Integration of bioactive compounds rich pomegranate wastes into biorefinery

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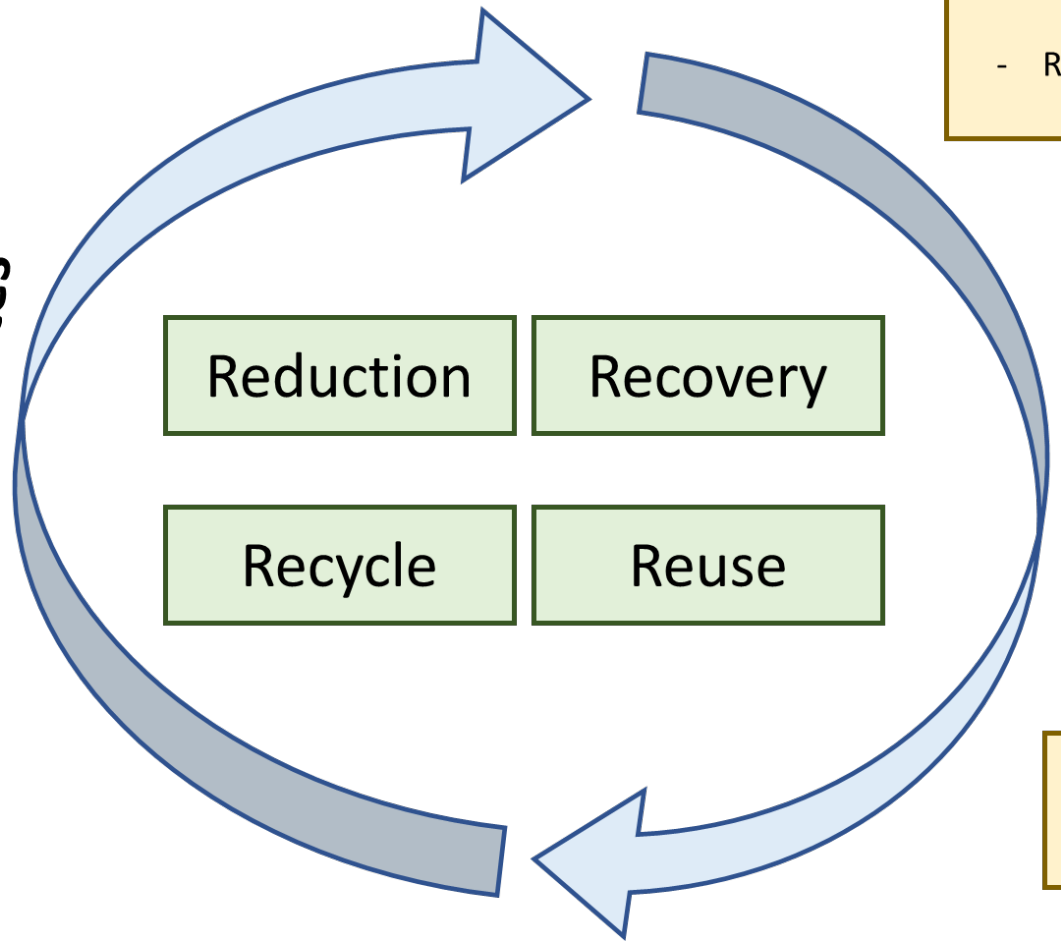
Food Industry Wastes
- Dairy Industry
- Vegetable Oil Industry
- Sugar Industry
- Fruit Juice Industry

Solid Food Wastes
- Fruits
- Vegetables

Wasted Food
- Bakery products
- Butcher/Poultry/Fishery products
- Dairy products
- Vegetables & Fruits
- Ready meals

Food Wastes



Extraction
- Recovery of oils, fatty acids, pectin, phenolic compounds etc.

Microbial Products
- Biogas
- Bioethanol
- Enzymes & Organic acids
- Single cell protein
- Biopolymer

Biofertilizer

Biomaterials
- Biofilm
- 3D edible foods

https://www.kew.org/plants/pomegranate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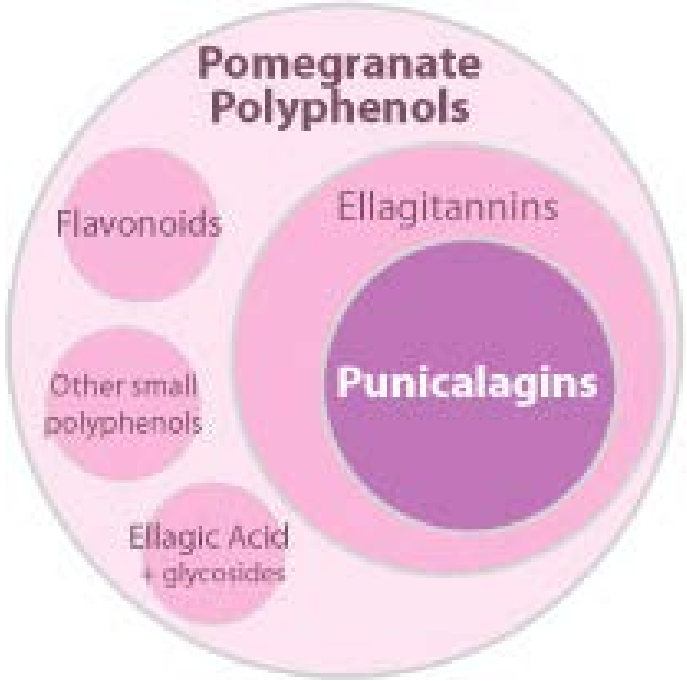
fersan
50
%100 NAR
EKSİSİ


