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The biological activities of propolis samples are the result of many bioactive compounds present in the propolis. The aim of the present study was to determine the various chemical compounds of some selected propolis samples collected from Palestine and Morocco by the High-Performance Liquid Chromatography–Photodiode Array Detection (HPLC-PDA) method, as well as the antioxidant and antibacterial activities of this bee product. The chemical analysis of propolis samples by HPLC-PDA shows the cinnamic acid content in the Palestinian sample is higher compared to that in Moroccan propolis. The results of antioxidant activity demonstrated an important free radical scavenging activity (2,2-Diphenyl-1-picrylhydrazyl (DPPH); 2,2'-azino-bis 3-ethylbenzothiazoline-6-sulphonic acid (ABTS) and reducing power assays) with EC₅₀ values ranging between 0.02 ± 0.001 and 0.14 ± 0.01 mg/mL. Additionally, all tested propolis samples possessed a moderate antibacterial activity against bacterial strains. Notably, Minimum Inhibitory Concentrations (MICs) values ranged from 0.31 to 2.50 mg/mL for Gram-negative bacterial strains and from 0.09 to 0.125 mg/mL for Gram-positive bacterial strains. The S2 sample from Morocco and the S4 sample from Palestine had the highest content of polyphenol level. Thus, the strong antioxidant and antibacterial properties were apparently due to the high total phenolic and flavone/flavonol contents in the samples. As a conclusion, this study confirms the correlation between phenolic compound content and antioxidant and antibacterial activity. Moroccan samples from Sefrou and Palestinian samples from Jenin have interesting but different antibacterial and antioxidant activities. Further work involving a larger number of propolis samples is needed to judge the usefulness of cinnamic acid and pinocembrin as quality indicators for Palestinian and Moroccan propolis, respectively.



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Propolis from African and Asian Region Composition and Impact on Antioxidant and Antibacterial Activities

جامعة سيدي محمد بن عبد الله - فاس
UNIVERSITÉ SIDI MOHAMED BEN ABDELLAH DE FES
كلية الطب والصيدلة وطب الأسنان
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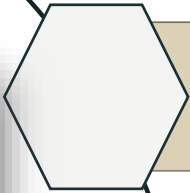


NO CONFLICT OF INTEREST

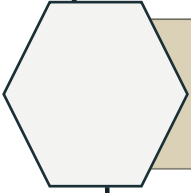
Article

Determination of Phenolic Compounds in Various Propolis Samples Collected from an African and an Asian Region and Their Impact on Antioxidant and Antibacterial Activities

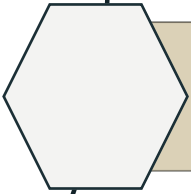
Soumaya Touzani ¹, Hamada Imtara ^{2,*}, Shankar Katekhaye ^{3,4}, Hamza Mechchate ⁵, Hayat Ouassou ⁶, Ali S. Alqahtani ⁷, Omar M. Noman ⁷, Fahd A. Nasr ⁷, Hugo Fearnley ⁴, James Fearnley ⁴, Anant Paradkar ⁴, Ilham ElArabi ¹ and Badiaa Lyoussi ¹



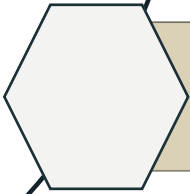
Rational & Aim



Methods



Results & discussion



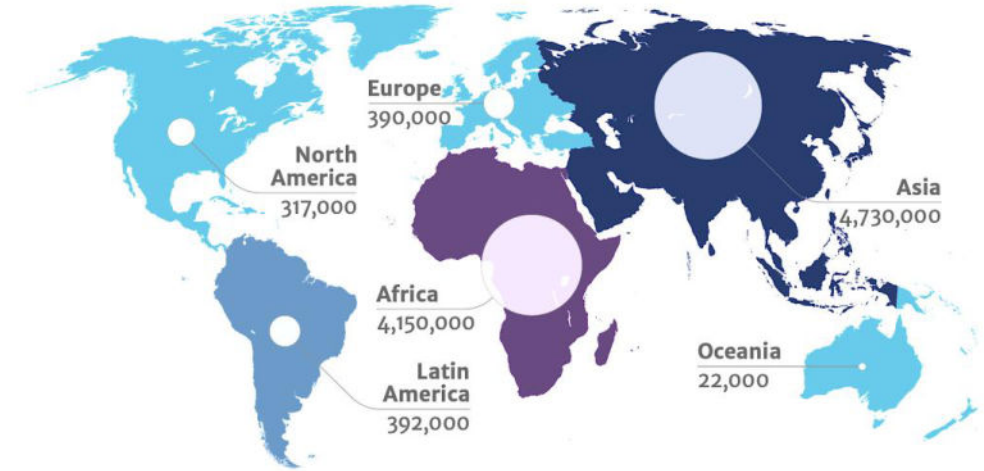
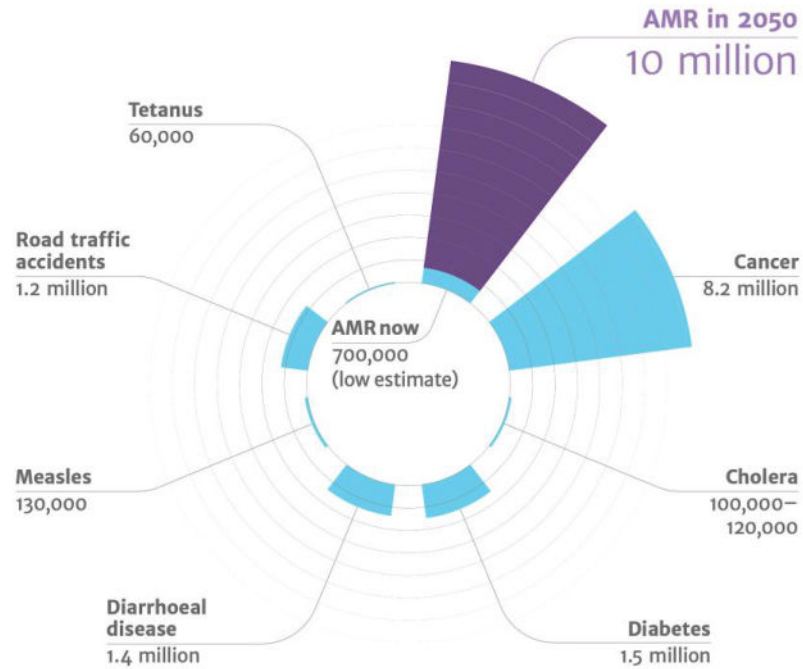
Conclusions



Antimicrobial resistance

10 Millions deaths/year by 2050

WHO



number of deaths

Mortality per 10,000 population

5 6 7 8 9 10 >



Investigating Natural products is compelling...



