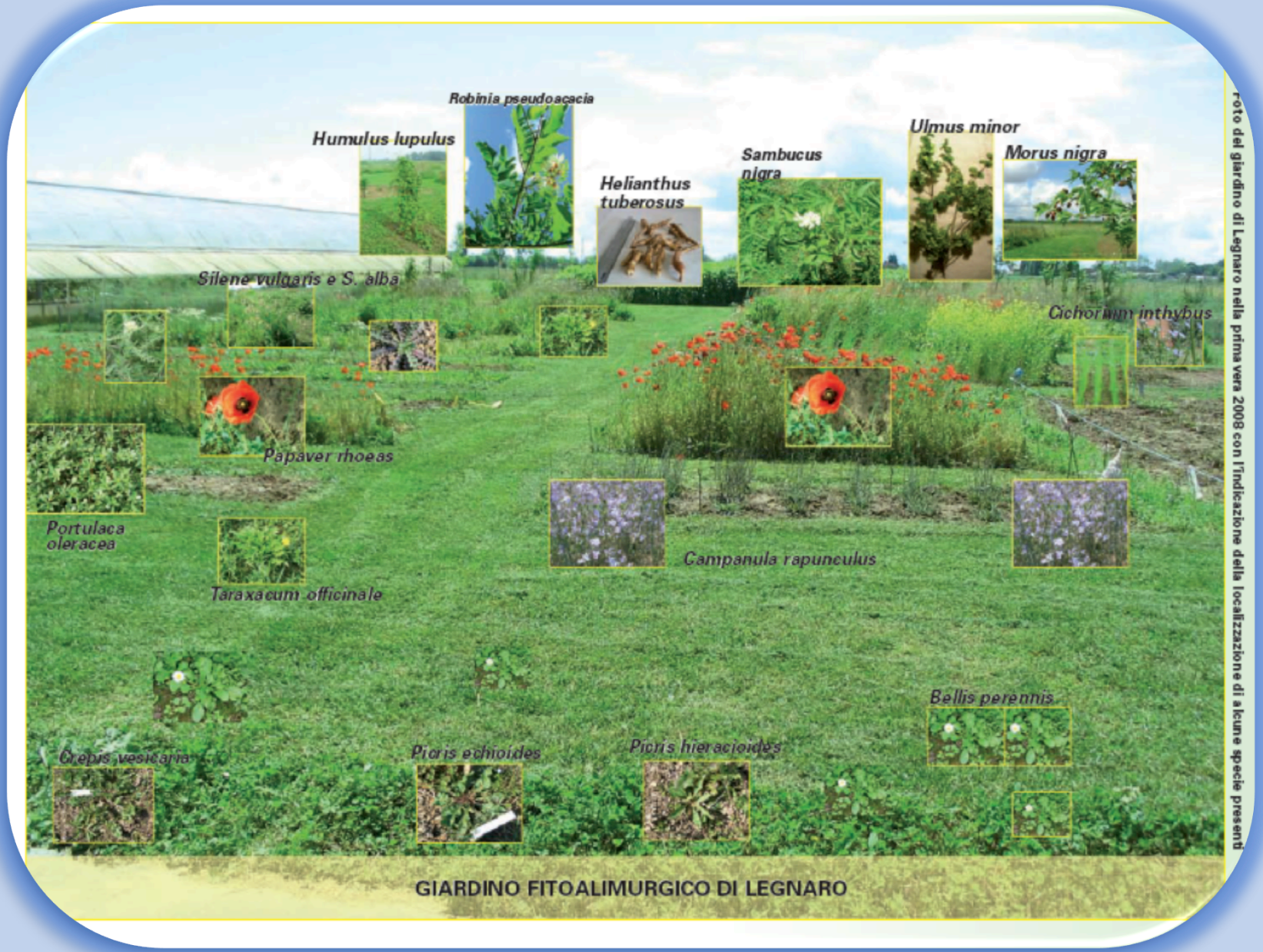
Il termine "alimurgia" è stato coniato da Giovanni Targioni-Tozzetti nel 1767 per indicare lo studio delle soluzioni da ricercare in caso di "urgenza" (necessità) alimentare (*alimenta urgentia* = alimurgia).

Questo termine è stato riproposto più recentemente da Oreste Mattirolo nel 1918, con l'aggiunta del prefisso "fito", per rendere il termine più preciso e definirne meglio il campo di interesse; il termine non è riportato nei dizionari della lingua italiana.

In passato la cronica indigenza e soprattutto le frequenti carestie e le guerre costringevano l'uomo a ricercare soluzioni alimentari diverse dalle tradizionali e l'utilizzo delle piante spontanee era spesso l'unica soluzione disponibile.

Fortunatamente il nostro Paese non ha più urgenze simili, rimane però il fatto oggettivo che le piante spontanee sono ancora utilizzate per l'alimentazione umana. Le "*piante alimurgiche*" sono quindi "*piante erbacee, suffrutici o alberi spontanei di cui uno o più organi o parti di essi vengono usati come alimento se raccolti ad un appropriato stadio del ciclo della pianta e*

* Ist. Biologia Agroambientale e Forestale, CNR, Sez. Legnaro (PD), ** Dip. Agronomia ambientale e Produzioni vegetali, Università degli Studi di Padova.

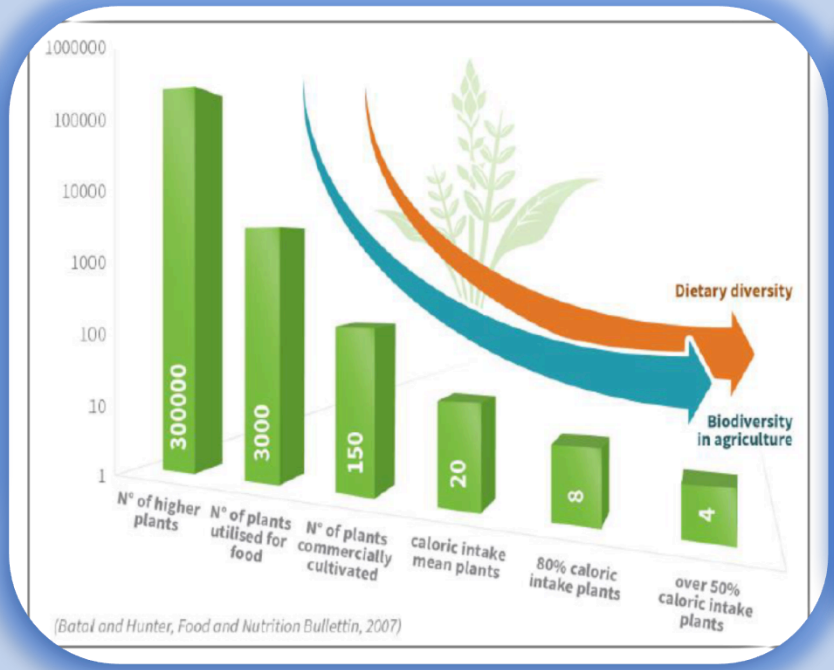


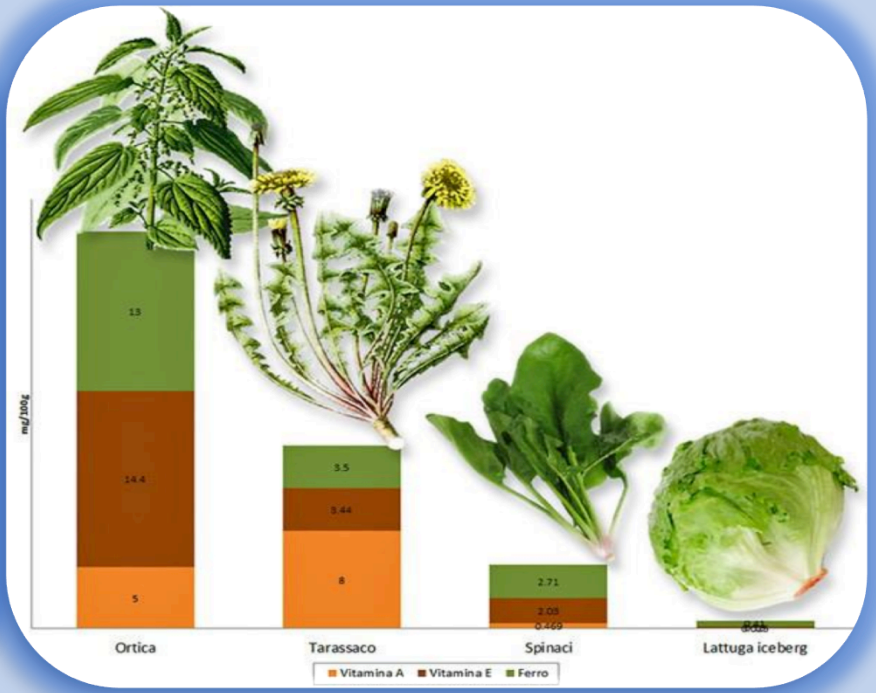
roto del giardino di Legnaro nella primavera 2008 con l'indicazione della localizzazione di alcune specie presenti

eat wild

SAFEGUARD OF WILD EDIBLE PLANTS
FROM TRADITIONS TO SUSTAINABLE AGRICULTURE
TOWARDS NEW POTENTIAL FOOD PRODUCTS

a proposal *for* H2020-SFS-07b-2015





plants

MDPI

Review

Born to Eat Wild: An Integrated Conservation Approach to Secure Wild Food Plants for Food Security and Nutrition

Teresa Borelli [1,*], Danny Hunter [1], Bronwen Powell [2], Tiziana Ulian [3], Efisio Mattana [3], Céline Termote [1], Lukas Pawera [4,5], Daniela Beltrame [6], Daniela Penafiel [7,8], Ayfer Tan [9], Mary Taylor [10] and Johannes Engels [1]

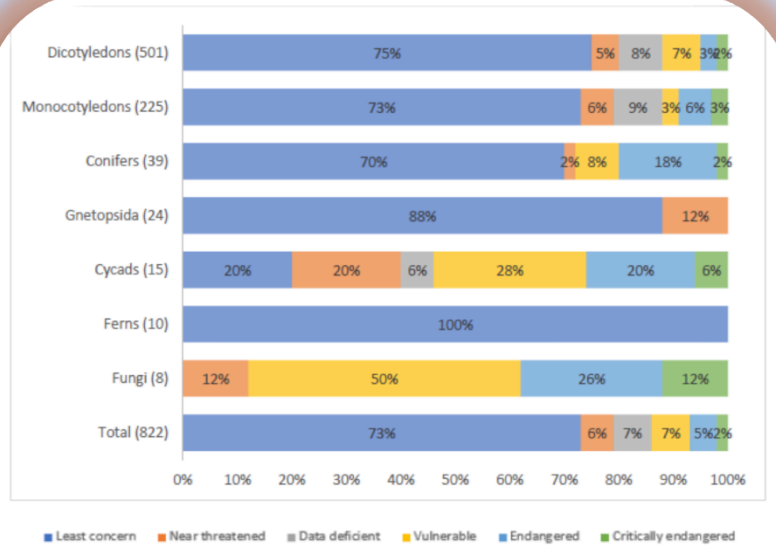


Figure 1. Number of WFPs and fungi on the IUCN Red List of Threatened Species classified by class and risk category Source: IUCN Red List 2017. Adapted from FAO [45].

Food & Function

ROYAL SOCIETY OF CHEMISTRY

REVIEW

View Article Online
View Journal

Check for updates

Cite this: DOI: 10.1039/d2fo02593k

Science and claims of the arena of food bioactives: comparison of drugs, nutrients, supplements, and nutraceuticals

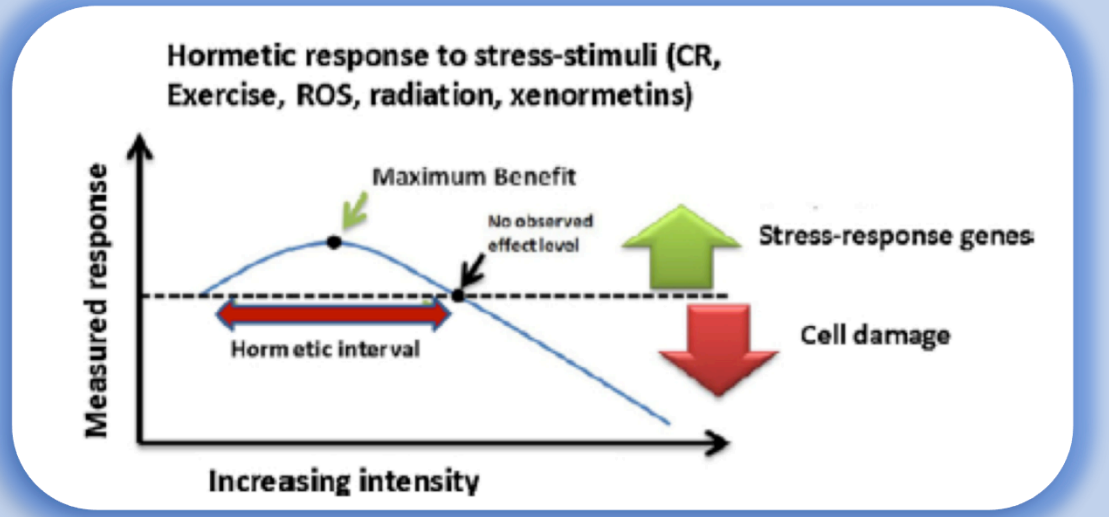
Francesco Visioli [a,b]

Food & Function

Nutritional hormesis

What has been discussed above fits very well with the concept of nutritional hormesis. The ingestion of molecules that act as electrophiles triggers the nucleophile response, in turn contributing to homeostasis *via* the redox mechanism and, hence, anti-inflammatory feedback.