홍초
100%
자연발효초사용
석류
900 ml

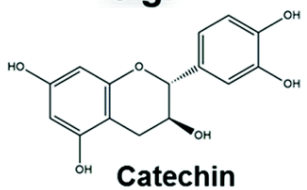

BRETTENBACH
WINE CELLARS
POMEGRANATE WINE
Amish Country Wines



Pomegranate peel accounts for about **30–40% of the total fruit** weight and contains a high proportion of **ellagic acid** and its derivatives, **ellagitannins** such as **punicalagin** and **punicalin**, and proanthocyanidins and flavonoids.

Flavonoids

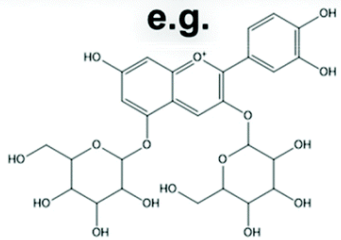
e.g.



Catechin

Anthocyanins

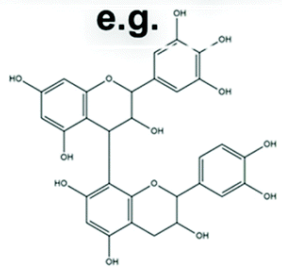
e.g.



Cyanidin 3,5-diglucoside

Proanthcyanidins

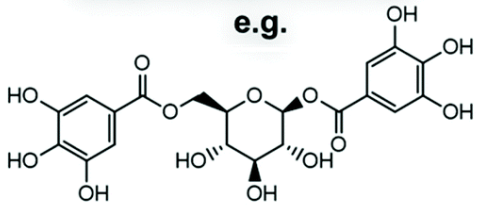
e.g.



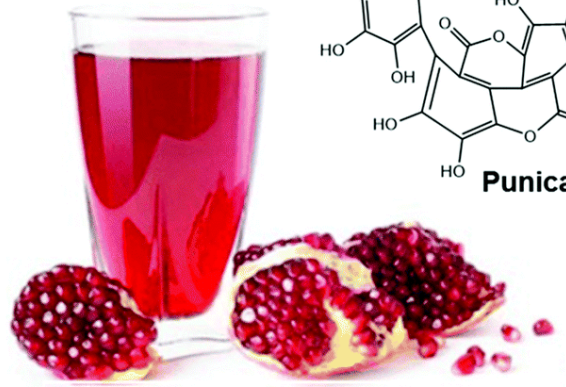
Gallocatechin-(4-8)-catechin

Gallotannins

e.g.

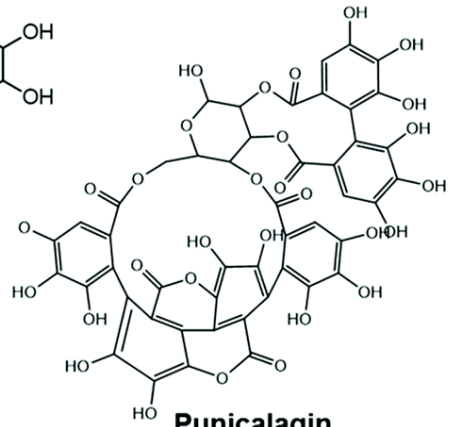


Digalloyl hexoside

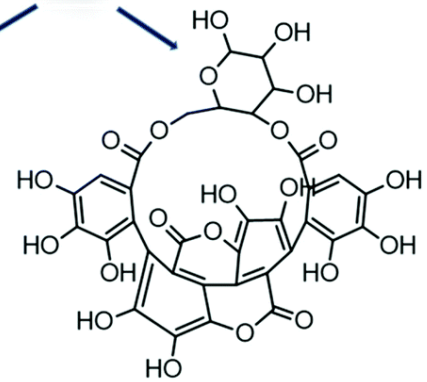


Ellagitannins

e.g.



Punicalagin

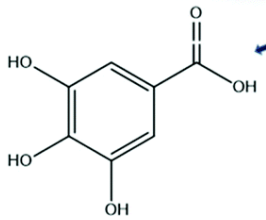


Punicalin

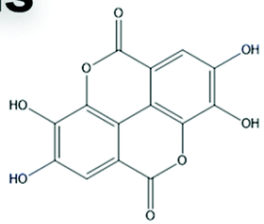
metabolism

Phenolic acids

e.g.