Antimicrobial resistance

10 Millions deaths/year by 2050

WHO



Oxydative stress = A ticking time bomb

→ neurodegenerative, cancer and cardiovascular co-morbidities



Diabetes = Curse of the century

662 Millions by 2040 (Vs 422 M in 2014)

WHO



Era of pandemics

COVID-19

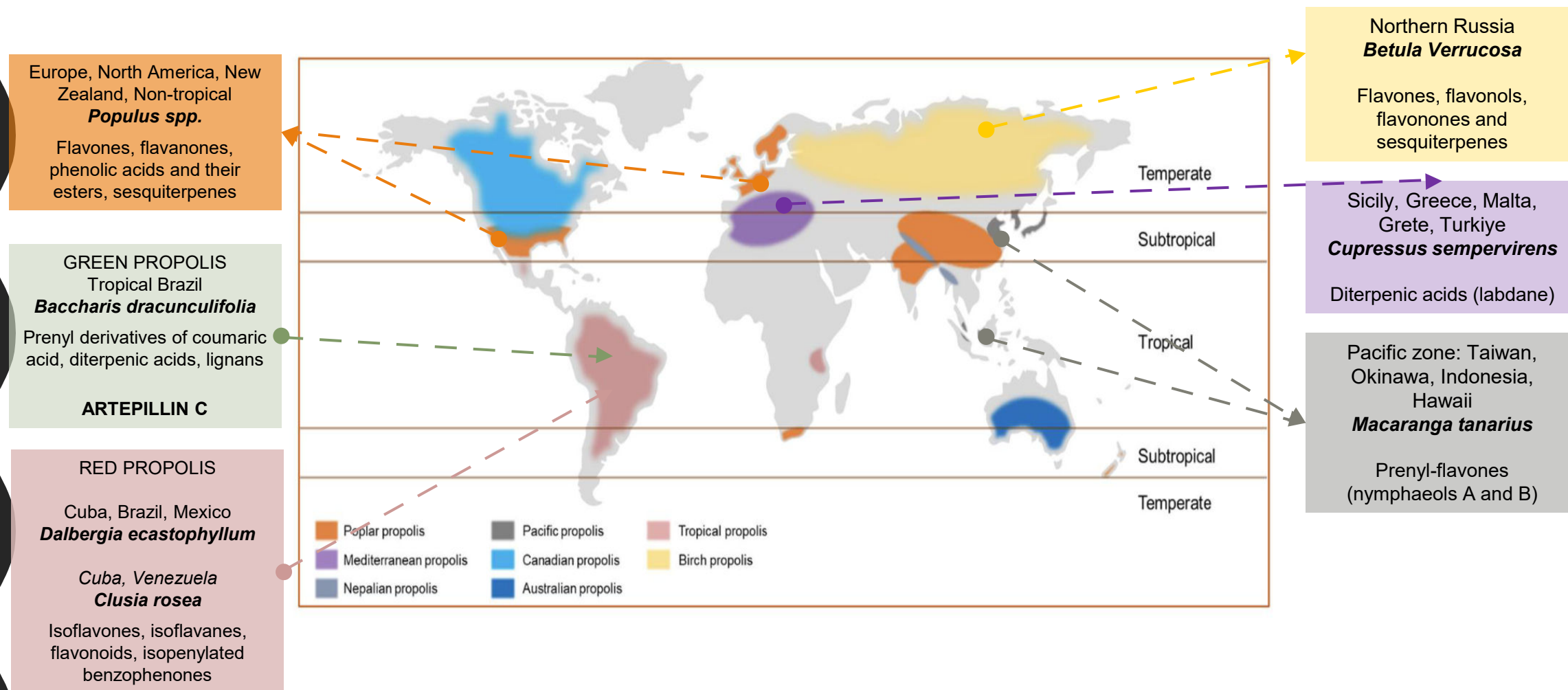


Investigating Natural products is compelling...



Chemical composition of propolis :

- ✓ Impacts its biological activity
- ✓ Depends on geobotanical origin, climatic conditions and season, processing methods





Chemical composition of propolis :

- ✓ Impacts its biological activity
- ✓ Depends on geobotanical origin, climatic conditions and season, processing methods

→ Characterize propolis from two geographically different countries:

Palestine (Asia) and Morocco (Africa) :

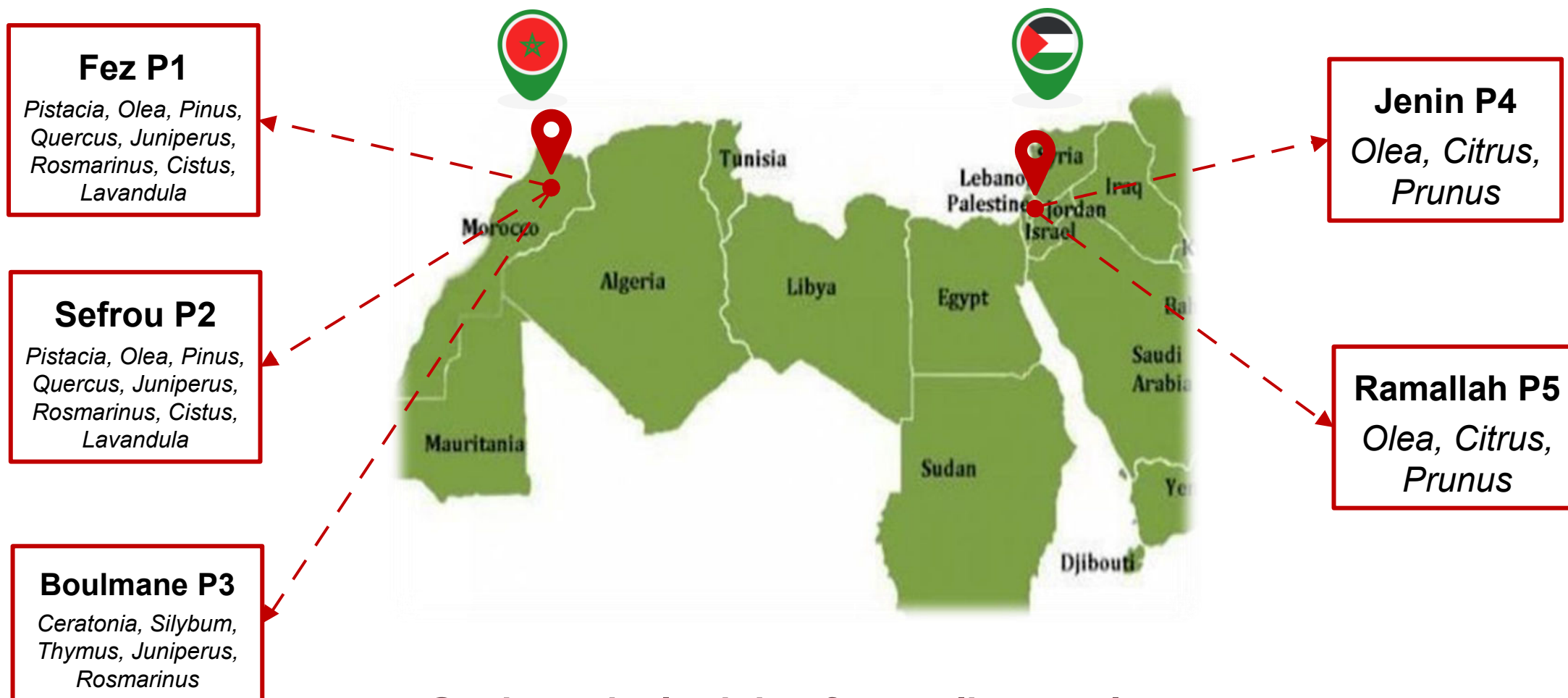
- Highlight interregional and intercontinental variability

→ Investigate the impact of the phenolic composition of the two propolis :

- As an indicator of quality
- On their antioxidant and antimicrobial activities



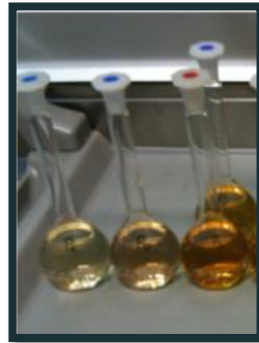
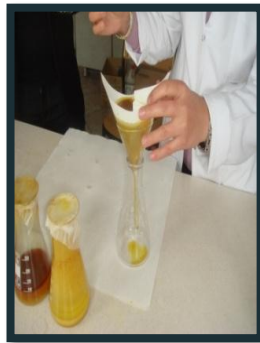
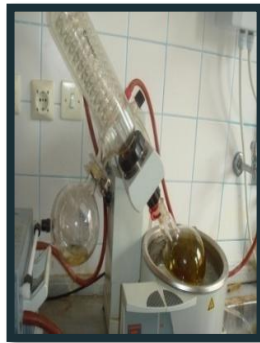
Geobotanical origin of propolis samples



Geobotanical origin of propolis samples



10g Raw Propolis + 100ml Ethanol 70%
Maceration, agitation, filtration, centrifugation



**Propolis
ethanol
extract
(70%)**



Propolis ethanol extract (70%)