The notion of hormesis refers to the **non-linear relationship between the dose and the effect: a substance that is toxic at high doses might be healthy at lower ones.** From a nutritional viewpoint, the "hormetic zone" is the optimal dose range between ineffective and toxic.



BioMemory Project

BioMemory is the **network of biological collections** of the Department of Biology, Agriculture and Food Sciences (DiSBA) of the National Research Council of Italy (CNR) for bio-monitoring, biodiversity conservation, agri-food and environmental sustainability, and human well-being.

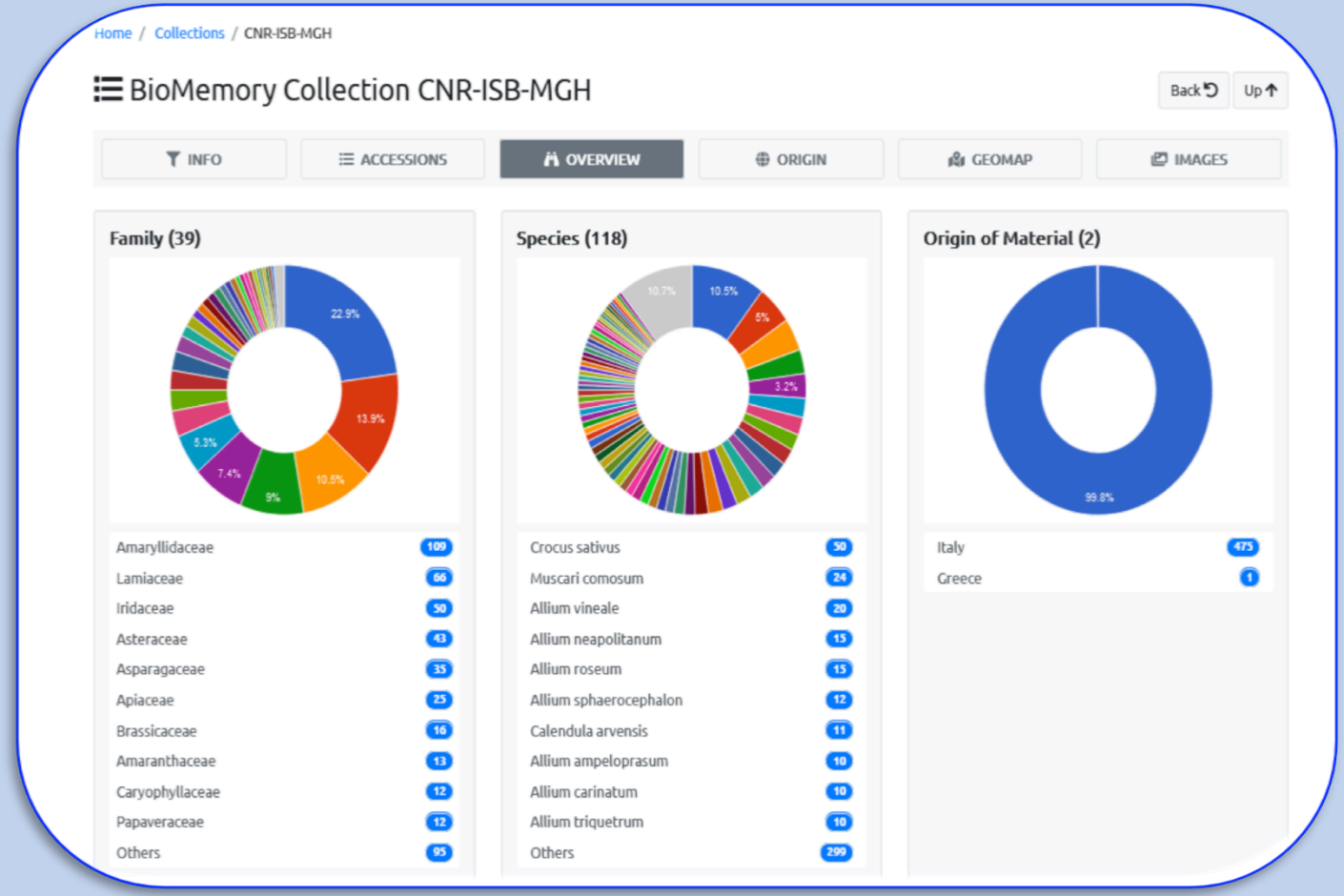
Medicinal Herb Garden

CNR-ISB-MGH

Medicinal and Wild Edible Plants

Field collection, Seed collection

L'ISB partecipa al Progetto Biomemory CNR e cura una collezione di 102 specie medicinali

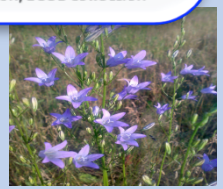


Aromatiche
Alimurgiche
Tintorie

Piante:
Spontanee *in situ*
Raccolte *ex situ*
Seminate

Attività:

- Conservazione del germoplasma
- Raccolta nel periodo balsamico
- Preparazione estratti


Campanula rapunculus


Allium ursinum

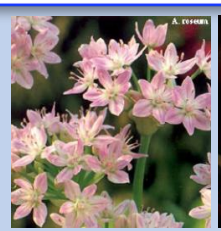

Allium ampeloprasum

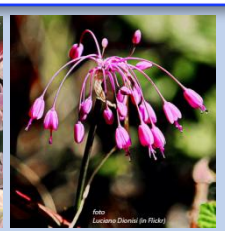

Allium nevskianum


Daucus carota


Silene dioica


Glechoma hederacea


Allium roseum


Allium carinatum


Allium sphaerocephalon


Plantago coronopus


Hypericum perforatum


Allium flavum


Centaurium erythrae


Geranium sanguineum


Allium vineale

Preparazione di Estratti alcolici e Olii Essenziali

Piante Medicinali Aromatiche_ *L. angustifolia*
Parti della pianta con proprietà fitoterapiche (fiori), raccolte nel periodo balsamico (fine dell'estate)

Essiccazione e frantumazione

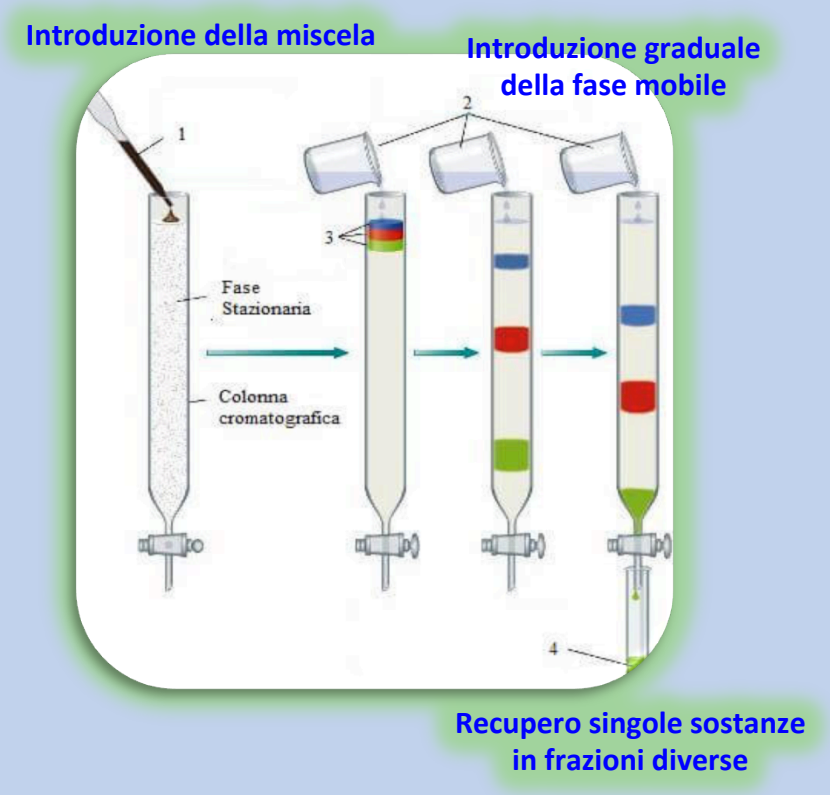
Sminuzzamento in N2 liquido e determinazione del peso

Macerazione in Solvente idro-alcolico per preparare Estratto

Distillazione in corrente di vapore per estrarre l'Olio Essenziale (OE)

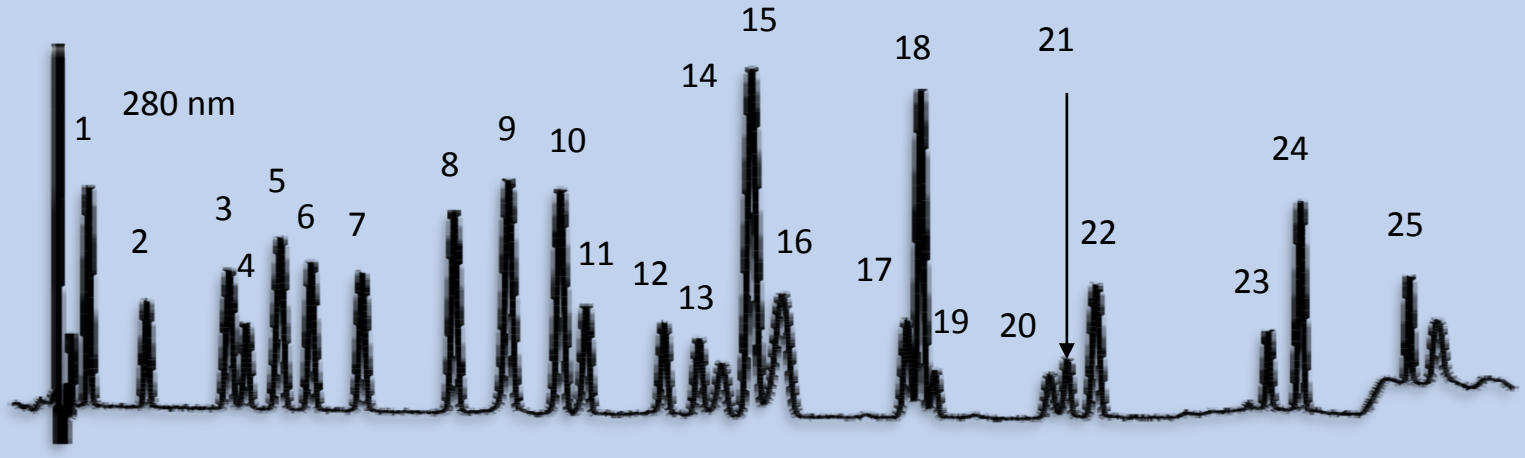
Identifichiamo le sostanze contenute in un estratto

La **CROMATOGRAFIA** è una tecnica che permette la separazione delle sostanze contenute in una miscela in seguito alla loro distribuzione tra due fasi, una solida (fase stazionaria) e una liquida in movimento lungo una direzione definita (fase mobile)



Gli stessi principi che separano le sostanze nella colonna di vetro vengono applicati in apparecchiature più sofisticate, in grado di lavorare anche su quantità molto piccole (**UHPLC**)

Nel cromatogramma ogni segnale corrisponde ad una sostanza



1. Acido gallico, 2. Acido 3,4-diidrossibenzoico, 3. Acido caftarico, 4. Acido 4-idrossibenzoico,
5. Catechina, 6. Acido 3-idrossibenzoico, 7. Acido caffeico, 8. Epicatechina,
9. Delfinidina-3 glucoside, 10. Acido cumarico, 11. Cianidina-3-glucoside,
12. Pelargonidina-3-glucoside, 13. Acido sinapico, 14. Peonidina-3-glucoside, 15. *trans*-Piceide,
16. Malvidina-3-glucoside, 17. Naringenina-7-glucoside, 18. Rutina, 19. Quercitina-3-glucoside,
20. Miricetina, 21. Kamferolo-3-glucoside, 22. *trans*-Resveratrolo, 23. Quercitina,
24. Naringenina, 25. kamferolo

Laboratorio di Risonanza Magnetica “Annalaura Segre”, ISB

Strumentazione

- Spettrometro Bruker AVANCE III HD 600
- Frequenza: 600 MHz (B_0=14.1 T)
- Campioni liquidi, semi-solidi (HR-MAS)

Applicazioni

- La Risonanza magnetica è un metodo analitico avanzato che è in grado di identificare la struttura e la composizione molecolare di metaboliti nelle matrici biologiche (vegetali).
- Utile sia per composti isolati, che per lo studio di miscele complesse, senza separazione fisica dei componenti
- Può essere applicata per lo studio di estratti vegetali di diversa polarità (metaboliti idrosolubili, idrofobi (liposolubili), olii essenziali, ecc.)