Gallic acid

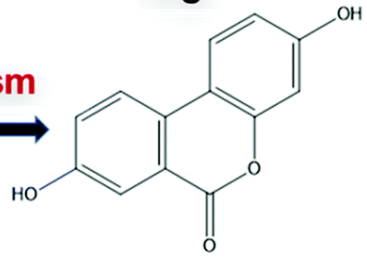


Ellagic acid

metabolism

Urolithins

e.g.



Urolithin A

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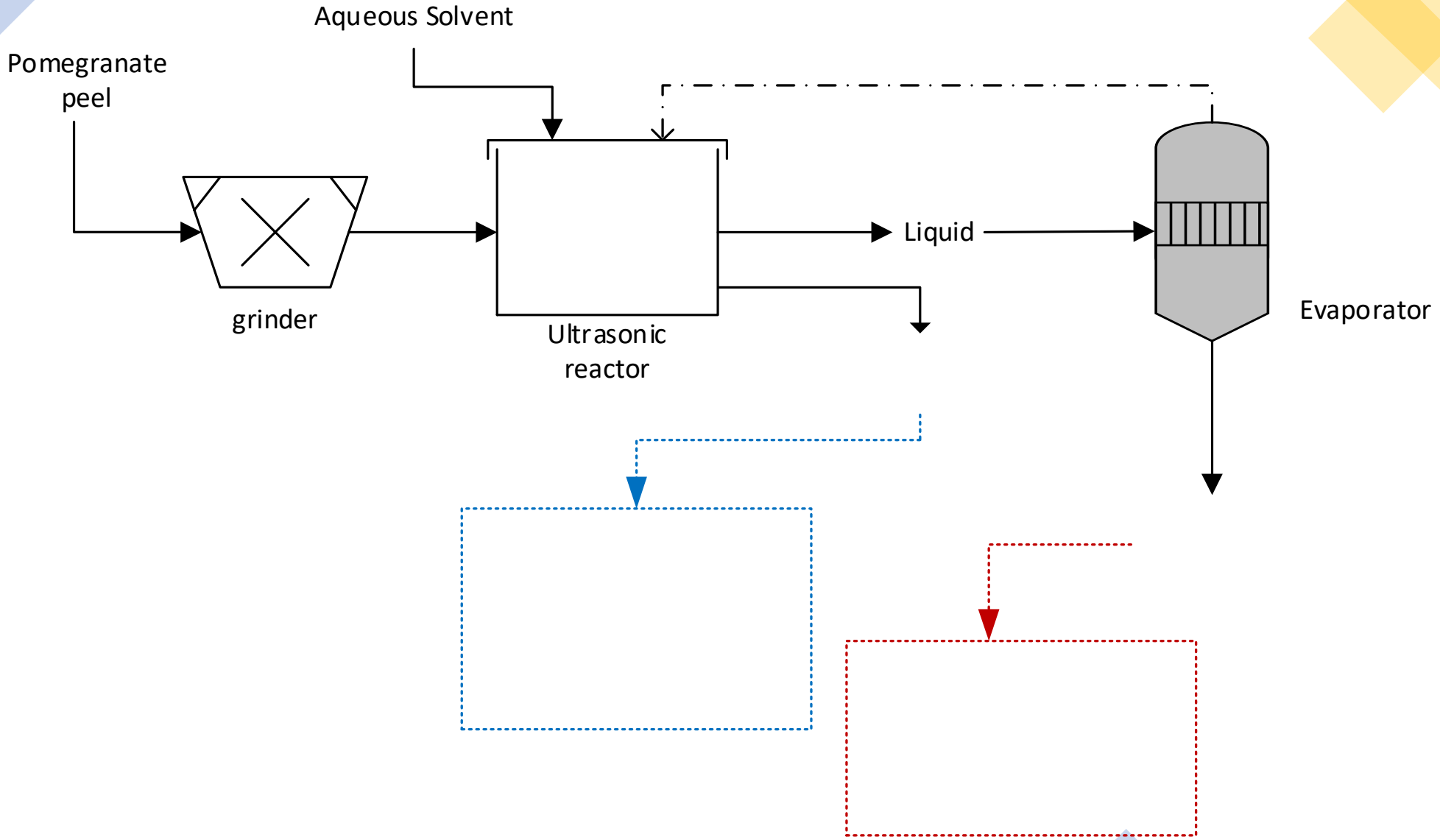
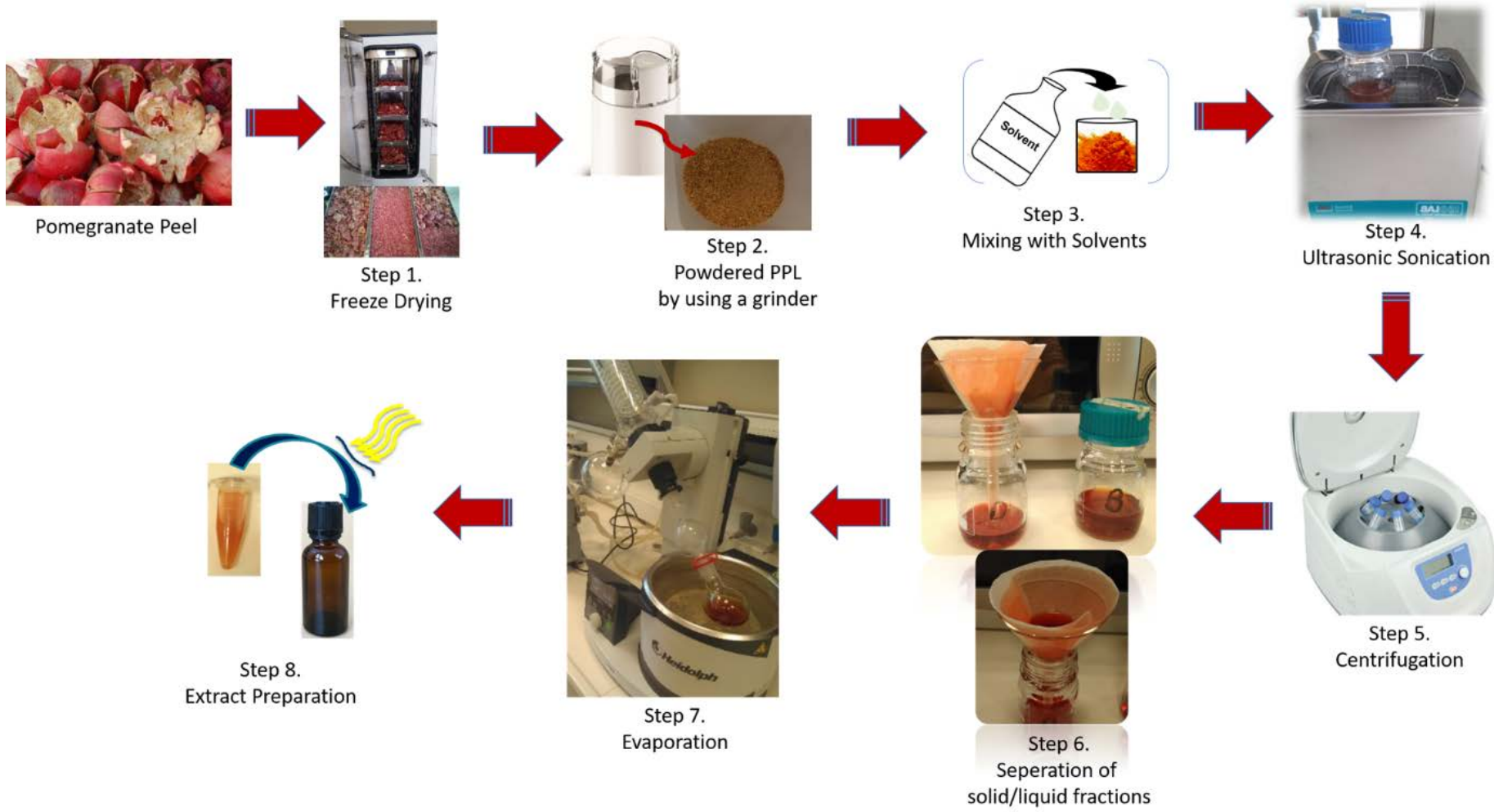
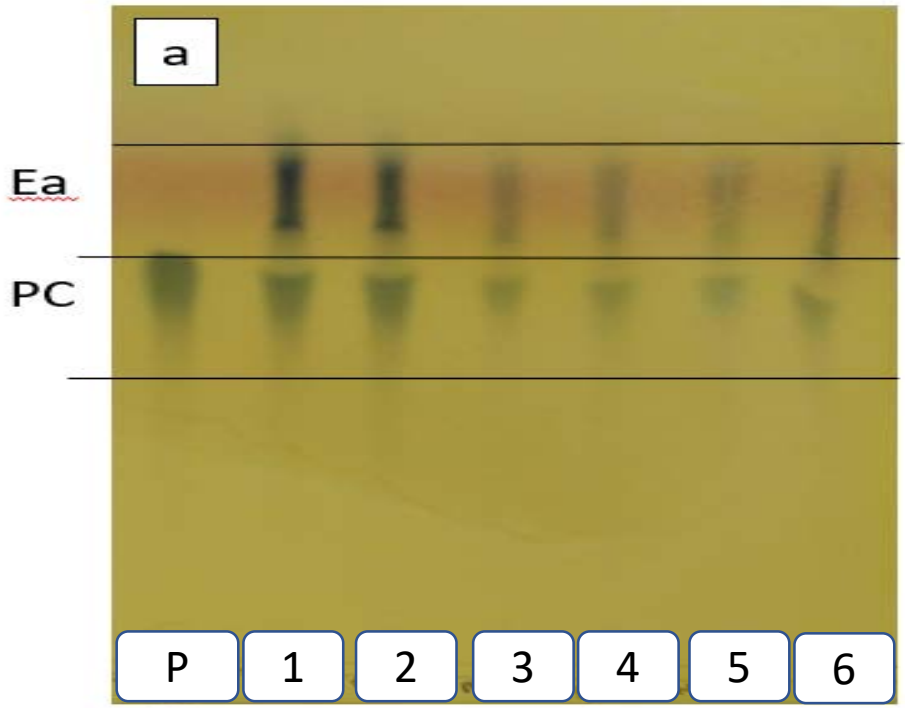