- ❑ **Physicochemical characteristics:** resin, wax, balsam, ash, pH, humidity
- ❑ **Total antioxidant capacity, phenol and flavone/flavonol content**
- ❑ **Antioxidant activity:** DPPH, ABTS, FRAP
- ❑ **Phenolic compounds/ RP- HPLC analysis**
- ❑ ***In vitro* antimicrobial activity (MIC/MBC)**

Bacterial strains	Antibiotic resistance
<i>E. coli</i> BLSE (ATB:87) BGN	CXM, CRO, CEC, AMX, CAZ, CTX, KF, CIP
<i>E. coli</i> (ATB:57) B6N	CXM, AMX, CTX, KF, SXT, CIP
<i>E. coli</i> (ATB:97) BGM	AMX
<i>Pseudomonas aeruginosa</i>	SXT, AMC
<i>Streptococcus faecalis</i>	SXT, TE, VA, E, P, OX
<i>Staphylococcus aureus</i>	VA



PHYSICO-CHEMICAL CHARACTERIZATION

Propolis	Wax (%)	Resin (%)	Balsam (%)	Moisture (%)	Ash (%)	pH
Fez	26.09 ± 1.92 ^c	56.33 ± 1.03 ^c	1.02 ± 0.02 ^b	2.05 ± 0.01 ^b	3.42 ± 0.01 ^b	5.2 ± 0.01 ^a
Sefrou	20.31 ± 1.03 ^d	59.01 ± 0.12 ^a	1.11 ± 0.01 ^{ab}	1.01 ± 0.01 ^c	4.83 ± 0.01 ^a	5.1 ± 0.11 ^a
Boulmane	43.12 ± 1.23 ^a	54.14 ± 0.19 ^d	0.76 ± 0.01 ^c	2.07 ± 0.02 ^b	2.53 ± 0.02 ^c	4.5 ± 0.2 ^{bc}
Jenin	13.39 ± 1.08 ^e	57.76 ± 0.08 ^b	1.3 ± 0.03 ^a	1.03 ± 0.01 ^c	5.11 ± 0.01 ^a	4.8 ± 0.2 ^{ab}
Ramallah	29.86 ± 1.02 ^b	45.25 ± 0.13 ^e	0.69 ± 0.01 ^c	2.79 ± 0.09 ^a	1.67 ± 0.02 ^d	4.2 ± 0.1 ^c
Bankova et al	25 – 35 %	≥ 45%		≤ 8%	≤ 5 %	
Brazil Legisl.	≤ 25 %	≥ 35%		≤ 8%	≤ 5 %	

CONFORME

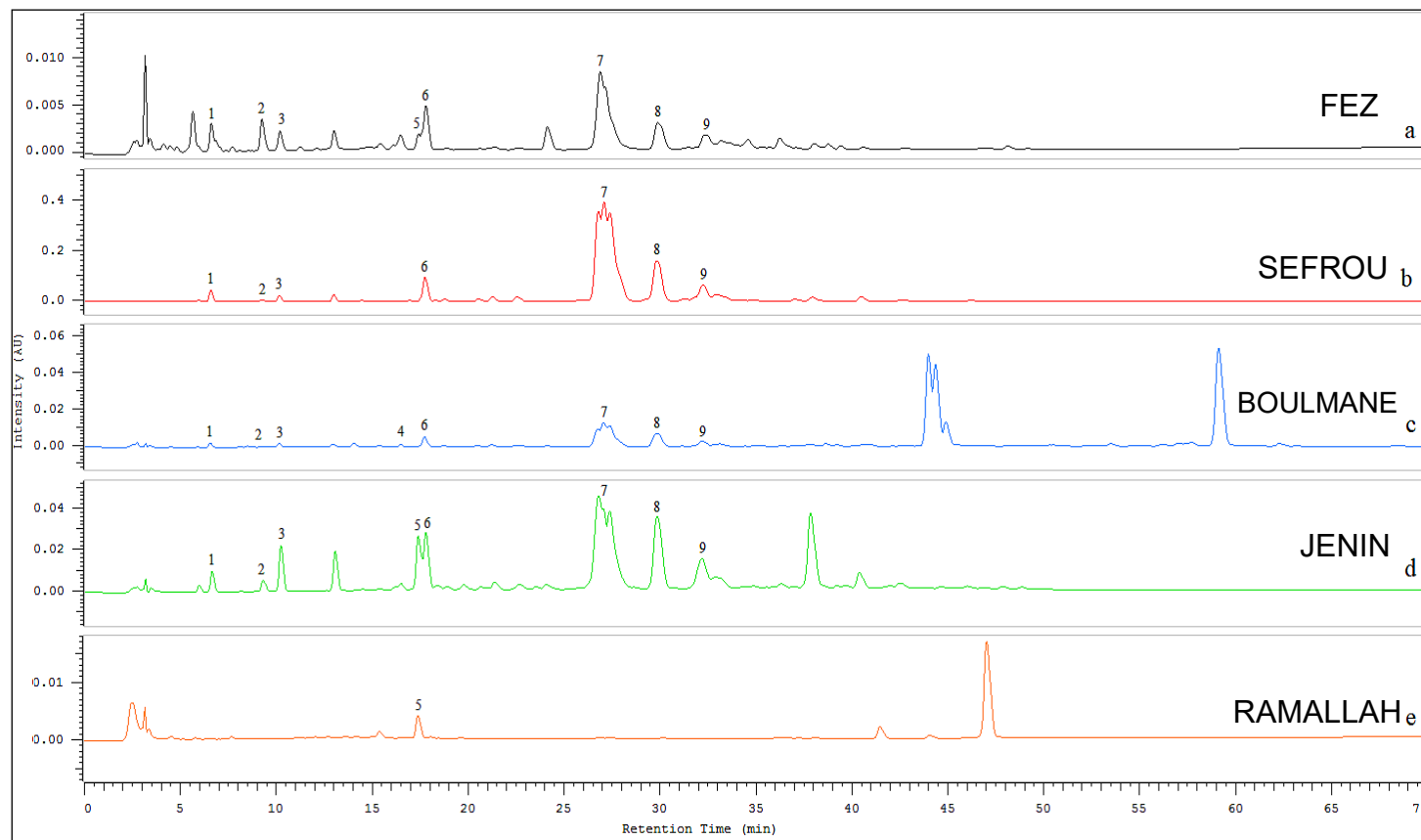


ANTIOXIDANT ACTIVITY

Propolis	Phenols (mg GAE/g)	Flavone Flavonol (mg QE/g)	TAA (mg AAE/g)	DPPH IC ₅₀ (mg/mL)	ABTS IC ₅₀ (mg/mL)	FRAP IC ₅₀ (mg/mL)
Fez	122 ± 0.81 ^c	76.52 ± 0.41 ^d	83.34 ± 1.20 ^a	0.08 ± 0.02 ^b	0.02 ± 0.001^d	0.06 ± 0.002 ^c
Sefrou	148 ± 1.31 ^a	118 ± 1.92^a	90.87 ± 2.91^a	0.02 ± 0.02 ^c	0.05 ± 0.001 ^a	0.04 ± 0.001 ^e
Boulmane	115 ± 1.42 ^c	98.21 ± 0.41 ^c	67.82 ± 3.46 ^b	0.07 ± 0.01 ^{bc}	0.04 ± 0.01 ^b	0.07 ± 0.006 ^b
Jenin	136 ± 1.73 ^b	107 ± 0.98 ^b	87.67 ± 1.92 ^a	0.04 ± 0.001 ^{bc}	0.03 ± 0.02 ^c	0.05 ± 0.006 ^d
Ramallah	74.71 ± 0.89 ^d	26.97 ± 2.44 ^e	48.01 ± 0.51 ^c	0.14 ± 0.01 ^a	0.04 ± 0.01 ^b	0.09 ± 0.003 ^a