Esempi di classi di composti studiati con NMR

Estrazioni non specifiche

Metaboliti idrosolubili

Amino acidi liberi,

Acidi organici,

Zuccheri,

Polifenoli, Vitamina C

Metaboliti liposolubili:

Un profilo di acidi grassi,
Steroli,
Fosfolipidi,
Tri- e digliceridi,
Terpeni,
Carotenolidi

Estrazioni/metaboliti target

Glucosinolati,

Antocianine, Flavonoidi,

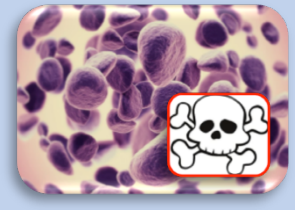
Sesquiterpeni lattoni,
Terpeni

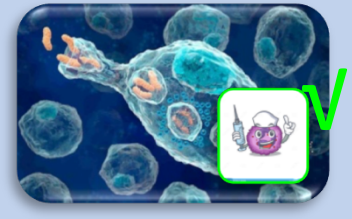
Analisi delle proprietà antimicrobiche e immunoadiuvanti delle Piante Aromatiche Medicinali (PAM)

L'Istituto per i Sistemi Biologici dispone di una BIO Banca di 200 estratti di PAM

L'ISB studia l'attività

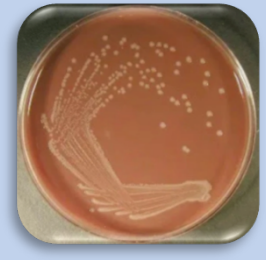

antibatterica

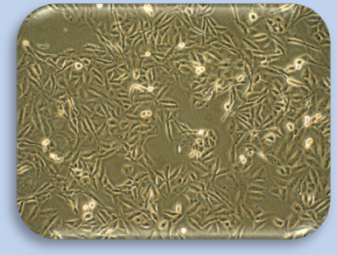

antitumorale

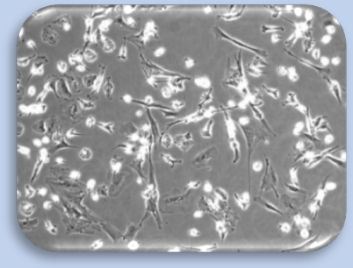

Immunomodulante (macrofago attivato)

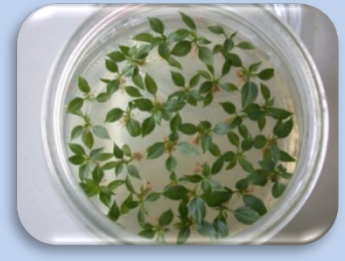

antimicrobica

degli estratti vegetali su :


Batteri su piastra


Cellule tumorali


Macrofagi umani


Cellule vegetali

Alcune delle piante studiate

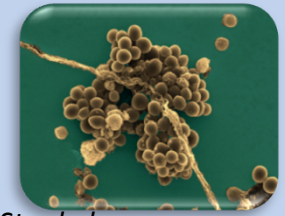

Lavandula angustifolia

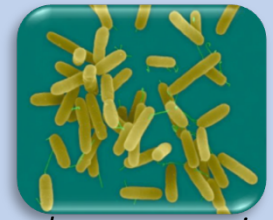

Cinnamomum zeylanicum


Rosmarinus officinalis

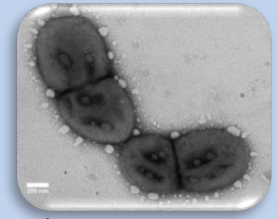

Cannabis sativa

Batteri bersaglio


Staphylococcus aureus

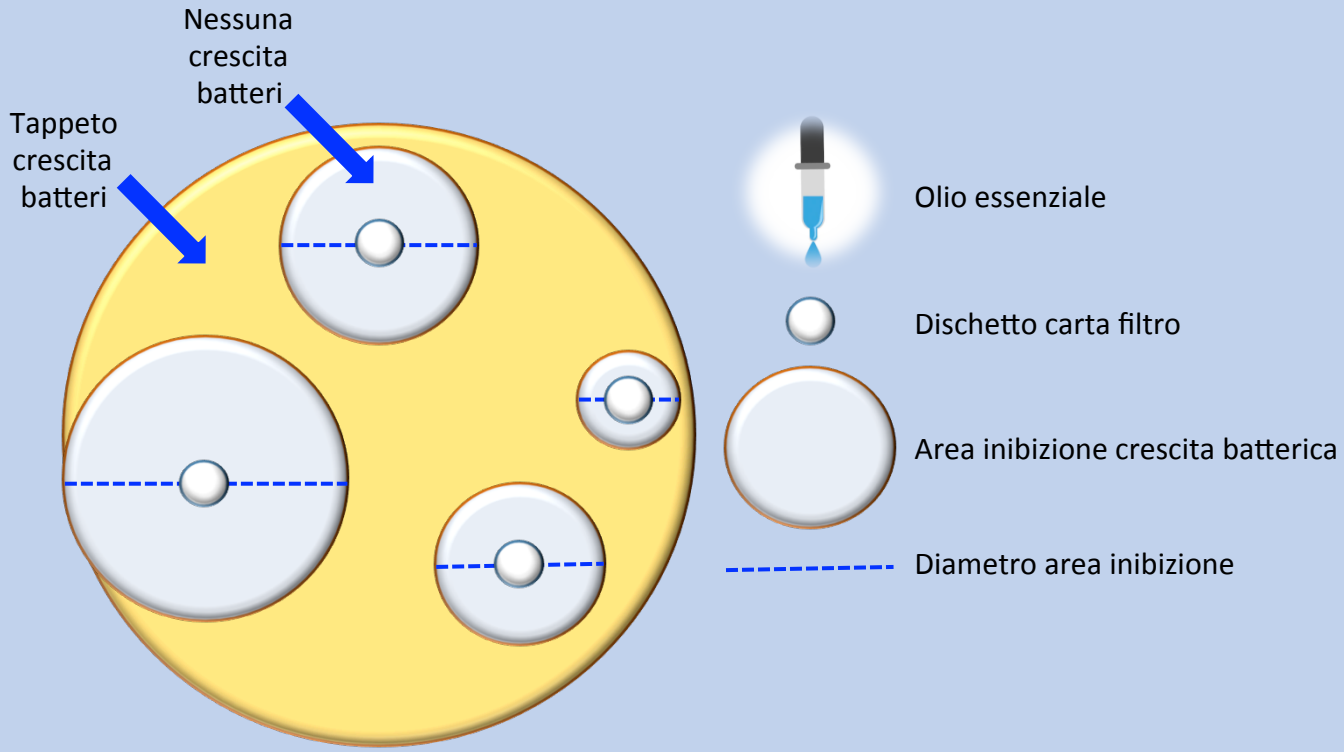

Pseudomonas aeruginosa


Staphylococcus epidermidis


Porphyromonas gingivalis

Olii Essenziali *vs* Antibiotici

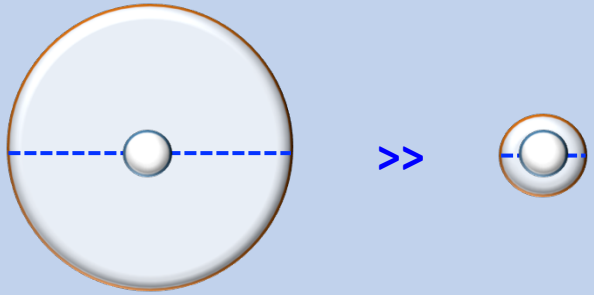
Il vantaggio dell'utilizzo di Olii Essenziali per debellare le infezioni batteriche sta proprio nella loro complessa composizione, che **non permette ai batteri patogeni di sviluppare resistenze**, come nel caso **degli Antibiotici** convenzionali, costituiti prevalentemente da una singola molecola.



Sensibili ***vs*** **Resistenti**

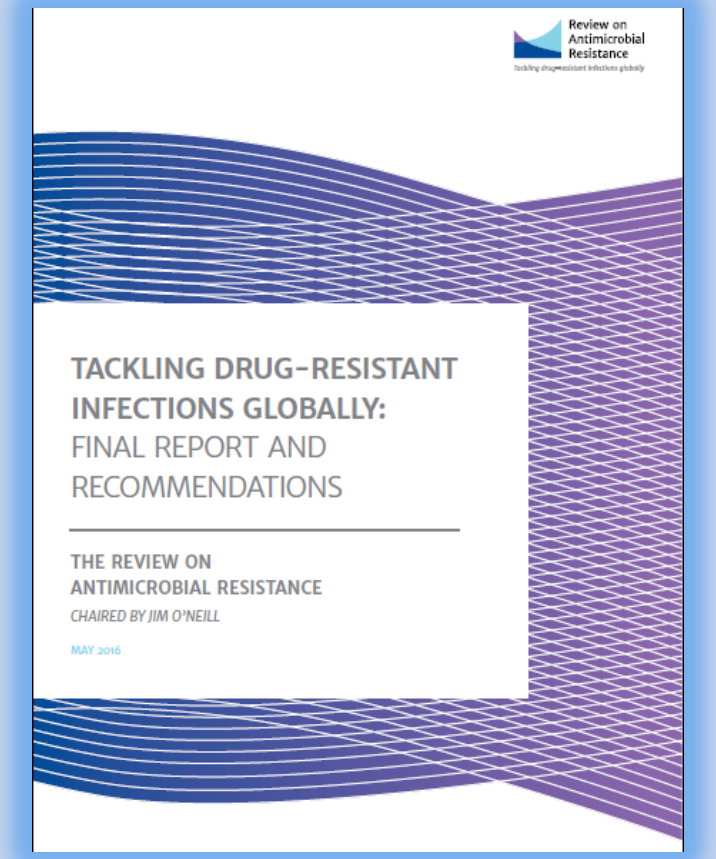
Diametro area di inibizione della crescita