Aqueous Solvent
Pomegranate peel
grinder
Ultrasonic reactor
Liquid
Evaporator

Pomegranate peel extraction
As Natural Antibiofilm Agents

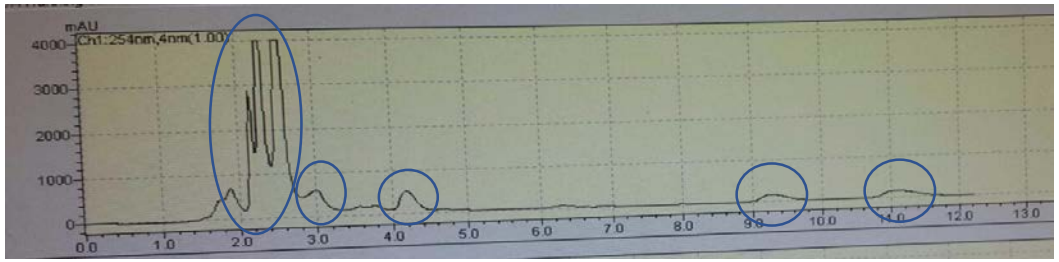


Determination of phenolics compounds (punicalagins and ellagic acid)

TLC – Punicalagin & Elagic acid



HPLC – Punicalagin & Elagic acid

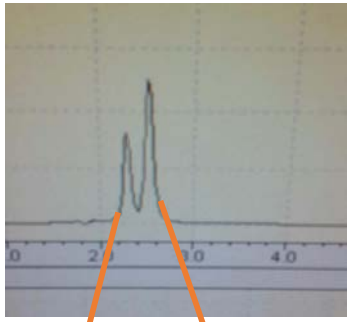


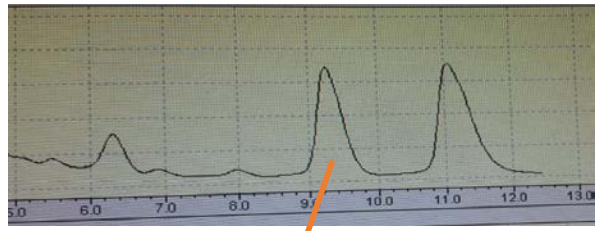
Instrument Parameters

Instrument:	Dionex HPLC System
Detection:	UV-vis
Mobile Phase A:	1% Formic Acid in Milli-Q Water
Mobile Phase B:	Acetonitrile
Gradient Program:	

Time (min)	%A	%B
0	95	5
18	85	15
20	35	65
25	95	5
30	95	5

Column:	Dionex Acclaim® Polar Advantage PA II 150 × 3.0 mm, 3 µm particle
Flow Rate:	1.0 mL/min
Temperature:	30 °C
Injection Volume:	10 µL
UV Detection:	260 nm