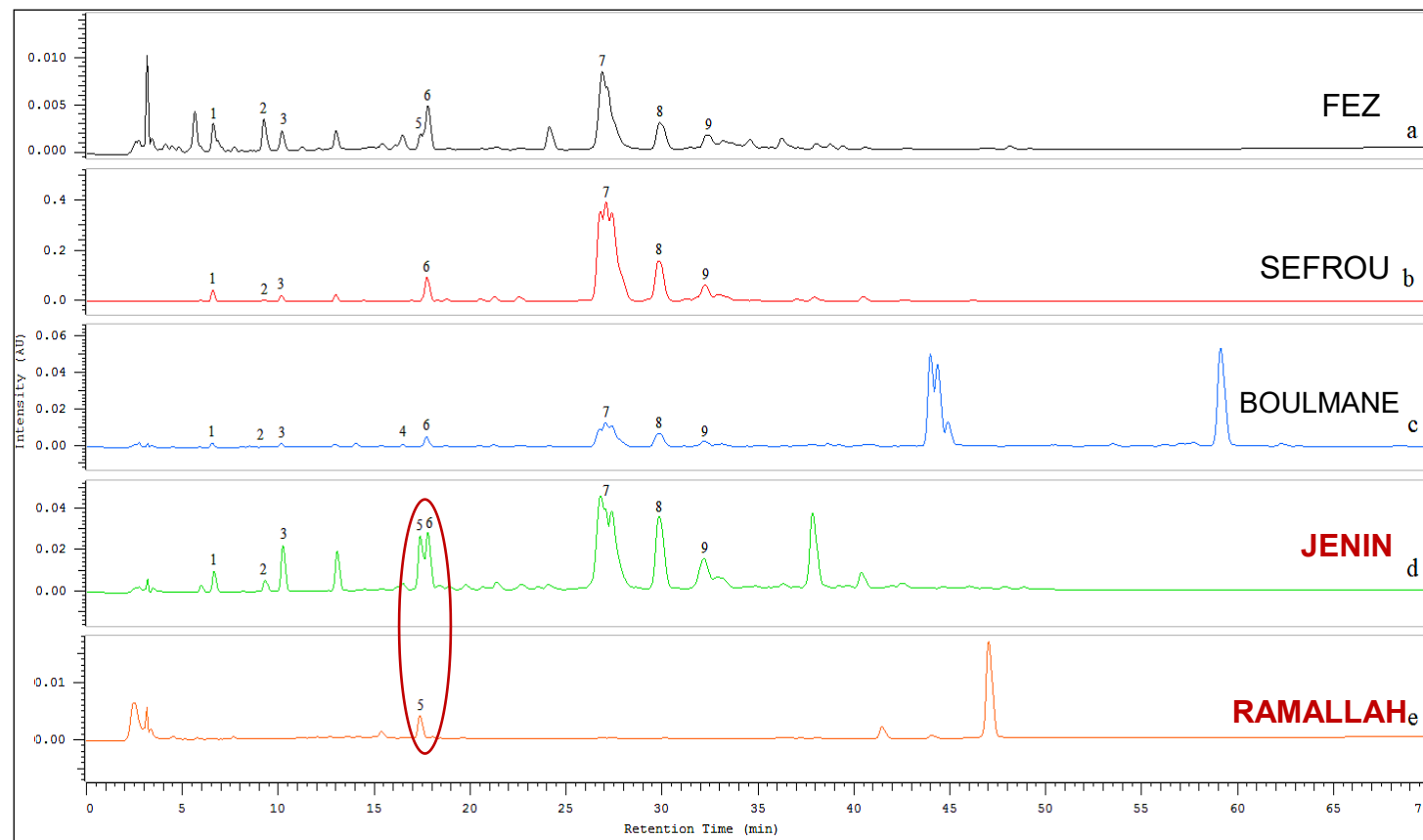
MARKER PHENOLIC COMPOUNDS (HPLC)

1. Caffeic acid
2. *p*-coumaric acid
3. Ferulic acid
4. Quercetin
5. Cinnamic acid
6. Naringenin
7. Pinocembrine
8. Chrysin
9. Galangin



MARKER PHENOLIC COMPOUNDS (HPLC)

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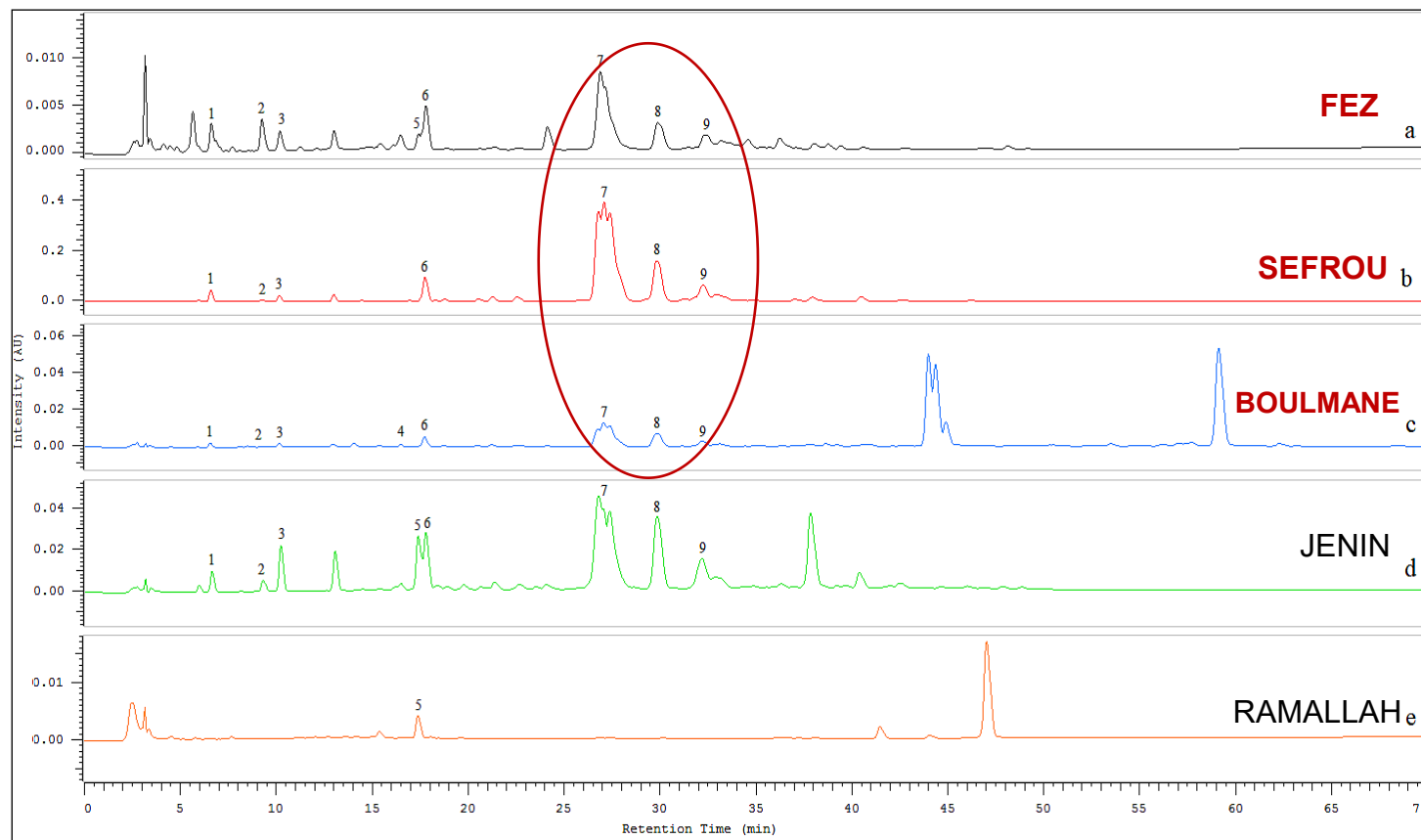


MARKER PHENOLIC COMPOUNDS (HPLC)

Flavonoids / Phenolic acid Esters

Poplar Propolis

1. Caffeic acid
2. *p*-coumaric acid
3. Ferulic acid
4. Quercetin
5. Cinnamic acid
6. Naringenin
7. Pinocembrine
8. Chrysin
9. Galangin



MARKER PHENOLIC COMPOUNDS (HPLC)