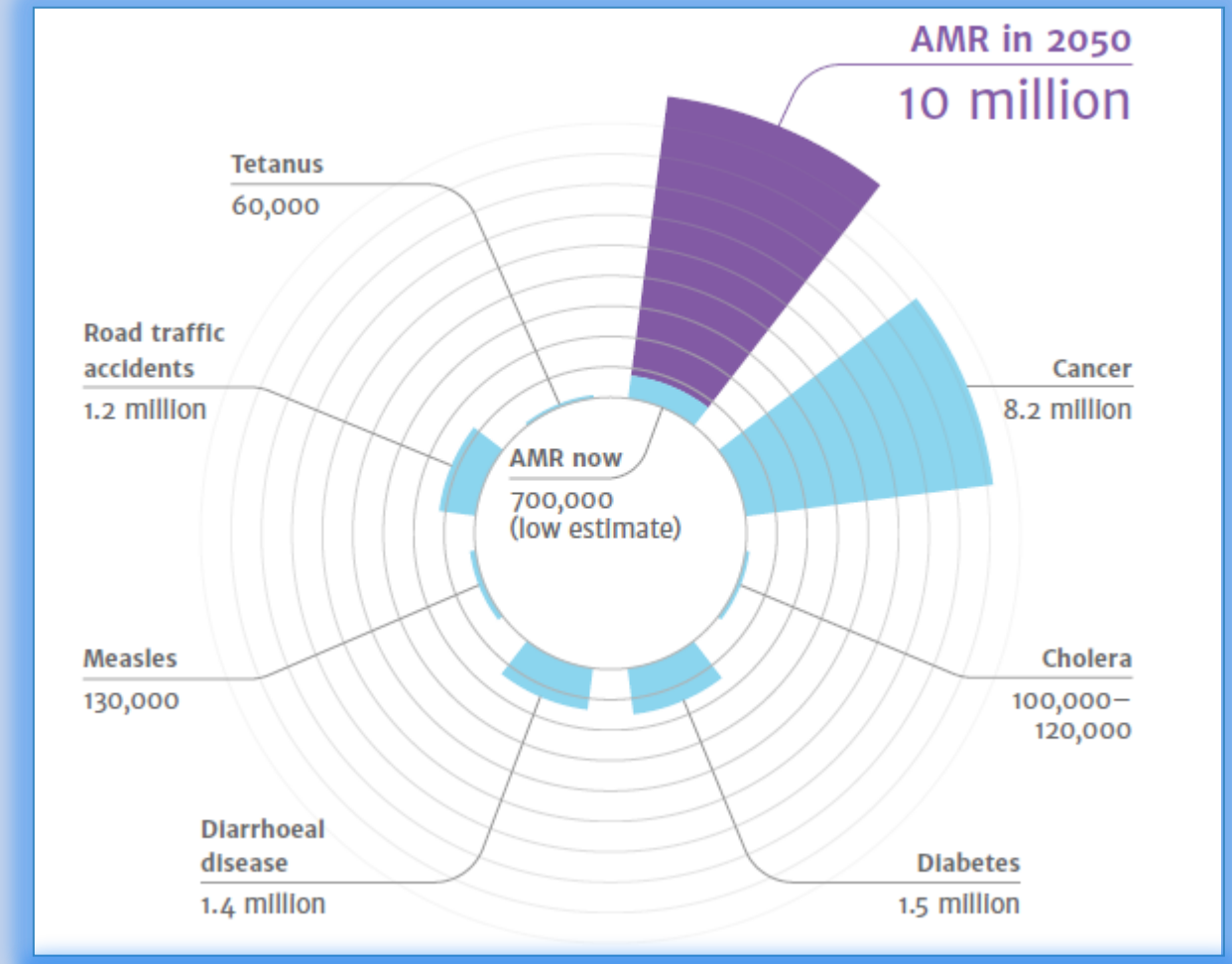
Batteri Sensibili >> Batteri Resistenti



Maggiore è il potere antibatterico di un OE e maggiore sarà il diametro di inibizione della crescita su una piastra con terreno solido

DEATHS ATTRIBUTABLE TO AMR EVERY YEAR



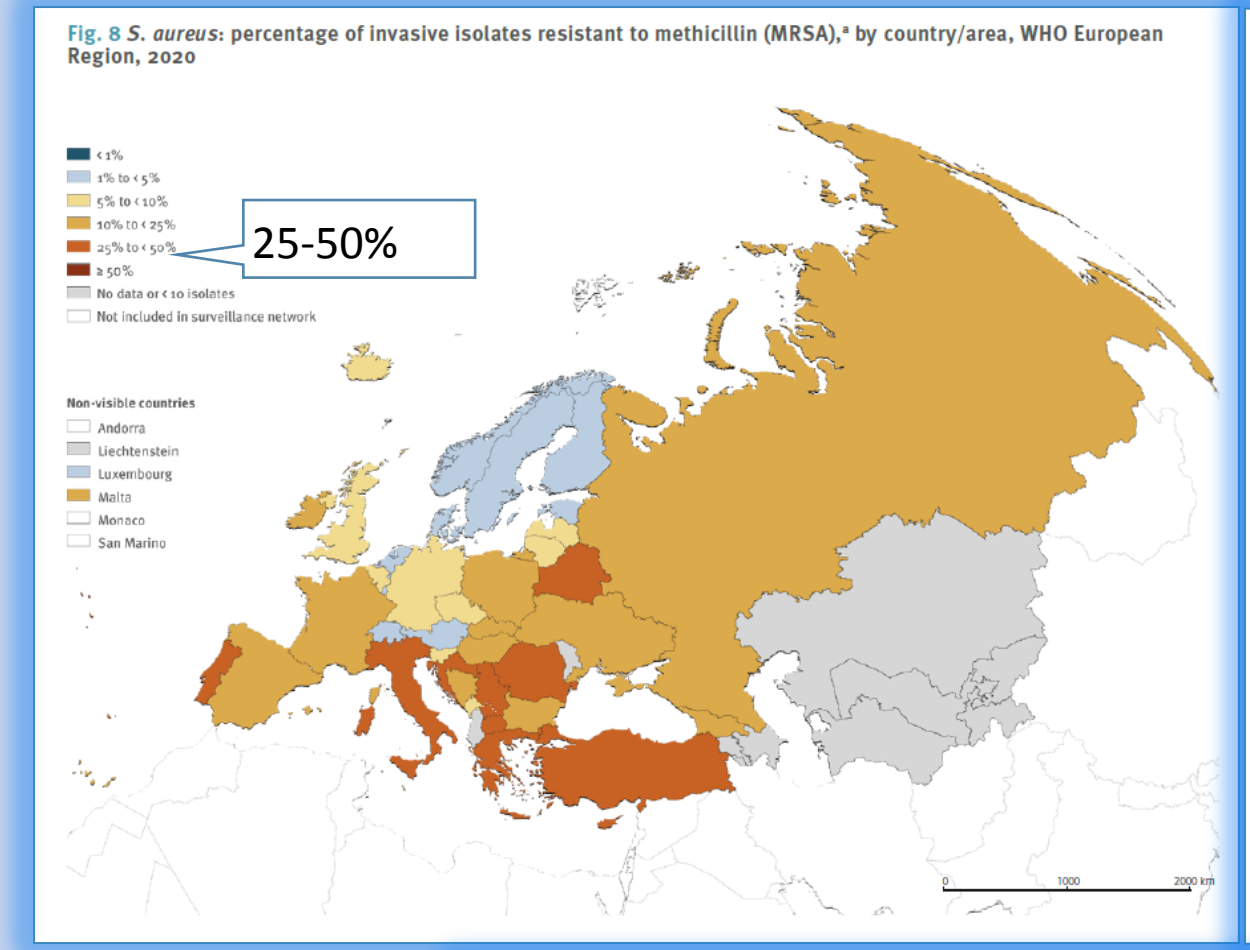


Sources:

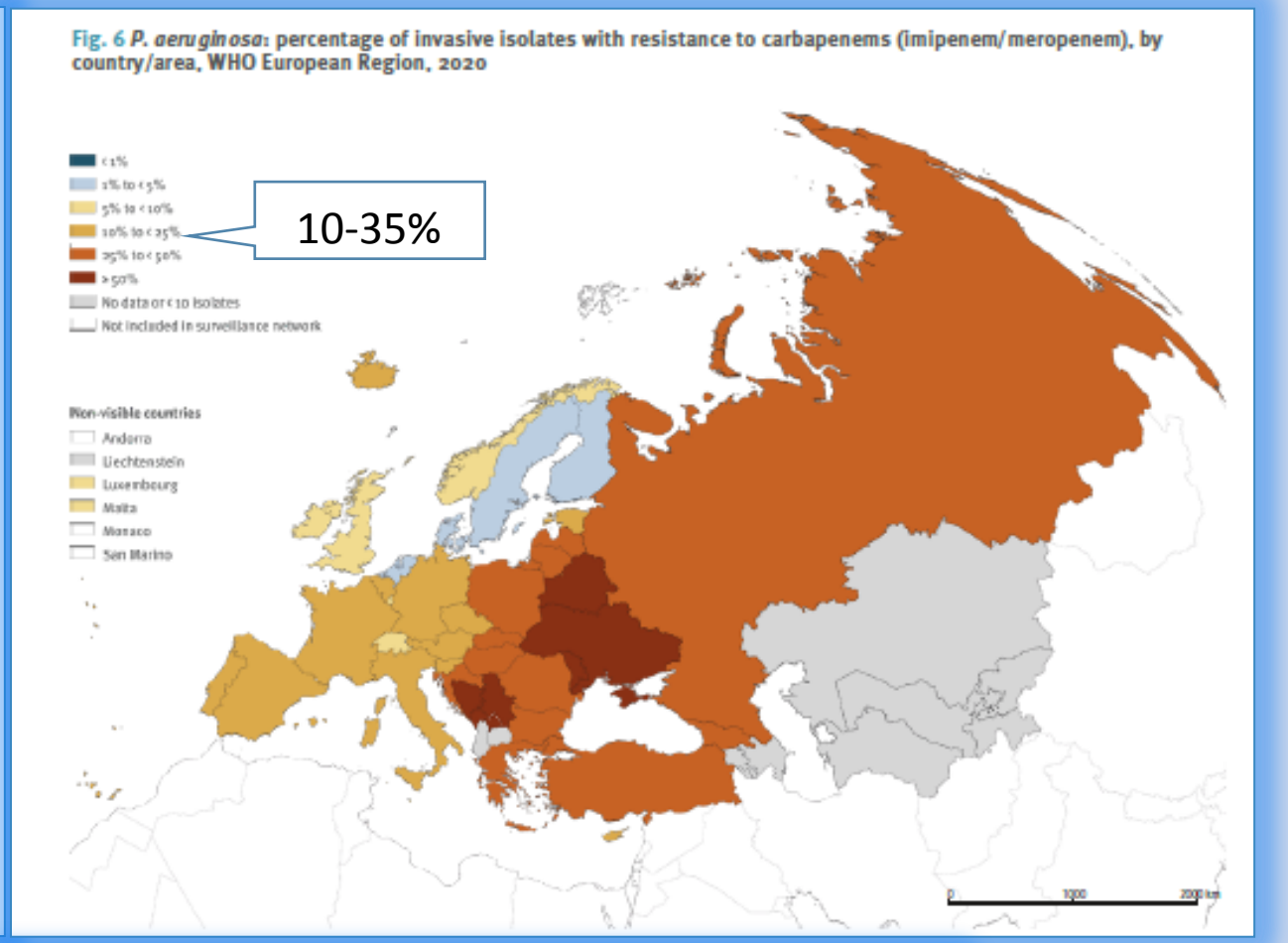
Diabetes: www.who.int/mediacentre/factsheets/fs312/en/ Cancer: www.who.int/mediacentre/factsheets/fs297/en/
Cholera: www.who.int/mediacentre/factsheets/fs107/en/ Diarrhoeal disease: www.sciencedirect.com/science/article/pii/S0140673612617280
Measles: www.sciencedirect.com/science/article/pii/S0140673612617280 Road traffic accidents: www.who.int/mediacentre/factsheets/fs358/en/
Tetanus: www.sciencedirect.com/science/article/pii/S0140673612617280

Review on Antimicrobial Resistance

*S.aureus*_Gram positive



*P.aeruginosa*_Gram negative

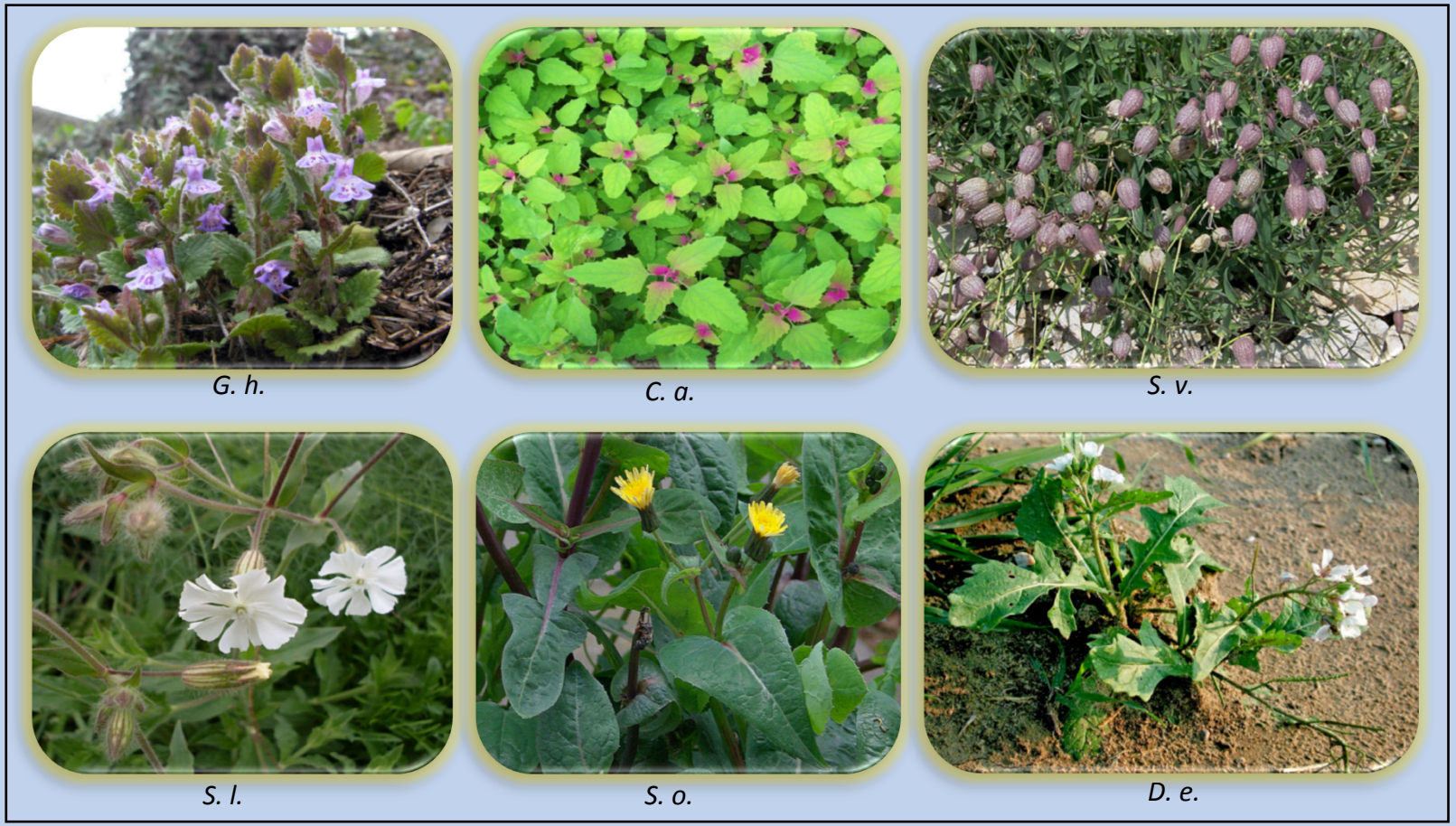


SURVEILLANCE REPORT **Antimicrobial resistance surveillance in Europe 2022** – 2020 data