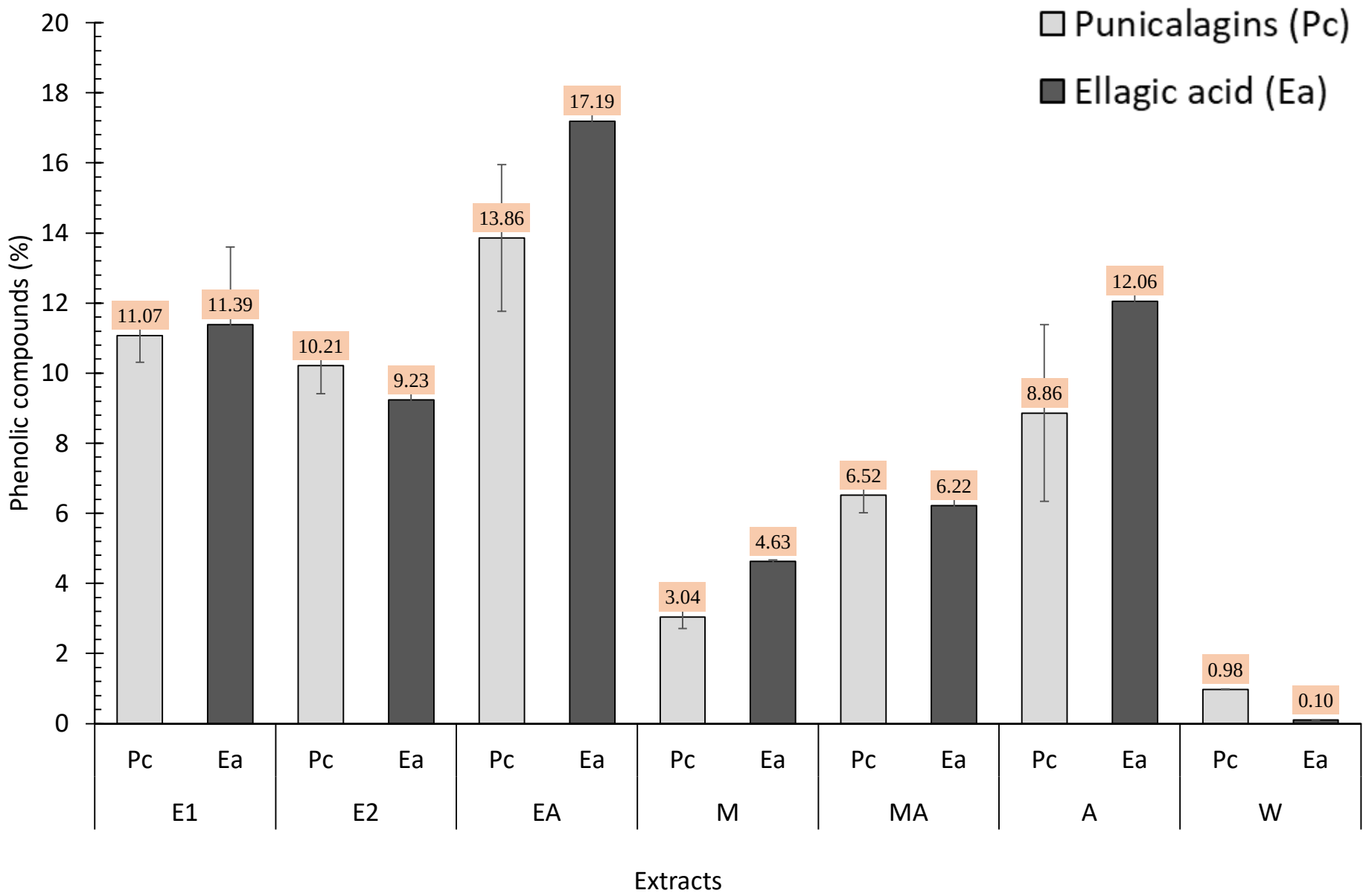


Punicalagin B

Punicalagin A

Ellagic acid

5 g pomegranate peel + 100 mL solvent



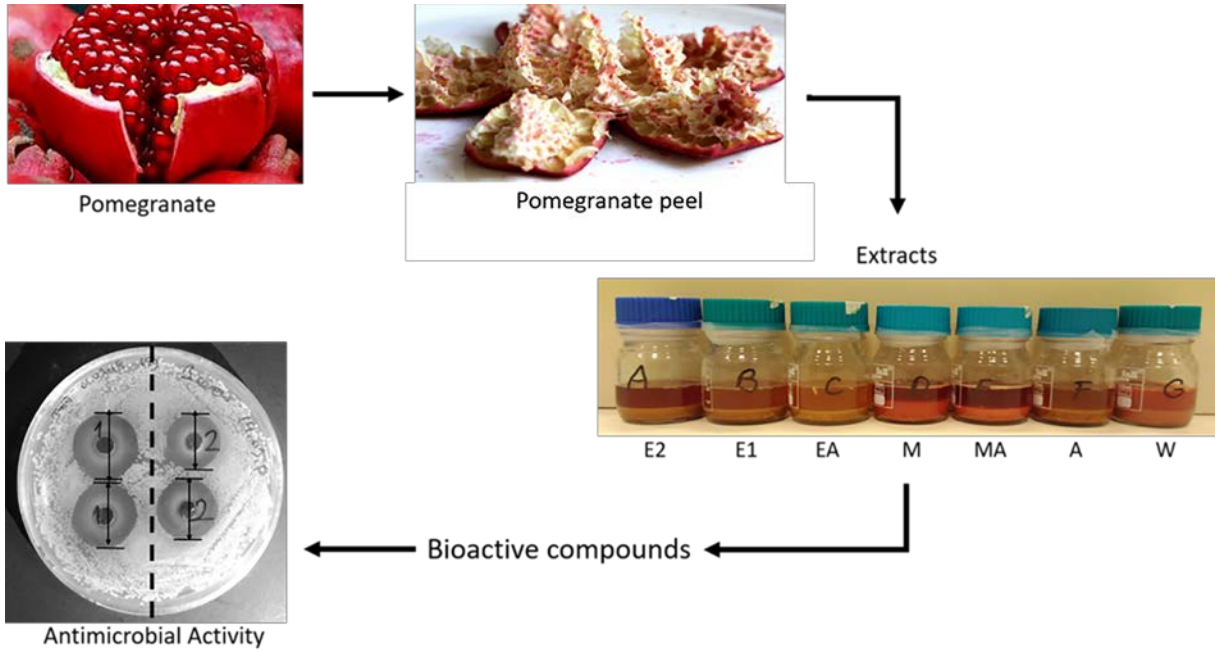
5 g pomegranate peel + 100 mL solvent

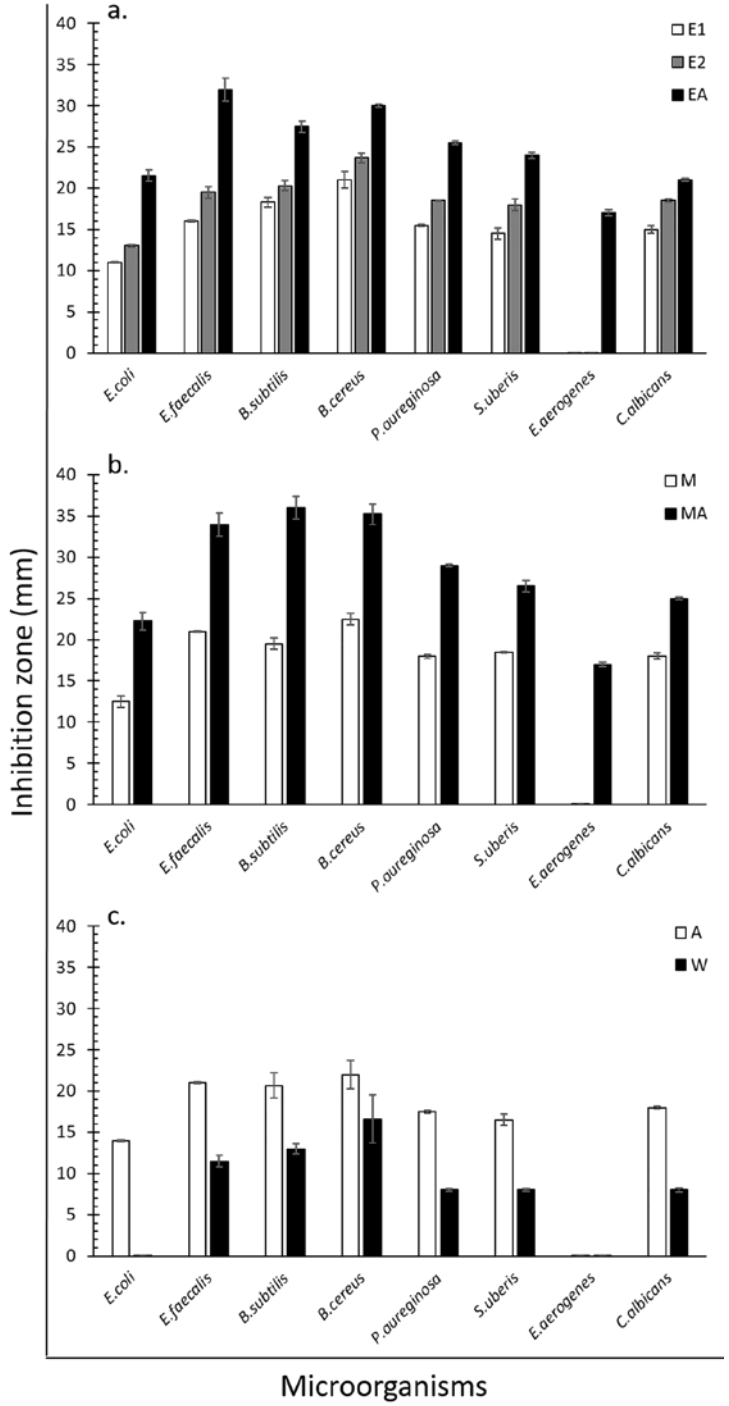
Extracts	pH	Malic acid (%)	Citric acid (%)	Total Sugar (%)
EtOH (30 min)	3.10 ± 0.05	0.01 ± 0.00	0.44 ± 0.03	3.72 ± 0.24
EtOH (60 min)	3.10 ± 0.04	0.03 ± 0.01	0.62 ± 0.07	4.98 ± 0.21
EtOH + acid	0.30 ± 0.02	**1.59 ± 0.12**	**1.13 ± 0.14**	4.93 ± 0.14
MeOH	3.40 ± 0.04	0.00 ± 0.00	0.69 ± 0.03	4.76 ± 0.29
MeOH + acid	0.26 ± 0.02	**3.19 ± 0.14**	**0.97 ± 0.04**	5.95 ± 0.07
Aceton	3.50 ± 0.05	0.37 ± 0.04	0.65 ± 0.13	4.00 ± 0.13
Water	3.55 ± 0.07	0.04 ± 0.01	0.10 ± 0.01	1.69 ± 0.25