Amounts of Marker Compounds (µg/g)					
Standard	Fez	Sefrou	Boulmane	Jenin	Ramallah
Caffeic acid	431	2152	108	572	nd
<i>p</i> -coumaric acid	1110	2258	157	2479	nd
Ferulic acid	75.04	1829	89.18	1867	nd
Quercetin	nd	nd	1591	nd	nd
Cinnamic acid	820	nd	nd	21513	2901
Naringenin	599	8988	583	2805	nd
Pinocembrine	8721	352001	12423	25445	nd
Chrysin	542	30062	1384	598	nd
Galangin	234	25014	643	5856	nd



Comparison of two propolis samples Same region / different seasons



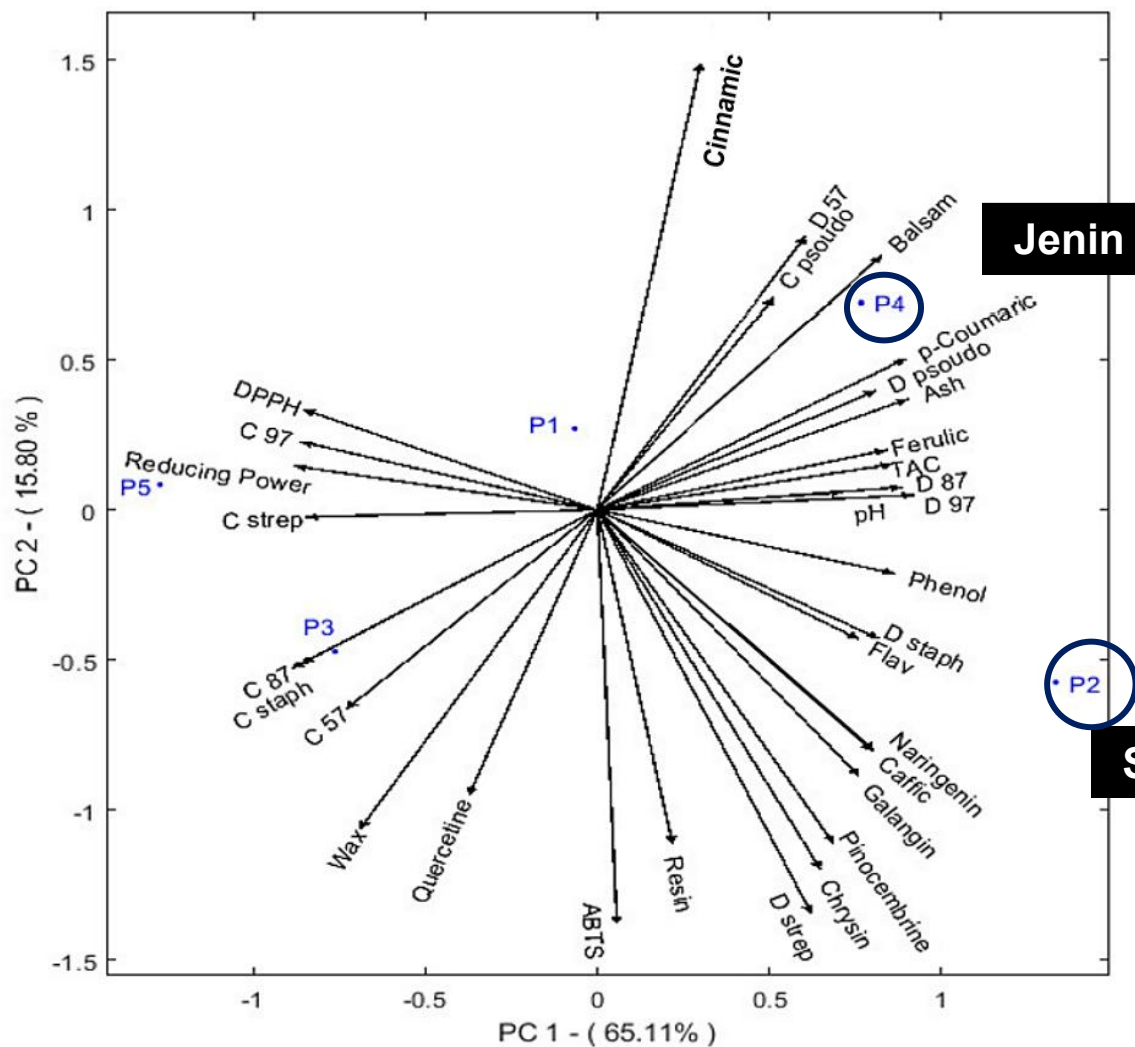
Propolis	Harvest Year	Phenols (mg GAE/g)	Flavone Flavonols (mg QE/g)	CAT (mg AAE/g)	DPPH IC ₅₀ (mg/mL)	Pinocembrine (mg/g)	Galangin (mg/g)
Sefrou	2017	148 ± 1.31	118 ± 1.92	90.87 ± 2,91	0.02 ± 0,02	352.001	25.014
Sefrou	2016	31.45 ± 2.01	26.31 ± 1.29	29.03 ± 1.67	0.53 ± 0.01	6.80	50.88



ANTIBACTERIAL ACTIVITY

Propolis	Tests	<i>E. coli</i> BLSE (ATB:87) BGN	<i>E. coli</i> (ATB:57) BGN	<i>E. Coli</i> (ATB:97) BGN	<i>P. aeruginosa</i>	<i>S. faecalis</i>	<i>S. aureus</i>
P1 FEZ	DI (mm)	17.23 ± 1.21 ^{ab}	13.6 ± 0.5 ^c	16.3 ± 1.26 ^{bc}	10.3 ± 0.6 ^{bc}	21.33 ± 1.57 ^c	23 ± 1.12 ^b
	MIC (mg/mL)	0.625	2.50	1.25	1.25	0.625	0.31
	MBC (mg/mL)	1.25	>5	2.50	>5	1.25	0.31
P2 SEFROU	DI (mm)	21.33 ± 1.52^a	19.76 ± 0.40 ^b	20.66 ± 1.57^a	15.54 ± 1.1 ^{ab}	32.5 ± 1.02^a	31.2 ± 1.73^a
	MIC (mg/mL)	0.31	0.31	0.31	0.625	0.09	0.09
	MBC (mg/mL)	0.31	0.625	0.31	1.25	0.09	0.09
P3 BOULMANE	DI (mm)	13.31 ± 1.57 ^b	-	15.22 ± 0.56 ^c	9.66 ± 0.6 ^c	27 ± 1.18 ^b	25 ± 0.57 ^b
	MIC (mg/mL)	1.25	5	1.25	>5	0.625	1.25
	MBC (mg/mL)	>5	>5	2.50	>5	0.625	1.25
P4 JENIN	DI (mm)	18.71 ± 1.73 ^{ab}	21.8 ± 0.35^a	19.76 ± 0.40 ^{ab}	20.33 ± 0.57^a	22.8 ± 1.25 ^{bc}	27.66 ± 0.57 ^{ab}
	MCI (mg/mL)	0.31	0.31	0.625	0.625	0.17	0.17
	MBC (mg/mL)	0.31	0.31	0.625	1.25	0.17	0.17
P5 RAMALLAH	DI (mm)	14.33 ± 1.15 ^b	14.6 ± 0.5 ^c	13.53 ± 0.89 ^c	-	18 ± 0.57 ^c	13 ± 1 ^c
	MCI (mg/mL)	1.25	2.50	2.50	-	0.625	1.25
	MBC (mg/mL)	>5	>5	>5	-	0.625	2.50
Eth70%	DI (mm)						
	MCI (mg/mL)	-	-	-	-	-	-
	MBC (mg/mL)						