European Centre for Disease Prevention and Control_An agency of the European Union

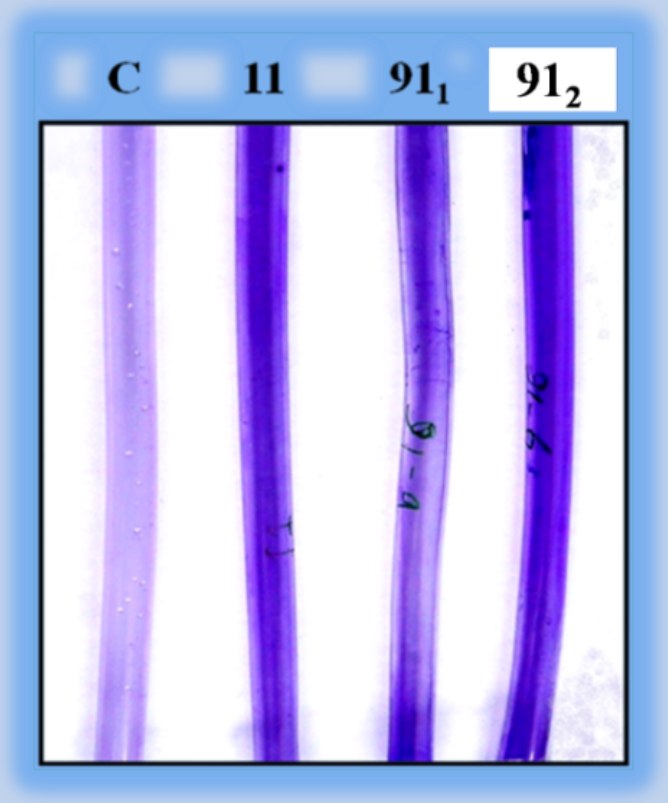
Un caso studio.

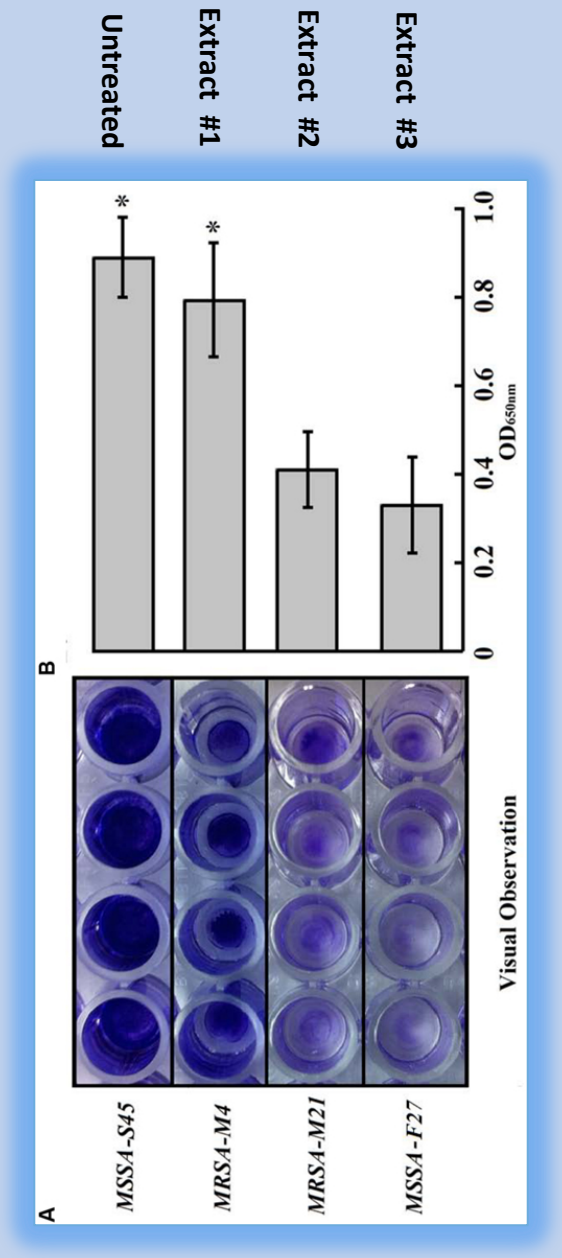
Analisi delle proprietà inibenti sulla crescita e sulla formazione del biofilm batterico di *S.aureus* ATCC 25923 degli estratti di sei specie di piante fitoalimurgiche e composizione metabolica degli estratti



Crystal Violet staining of bacterial mature biofilm

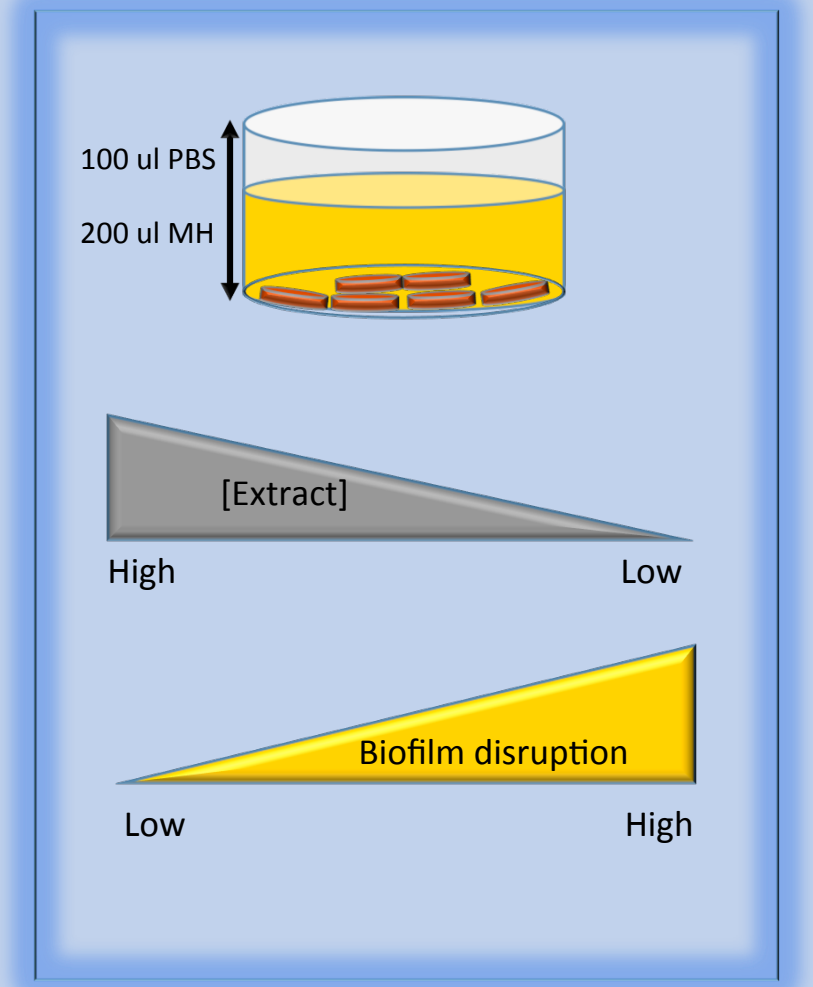
Nosocomial catheters-associated infections



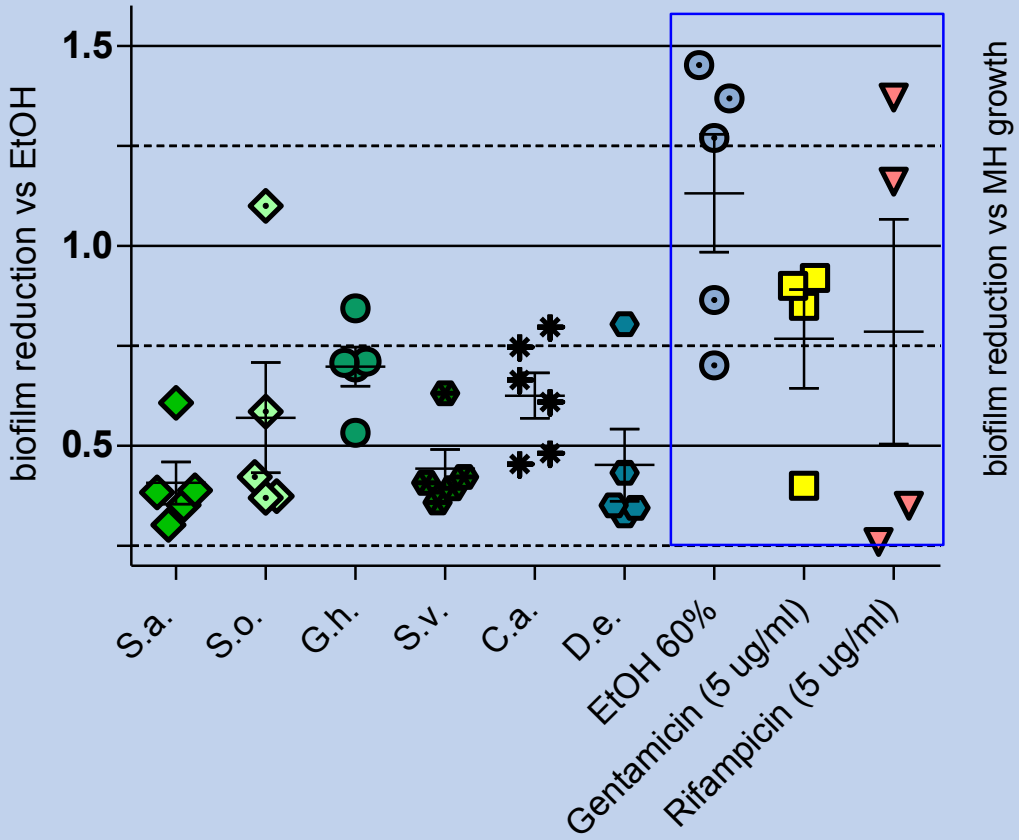


Anti-biofilm activity

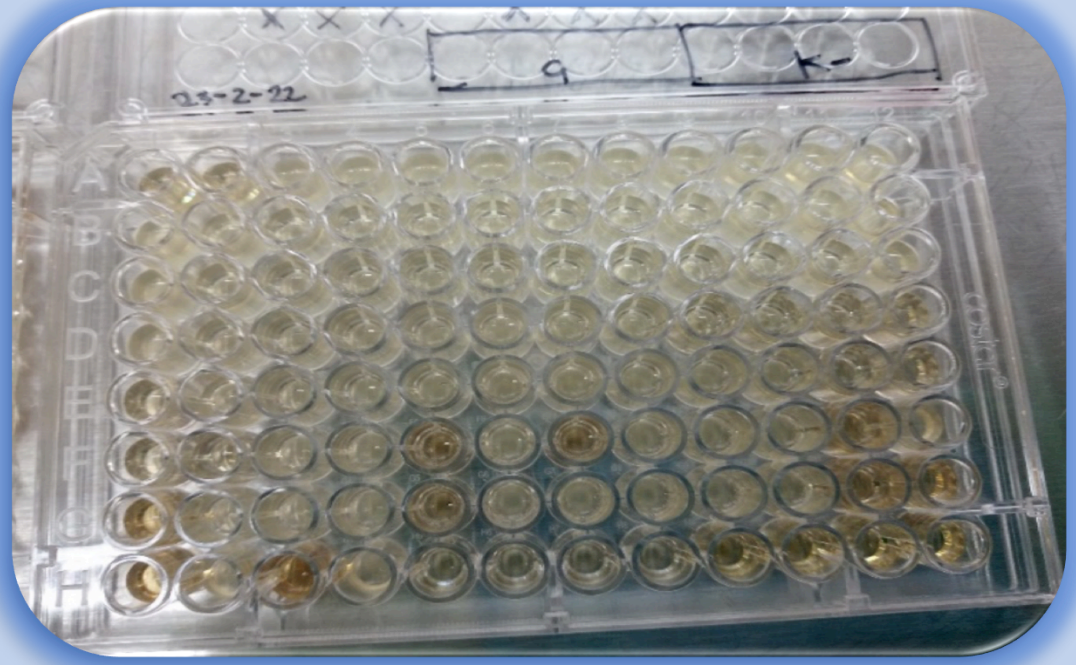
Piastra 96 hr
(ultime 24 hr + estratti in MH)