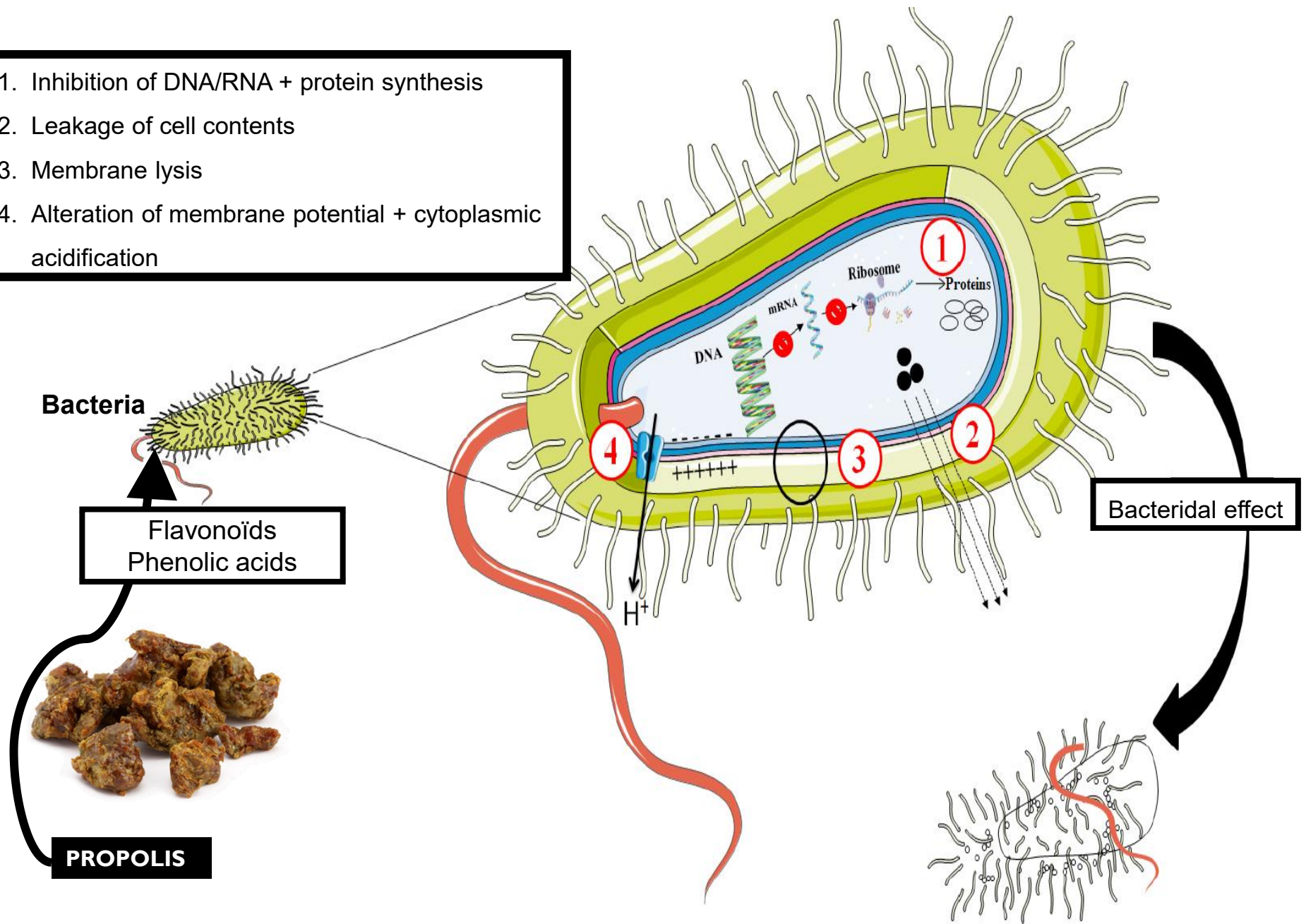
Principal component analysis (PCA) of different analyzed propolis samples



The highest total phenolic content is associated with the strongest antioxidant and antibacterial activities

ANTIBACTERIAL MECHANISMS

1. Inhibition of DNA/RNA + protein synthesis
2. Leakage of cell contents
3. Membrane lysis
4. Alteration of membrane potential + cytoplasmic acidification



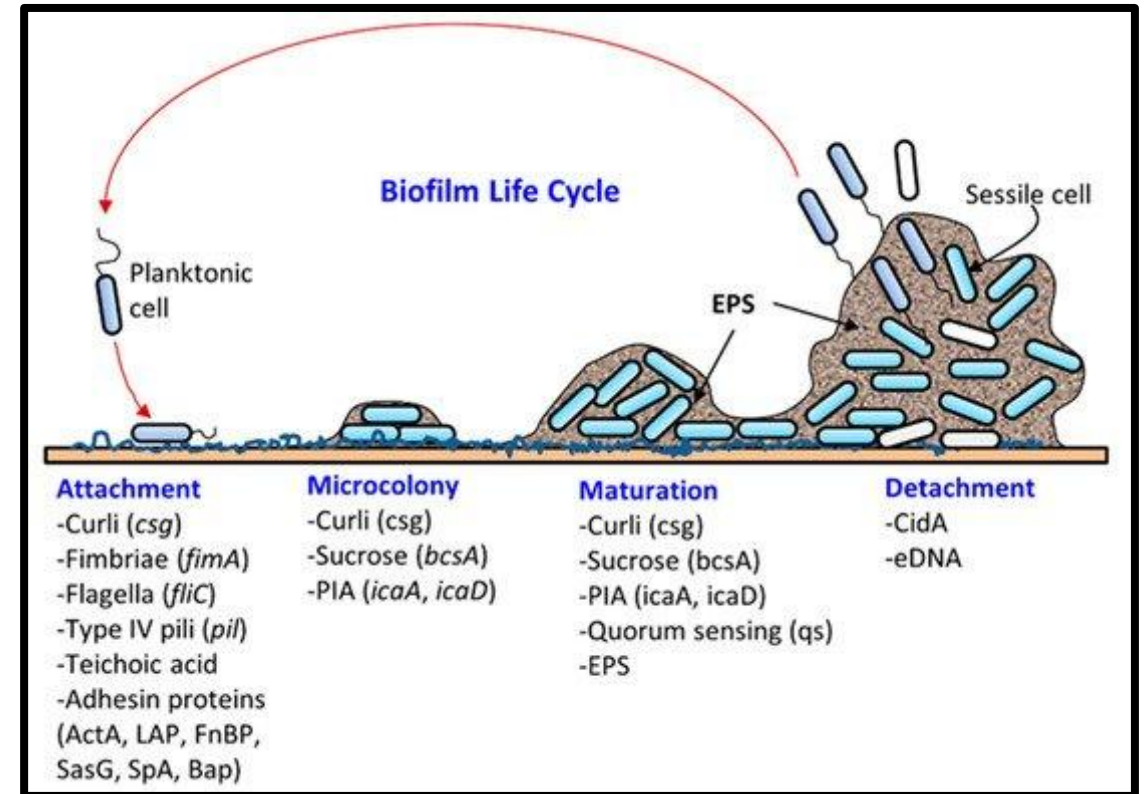
Inhibition of bacterial adhesion and
biofilm formation

Quorum sensing inhibition ?