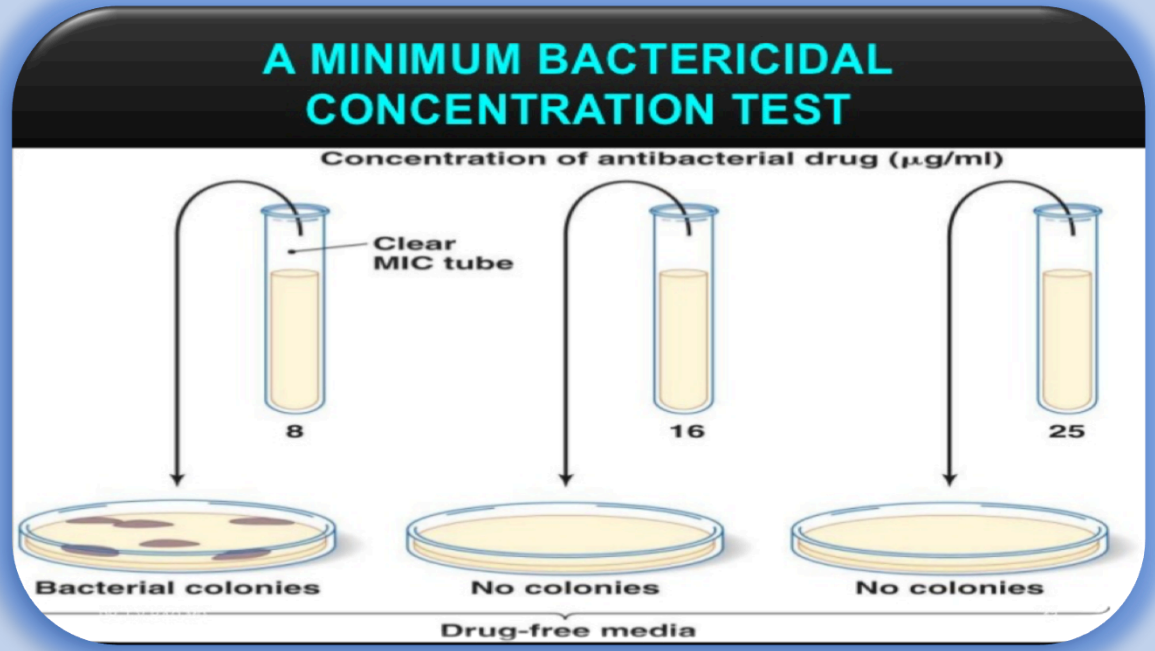
S.aureus Biofilm
96 hr in MH



Minimal Inhibiting Concentration (MIC) and **Minimal Bactericidal Concentration** (MBC)



t1 MIC



t2 MBC

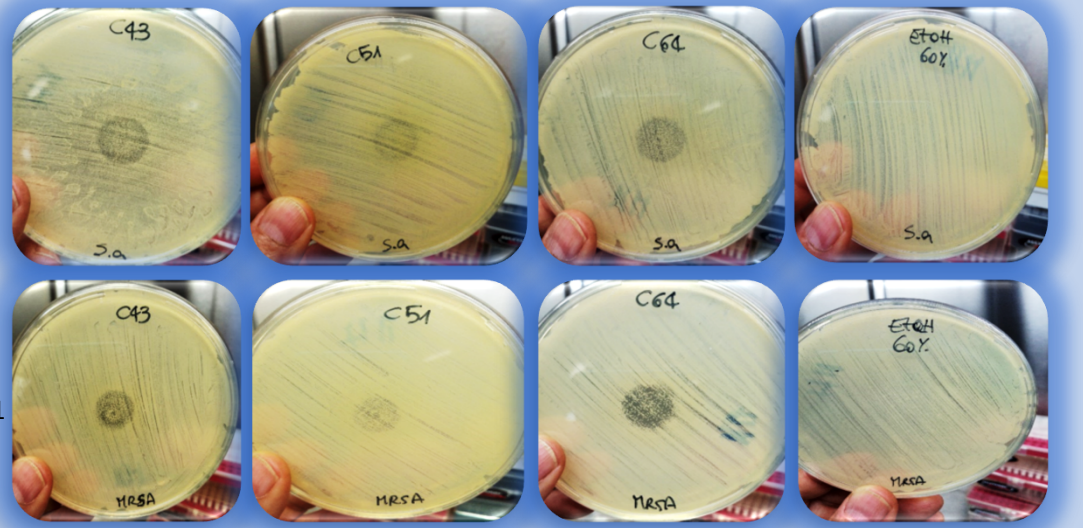
		Planktonic bacteria				Mature biofilms
		S.aureus		MRSA		*S.aureus*
		MIC	MBC	MIC	MBC	MBIC
		[mg/ml]		[mg/ml]		96 h
Plant Species	Extract					
S. a.	C51	>4,5<5	5	>4,5<5	5	nd
	C72	>4,5<5	5	>4,5<5	5	0,25
	C215	>20	>20	>20	>20	nd
	B216	>20	>20	>20	>20	nd
S. o.	C64	>8<9	9	9	10	0,25
	C56	>20	>20	>20	>20	0,25
G. h.	C43	<10	10	<10	10	0,25
C. a.	C210	5	10	20	>20	nd
	C206	2	20	20	>20	0,5
	C133	>20	>20	>20	>20	0,25
	C46	>20	>20	>20	>20	
S. v.	C73	15	20	15	20	0,25
	C49	20	>20	20	>20	0,25
D. e.	C171	>20	>20	>20	>20	0,25

Ordine decrescente proprietà antimicrobiche

Antiadesività
1/125 MIC

S. aureus
ATCC 25923

MRSA
ATCC 33591



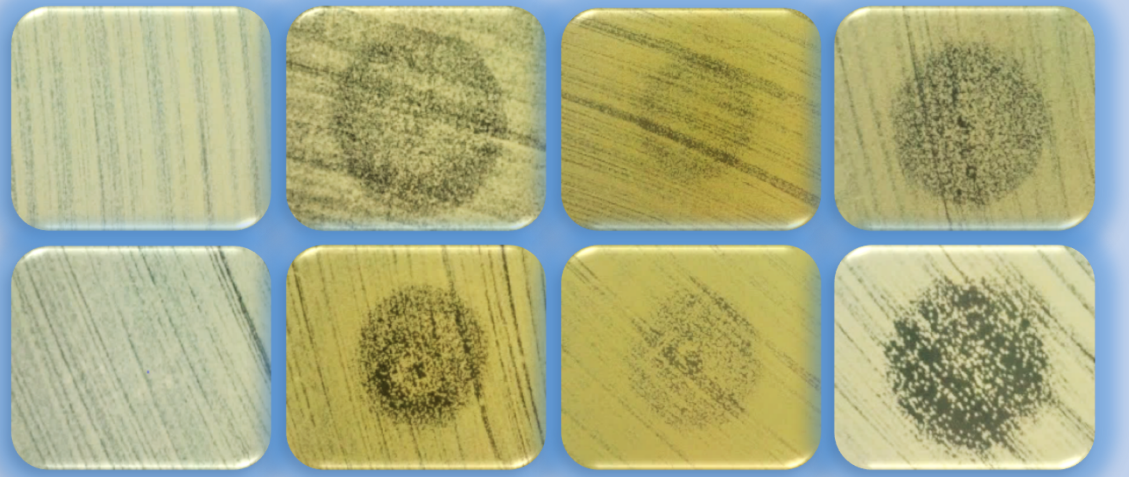
G.h. *S.a.* *S. o.* Solvente

Acquisizione con Paint 3D, stessa area della piastra, (1053 x 840 px)

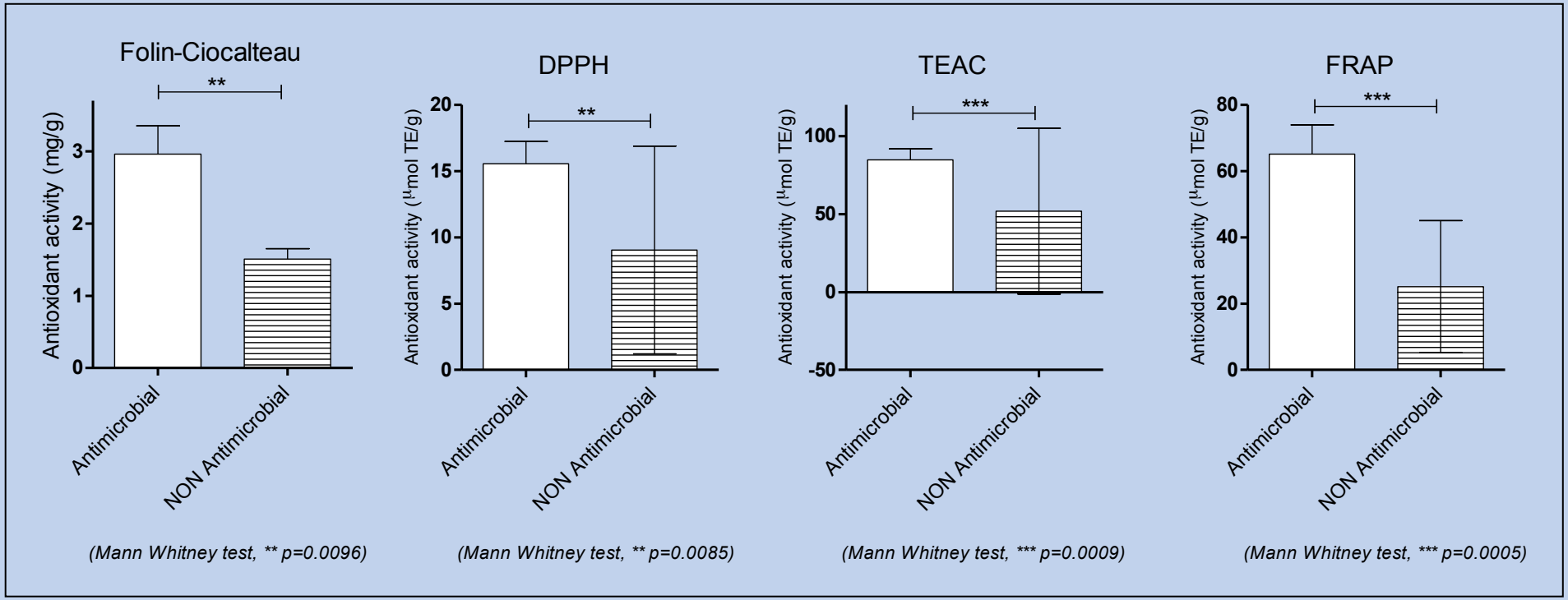
Et-OH 60% *G. h.* *S. a.* *S. o.*

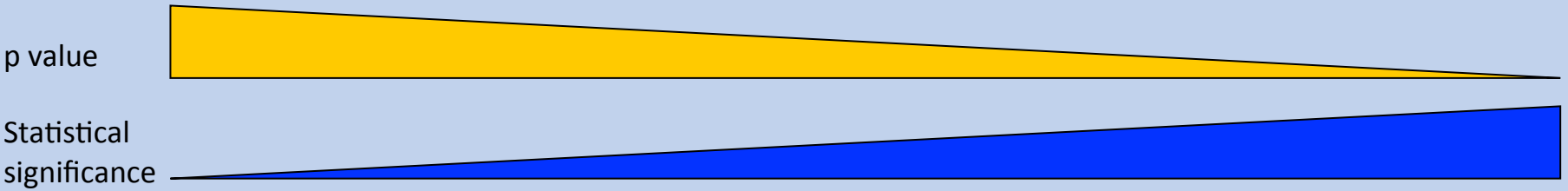
S. aureus
ATCC 25923

MRSA
ATCC 33591



Proprietà antiossidanti





Se tolgo C49 e C46: Folin,p>0.05, DPPH, ****p<0.0001, TEAC, ****p<0.0001, FRAP, ****p<0.0001