Flavonoïds
Phenolic acids

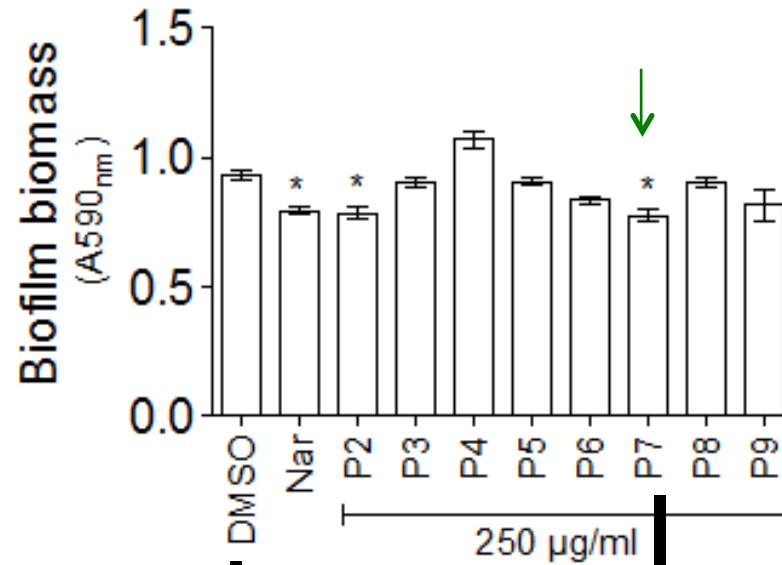


PROPOLIS



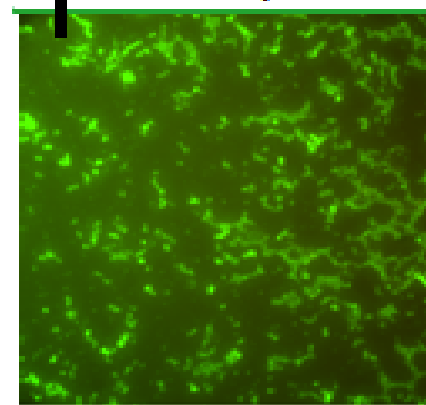
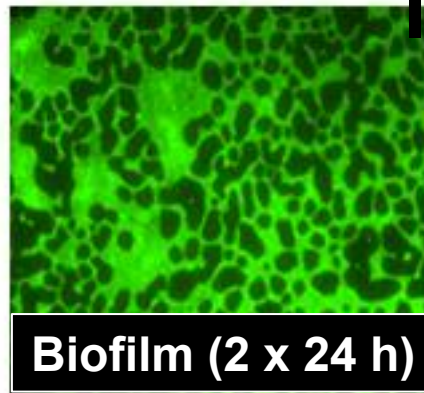
Soto SM. *Advances in Biology*. 2014
Rasamiravaka T, El Jaziri M. *Curr Microbiol*. 2016

P7 reduces biofilm production in *P. aeruginosa*



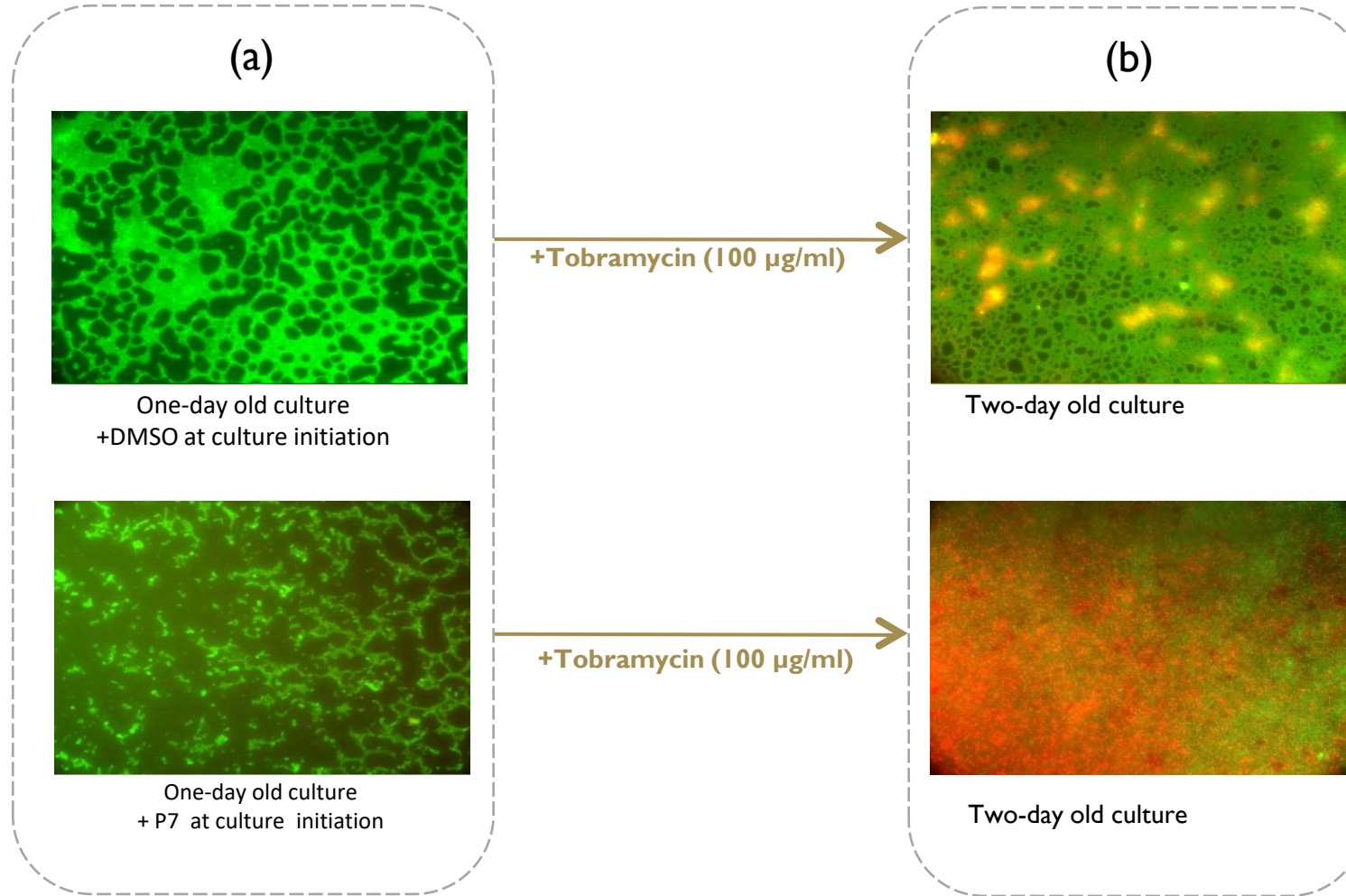
P7 have no effect on growth and on gene transcription in *P. aeruginosa*

Affects biofilm lifecycle/maturation

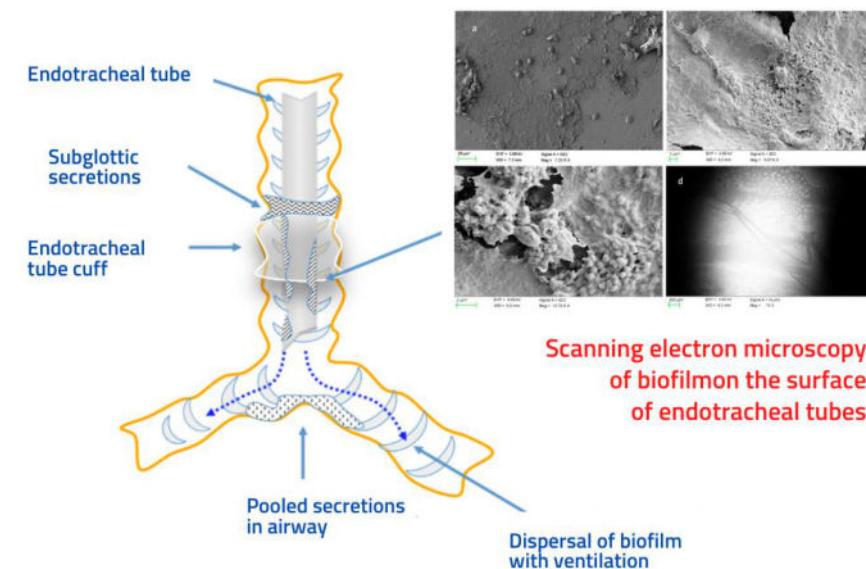
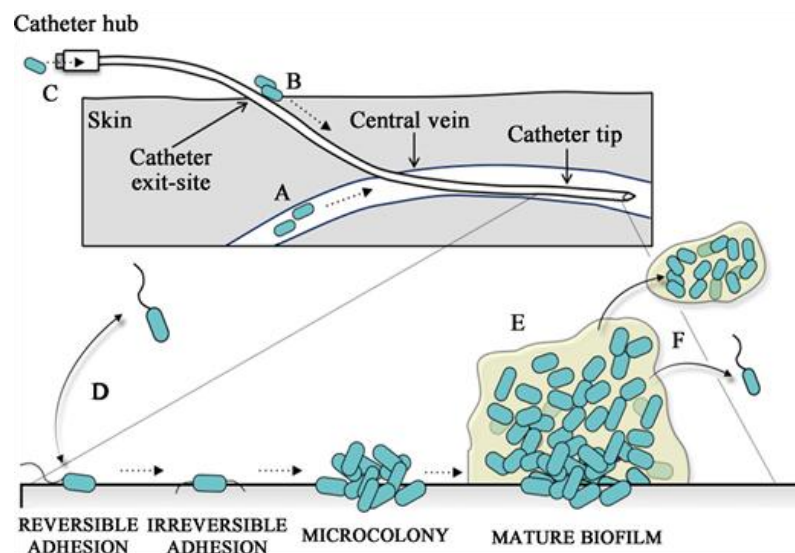