Bioprospecting

Ordine decrescente proprietà antimicrobiche

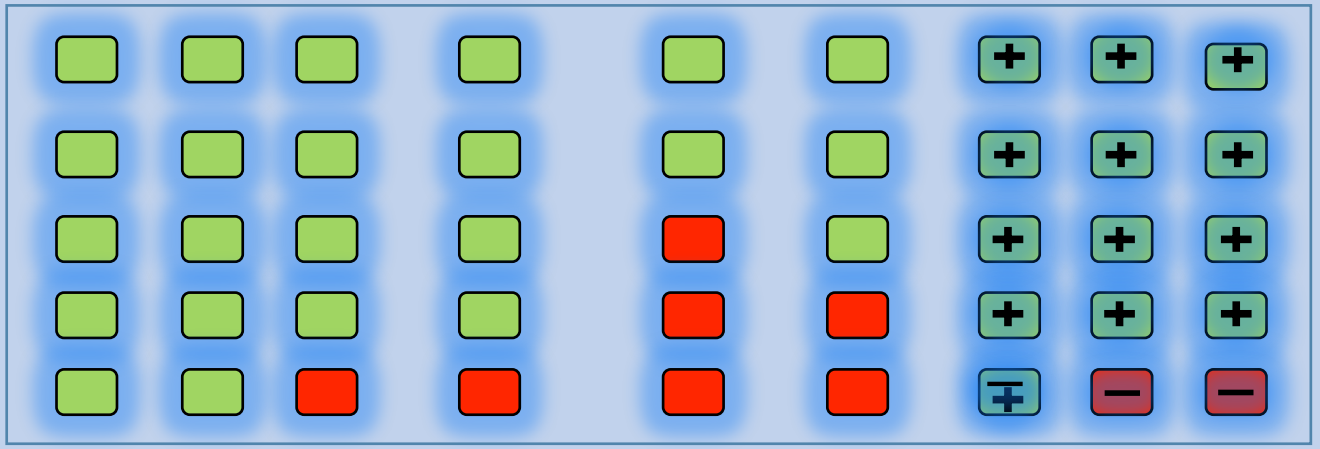
S. a.>

S. o.- G. h. >

C. a. >

S. v. >

S. v. (C49)



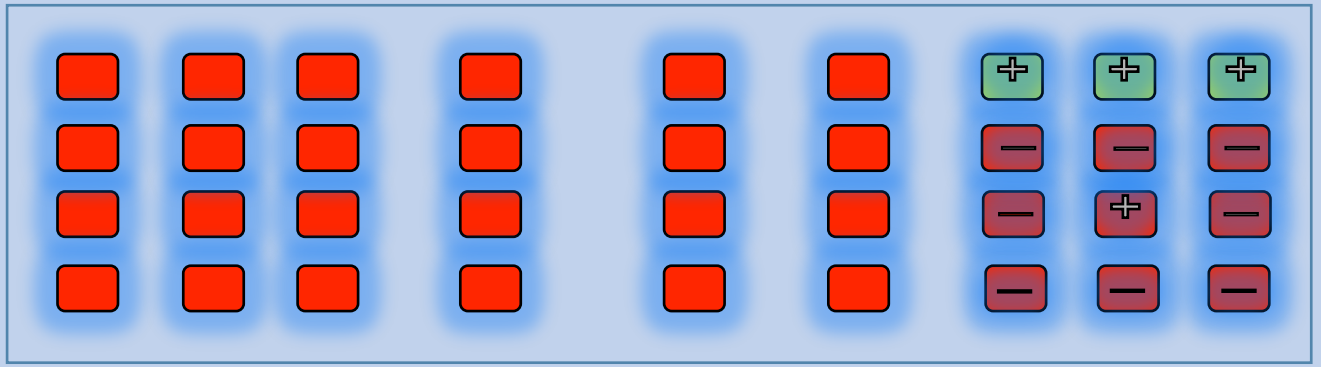
Estratti no MIC-MBC

C. a. (C46)

C. a. (C133)

S. o. (C56)

D. e. (C171)



Linea di ricerca sulle Piante Medicinali

Journal of Ethnopharmacology 191 (2016) 180–187

Contents lists available at ScienceDirect

Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jep

Commentary

A manifesto for the valorization of wild edible plants

Loretta Bacchetta [a,1], Francesco Visioli [b,k,*,1], Giulia Cappelli [c], Emily Caruso [d], Gary Martin [d], Eva Nemeth [e], Gianni Bacchetta [f], Gianni Bedini [g], Alexander Wezel [h], Tedje van Asseldonk [i], Leo van Raamsdonk [j], Francesca Mariani [c], on behalf of the Eatwild Consortium [a,2]

[a] ENEA BIOAG-PROBIO, Rome, Italy
[b] Department of Molecular Medicine, University of Padova, Italy
[c] Institute Cell Biology and Neurobiology, National Research Council, Monterotondo, RM, Italy

Journal of Functional Foods 45 (2018) 499–511

Contents lists available at ScienceDirect

Journal of Functional Foods

journal homepage: www.elsevier.com/locate/jff

A *Corylus avellana* L. extract enhances human macrophage bactericidal response against *Staphylococcus aureus* by increasing the expression of anti-inflammatory and iron metabolism genes

Giulia Cappelli[a], Daniela Giovannini[a,1], Anna Lisa Basso[a], Olivia Costantina Demurtas[b], Gianfranco Diretto[b], Chiara Santi[b], Gabriella Girelli[c], Loretta Bacchetta[b], Francesca Mariani[a,*]

[a] Institute of Cell Biology and Neurobiology, National Research Council, Via E. Ramarini 32, 00015, Monterotondo (RM), Italy
[b] Department of Sustainability and Productivity of Territorial Systems, Biotechnology and Agro-Industry Division, ENEA Casaccia Research Center, Via Anguillarese 301, S. M. di Galeria (Rome), Italy
[c] Immunohematology and Transfusion Medicine Unit, Policlinico Umberto I, Sapienza University of Rome, Italy

foods

MDPI

Review

A Systematic Review on the Antimicrobial Properties of Mediterranean Wild Edible Plants: We Still Know Too Little about Them, but What We Do Know Makes Persistent Investigation Worthwhile

Giulia Cappelli and Francesca Mariani *

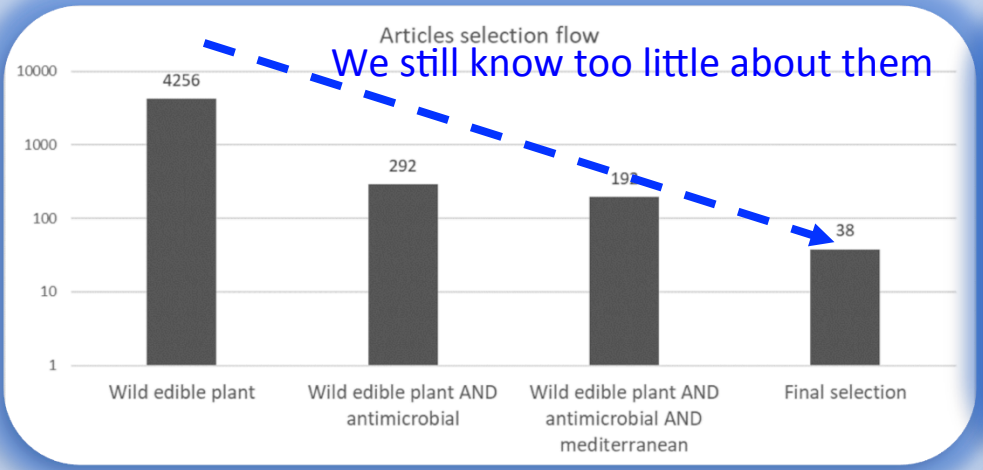
Institute for Biological Systems, National Research Council, Area RM1-(ISB-CNR), Strada Provinciale 35d, 9, Montelibretti, 00010 Rome, Italy; giulia.cappelli@cnr.it
* Correspondence: francesca.mariani@cnr.it; Tel.: +39-06-90672518

Abstract: (1) Introduction: Bacterial resistance to antibiotics is estimated to be the cause of a major number of deaths by 2050 if we do not find strategies to slow down the rise of drug resistance. Reviews on Mediterranean wild edible plants (MWEPs) with antimicrobial properties are scarce in the main databases (PubMed, Scopus, and WoS). Hence, we proceeded to conduct a new review of the studies on MWEPs. (2) Methods: We used 'wild edible plant' and 'antimicrobial' as keywords. Within this group, exclusion criteria were reviews, studies concerning non-Mediterranean plants or non-edible plants, studies on topics other than plants or containing no description of antimicrobial properties, or off-topic studies. (3) Results: Finally, out of the one hundred and ninety-two studies we had started with, we reviewed thirty-eight (19.8%) studies concerning the antimicrobial properties of seventy-four MWEPs species belonging to twenty-five Families. Fifty-seven (77%) species out of seventy-four proved to be antimicrobial, with a stringent threshold selection. (4) Conclusions: Studies are still very heterogeneous. We still know too little about MWEPs' properties; however, what we already know strongly recommends carrying on investigation.

Keywords: wild edible plants; antimicrobial effect; Mediterranean plant; Gram+ bacteria; Gram− bacteria; extraction protocols; bioactive compounds; essential oils

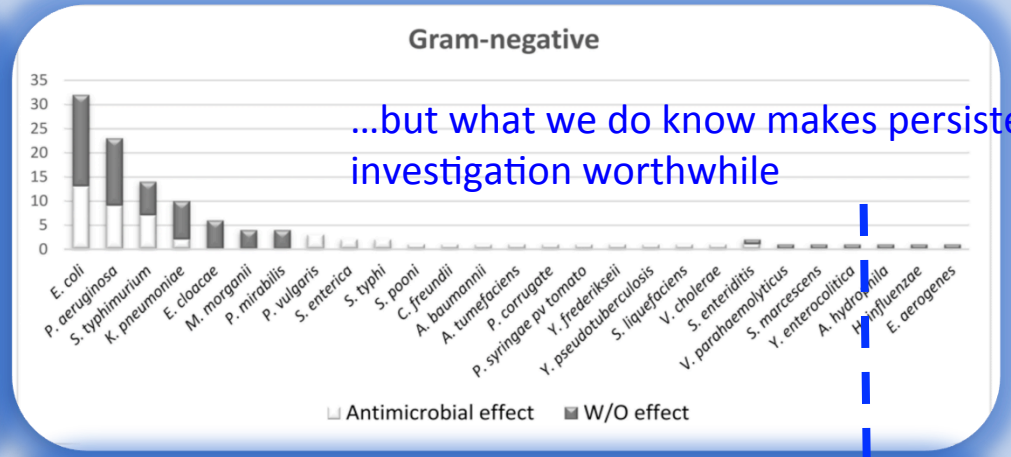
check for updates

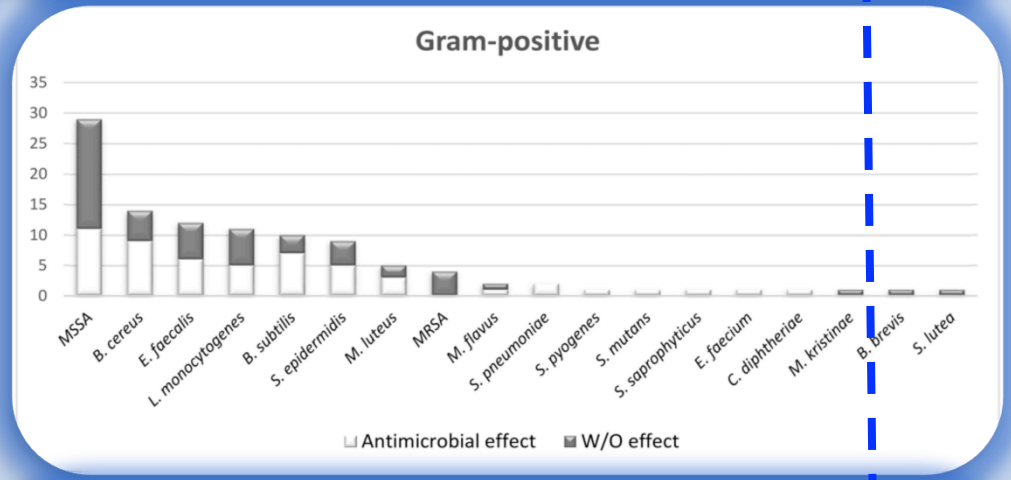
Citation: Cappelli, G.; Mariani, F. A Systematic Review on the Antimicrobial Properties of Mediterranean Wild Edible Plants: We Still Know Too Little about Them, but What We Do Know Makes Persistent Investigation Worthwhile. *Foods* **2021**, *10*, 2217. https://doi.org/10.3390/foods10092217