Unpublished data
Courtesy Prof Lyoussi, Prof Jaziri

P7 improves tobramycin penetration in *P. aeruginosa* biofilm



Unpublished data
Courtesy Prof Lyoussi, Prof Jaziri



Moghiseh et al. *BMC Nephrology* (2022) 23:408
<https://doi.org/10.1186/s12882-022-03036-7>

BMC Nephrology

RESEARCH

Open Access

The impact of Propolis on catheter exit site infection and peritonitis in peritoneal Dialysis patients: a clinical trial

Lila Moghiseh¹, Monir Nobahar^{1,2,3,4*}, Raheb Ghorbani^{2,5} and Shiva Sirafian⁶



Darbanian et al. *BMC Oral Health* (2024) 24:636
<https://doi.org/10.1186/s12903-024-04412-5>

BMC Oral Health

RESEARCH

Open Access

Effect of propolis mouthwash on the incidence of ventilator-associated pneumonia in intensive care unit patients: a comparative randomized triple-blind clinical trial

Nayereh Darbanian¹, Monir Nobahar^{2,3*} and Raheb Ghorbani^{4,5}

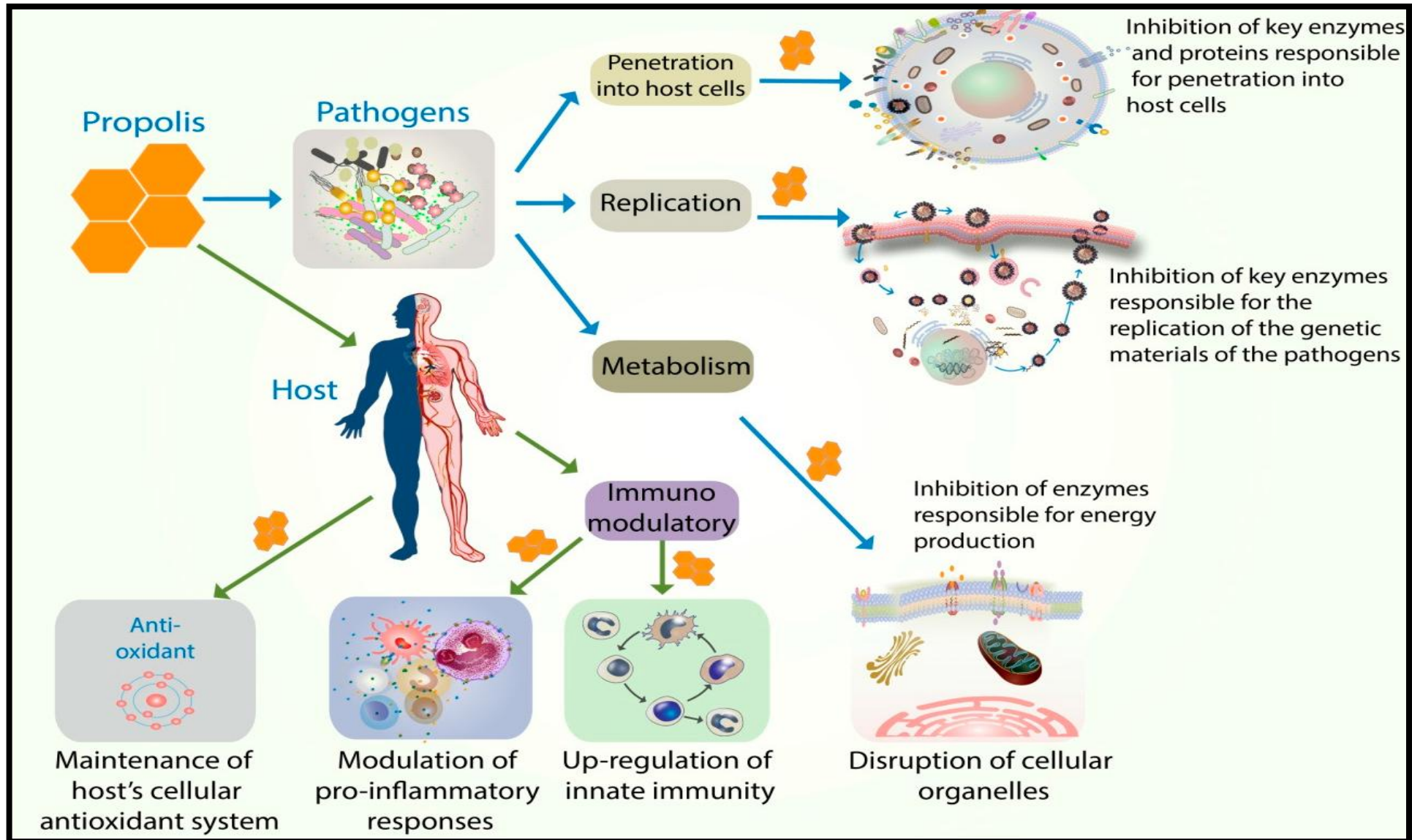




- ❑ **Statistical correlation** between phenolic compound content and antioxidant and antibacterial activity confirmed.
- ❑ The Moroccan samples from **Sefrou** and the Palestinian samples from **Jenin** have interesting but different antibacterial and antioxidant activities.
- ❑ **Pinocembrin** characterizes Moroccan propolis, while samples from Palestine are rich in **cinnamic acid**.
- ❑ Propolis activities depend on:
 - Geobotanical origin
 - Collection conditions
 - Synergistic actions / active ingredients not yet identified

MIXTURES

MULTITARGETS AGENTS



THE CHALLENGE

Optimal
dose ?

AI ?

Synergy
(Natural/synthetic) ?

Interaction with drugs ?

Standardization?

Safety?

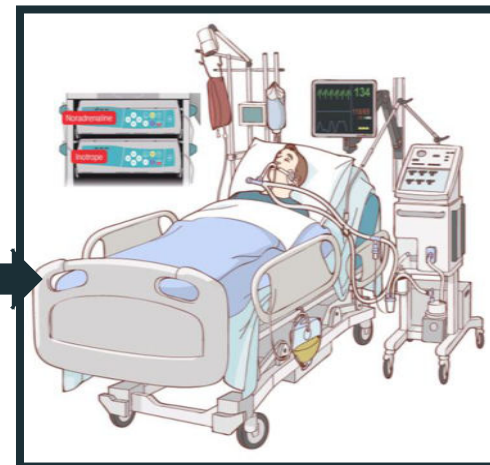
Pharmacokinetic
Pharmacodynamic ?

Clinical trials ?

Mechanisms & targets ?

Transfer of experimental results
from the laboratory to the bedside?

GAPS
TO
FILL





Integrating environmental outcomes in randomised clinical trials: a call to action

Petersen JJ et al. Lancet. 2025



Thus, the value of an intervention will be evaluated not only by its benefits and harms on individual patients, but also in relation to the broad environmental context and, ultimately, planetary health.⁵

interventions.^{18,19} Therefore, we have established the Implementing Climate and Environmental Outcomes in Trials Group (ICE-GROUP), comprising international experts from various fields including research methods, clinical trials, and environmental science. In time, we

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شكرا لكم
thank you



TAK
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