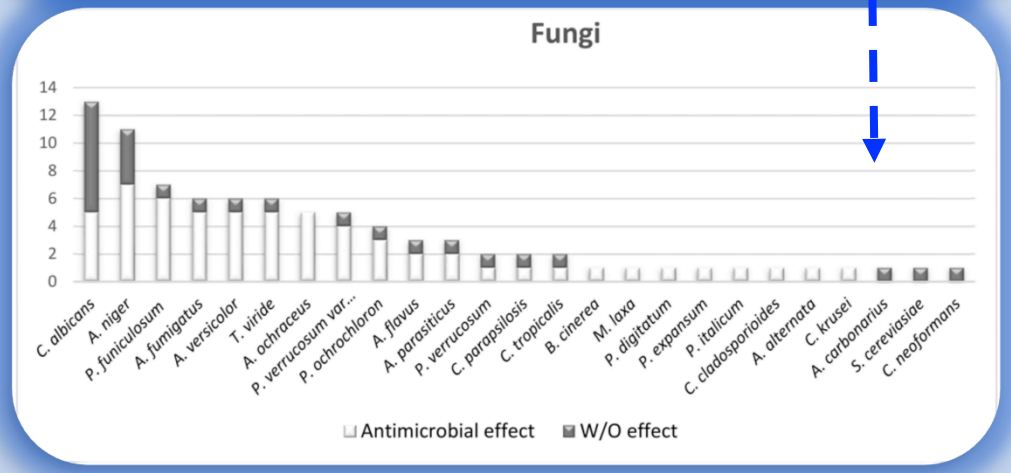


Families with the most studied species	Species	N° publications	Ref.
Amaranthaceae	*C.album*	2	[11,44]
Amaranthaceae	*C.murale*	2	[29,41]
Amaryllidaceae	***A.roseum***	**4**	[21,27,32,33]
Apiaceae	***F.vulgare***	**3**	[24,29,31]
Asphodelaceae	*E.spectabilis*	2	[18,22]
Asteraceae	***C.raphanina***	**4**	[16,17,20,37]
Asteraceae	*C.coronarium*	2	[24,35]
Asteraceae	*C.pumilum*	2	[13,24]
Asteraceae	*S.asper*	2	[7,19]
Asteraceae	***S.oleraceus***	**4**	[7,8,13,19]
Asteraceae	*T.officinale*	2	[8,19]
Brassicaceae	*N.officinale*	2	[41,44]
Caryophyllaceae	*S.vulgaris*	2	[19,39]
Lamiaceae	*Z.clinopodioides*	2	[25,40]
Papaveraceae	*P.rhoeas*	2	[29,44]
Polygonaceae	*P.aviculare*	2	[30,44]

Table S2. List of the 16 most studied species (described in more than one publication), belonging to 10 out of the total 25 botanical families. Four species (in bold) are analysed in more than two studies each, accounting for 39.5% of the whole thirty-eight studies reviewed.







Immunological Investigations
A Journal of Molecular and Cellular Immunology

ISSN: 0882-0139 (Print) 1532-4311 (Online) Journal homepage: http://www.tandfonline.com/loi/iimm20

Lavandula angustifolia Mill. Essential Oil Exerts Antibacterial and Anti-Inflammatory Effect in Macrophage Mediated Immune Response to Staphylococcus aureus

D. Giovannini, A. Gismondi, A. Basso, L. Canuti, R. Braglia, A. Canini, F. Mariani & G. Cappelli

International Journal of Molecular Sciences

submitted

Article

Cinnamomum zeylanicum Blume essential oil inhibits metastatic melanoma cell proliferation by triggering an incomplete tumour cell stress response

Giulia Cappelli [1], Daniela Giovannini[2^], Laura Vilardo[3], Annalisa Basso[2], Ilaria Iannetti[2], Marianna Massa[2§], Giuseppe Ruberto[4], Ryan Muir[5], Carlo Pastore[6], Igea D'Agnano [3*] and Francesca Mariani [2*]

1 Institute for Biological Systems (ISB)-CNR, Via Salaria Km 29,500 - 00015 Monterotondo, Italy
2 Institute of Cell Biology and Neurobiology (IBCN)-CNR, Via E. Ramarini 32, 00015 Monterotondo, Italy
3 Institute for Biomedical Technologies (ITB)-CNR, Via Fratelli Cervi 93, 20054, Segrate, Italy
4 Institute for Biochemical Chemistry (ICB)-CNR, Via Paolo Gaifami, 18, 95126 Catania, Italy

molecules

Article

A Rapid Nano-Liquid Chromatographic Method for the Analysis of Cannabinoids in *Cannabis sativa L.* Extracts

Lucie Žampachová [1,2], Zeineb Aturki [1,*], Francesca Mariani [1] and Petr Bednář [2]

1 Istituto per i Sistemi Biologici, Consiglio Nazionale delle Ricerche, Area della Ricerca di Roma I, Via Salaria Km 29.300, Monterotondo, 00015 Rome, Italy; luckazampachova@seznam.cz (L.Ž.); francesca.mariani@cnr.it (F.M.)
2 Department of Analytical Chemistry, Faculty of Science, Palacký University, 17. Listopadu 12, 771 46 Olomouc, Czech Republic; petr.bednar@upol.cz
* Correspondence: zeineb.aturki@cnr.it; Tel.: +39-06-90672255

Abstract: *Cannabis sativa L.* is an herbaceous plant belonging to the family of Cannabaceae. It is classified into three different chemotypes based on the different cannabinoids profile. In particular, fiber-type cannabis (hemp) is rich in cannabidiol (CBD) content. In the present work, a rapid nano liquid chromatographic method (nano-LC) was proposed for the determination of the main cannabinoids in *Cannabis sativa L.* (hemp) inflorescences belonging to different varieties. The nano-LC experiments were carried out in a 100 µm internal diameter capillary column packed with a C18 stationary phase for 15 cm with a mobile phase composed of ACN/H_2O/formic acid, 80/19/1% (*v/v/v*). The reverse-phase nano-LC method allowed the complete separation of four standard cannabinoids in less than 12 min under isocratic elution mode. The nano-LC method coupled to ultraviolet (UV) detection was validated and applied to the quantification of the target analytes in cannabis extracts. The nano-LC system was also coupled to an electrospray ionization–mass spectrometry (ESI-MS) detector to confirm the identity of the cannabinoids present in hemp samples. For the extraction of the cannabinoids, three different approaches, including dynamic maceration (DM), ultrasound-assisted extraction (UAE), and an extraction procedure adapted from the *French Pharmacopeia*'s protocol on medicinal plants, were carried out, and the results achieved were compared.

Keywords: cannabinoids; *Cannabis sativa L.*; hemp inflorescences extracts; nano-LC-UV; nano-LC–MS

Citation: Žampachová, L.; Aturki, Z.; Mariani, F.; Bednář, P. A Rapid Nano-Liquid Chromatographic Method for the Analysis of Cannabinoids in *Cannabis sativa L.* Extracts. *Molecules* **2021**, *26*, 1825. https://doi.org/10.3390/molecules26071825

Deposito domanda di Brevetto Internazionale (P.C.T.)

	Data	Numero	Nazione
Deposito:	06 maggio 2022	PCT/IB2022/054196	P.C.T.
Priorità:	11 maggio 2021	102021000012050	Italia
Titolare:	Consiglio Nazionale delle Ricerche		

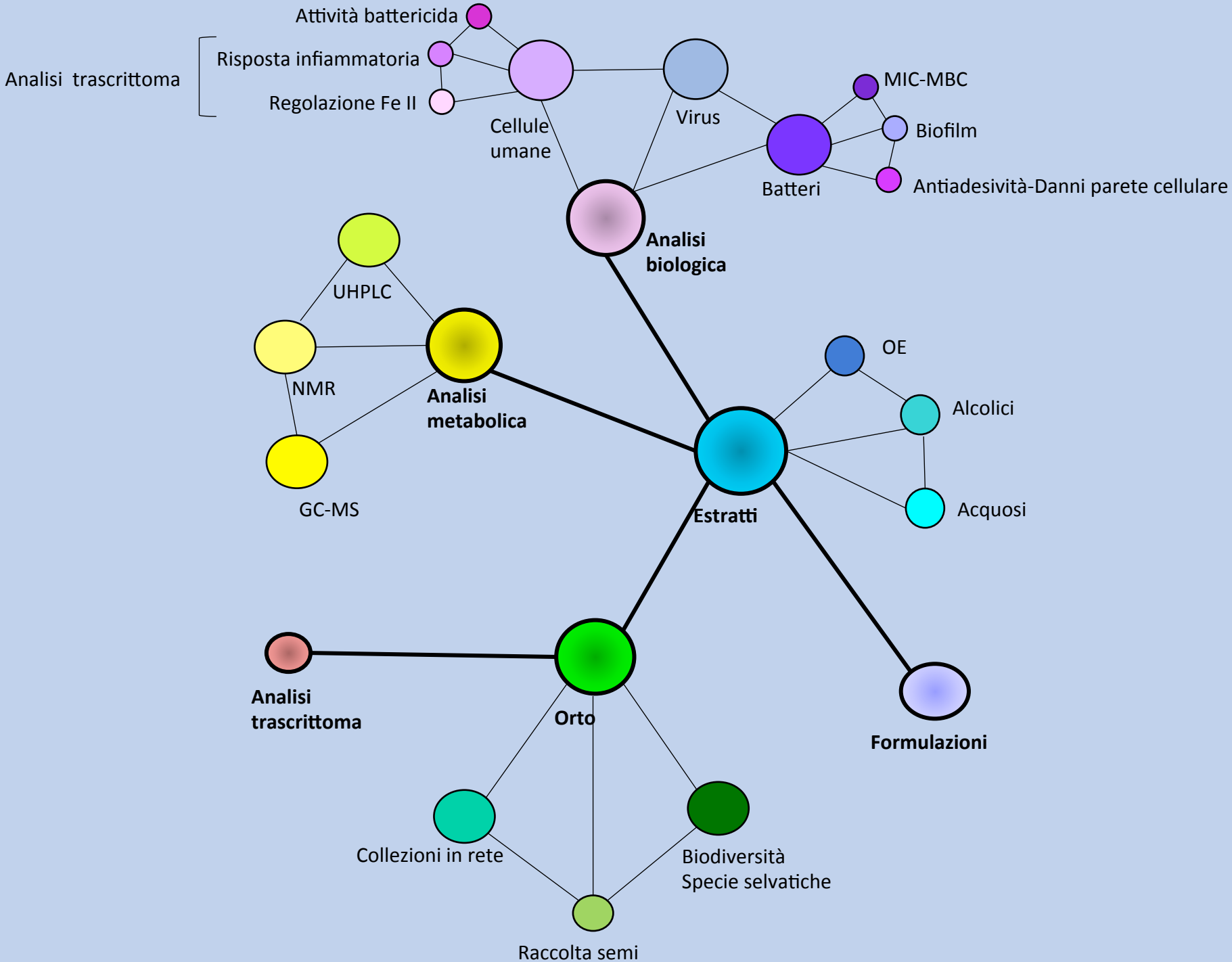
Progetti in corso

Olea europeae nano-formulated leaves extracts antimicrobial properties

Resveratrol anti-biofilm activity (“Liposomes as drug delivery systems of antimicrobial biomolecules obtained from F&V co-products”.)

Six **wild edible plants** antimicrobial and antioxidant properties

Cannabis sativa (EOs and Idro-alcoholic extracts) antimicrobial properties

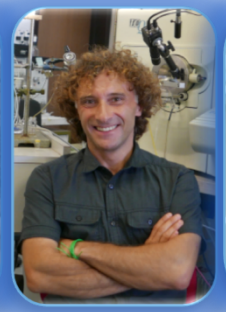

Attività battericida
Risposta infiammatoria
Regolazione Fe II
Analisi trascrittoma
Cellule umane
Virus
MIC-MBC
Biofilm
Antiadesività-Danni parete cellulare
Batteri
Analisi biologica
UHPLC
NMR
GC-MS
Analisi metabolica
OE
Alcolici
Acquosi
Estratti
Analisi trascrittoma
Orto
Formulazioni
Collezioni in rete
Biodiversità Specie selvatiche
Raccolta semi


F. Mariani


Z. Aturki


G. Cappelli


E. Donati


G. D'Orazio


I. Nicoletti


A. Sobolev


G. Testone


G. Mancini

Grazie per l'attenzione.

francesca.mariani@cnr.it
http://www.isb.cnr.it/

Area della Ricerca di Roma 1
Montelibretti
ISB