10 g pomegranate peel + 100 mL solvent

Extracts	pH	Total Sugars (%)	Organic acids (%)		Phenolic compounds (%)	
			Malic acid	Citric acid	Punicalagin	Ellagic acid
MeOH + acid	0.26 (0.03)	6.68 (0.23)	**0.92 (0.11)**	0.41 (0.07)	**4.51 (0.72)**	**10.94 (0.64)**
MeOH	3.28 (0.04)	8.20 (0.42)	0.07 (0.02)	0.72 (0.06)	4.28 (0.22)	7.56 (0.01)
EtOH + acid	0.20 (0.02)	7.04 (0.34)	0.60 (0.04)	**0.93 (0.08)**	4.76 (0.16)	4.42 (0.19)
EtOH	3.05 (0.05)	6.72 (0.19)	0.10 (0.03)	0.69 (0.05)	1.88 (0.23)	1.66 (0.47)
Water	3.45 (0.04)	2.13 (0.12)	0.04 (0.01)	0.10 (0.02)	0.62 (0.19)	0.09 (0.02)

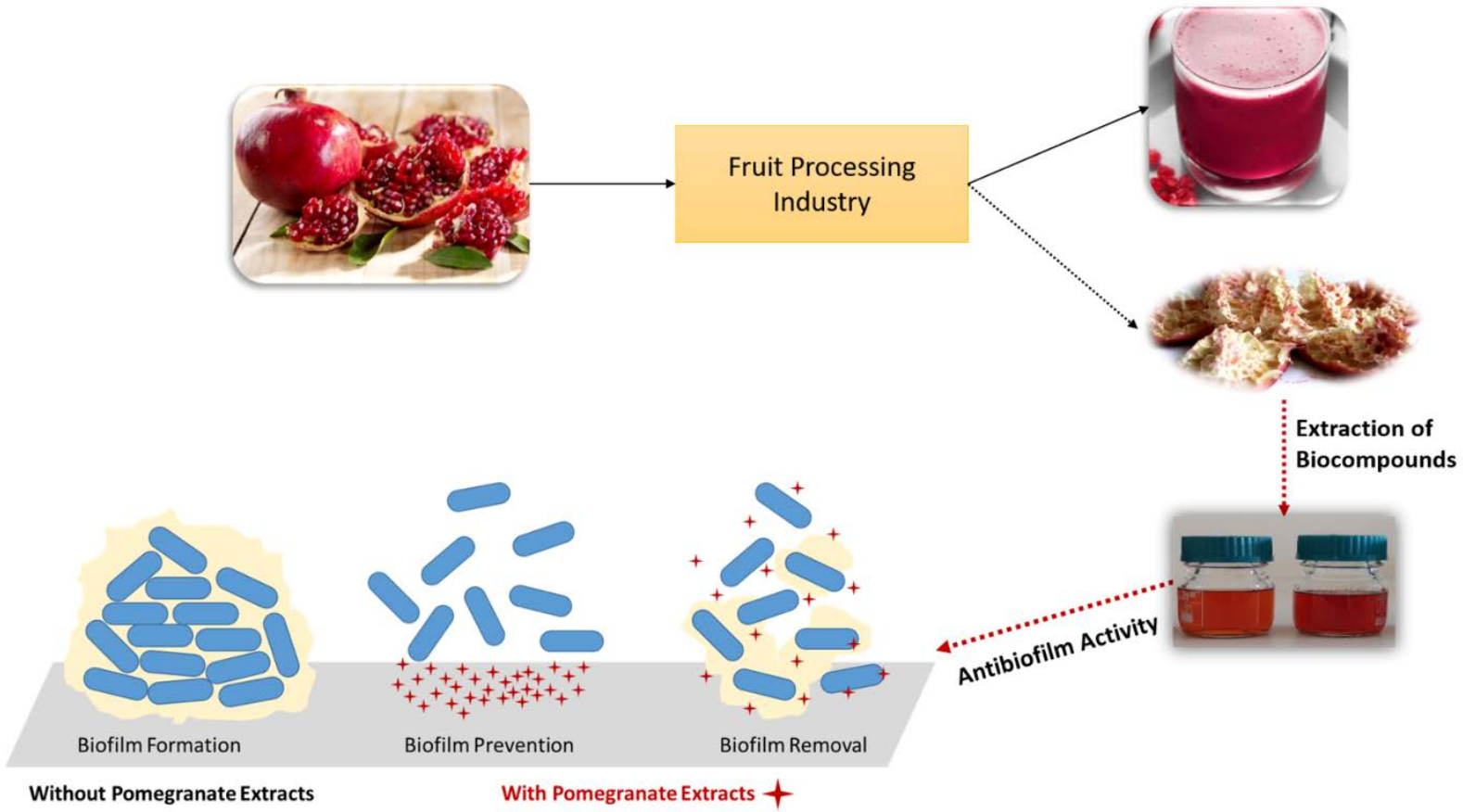
5 g pomegranate peel + 100 mL solvent



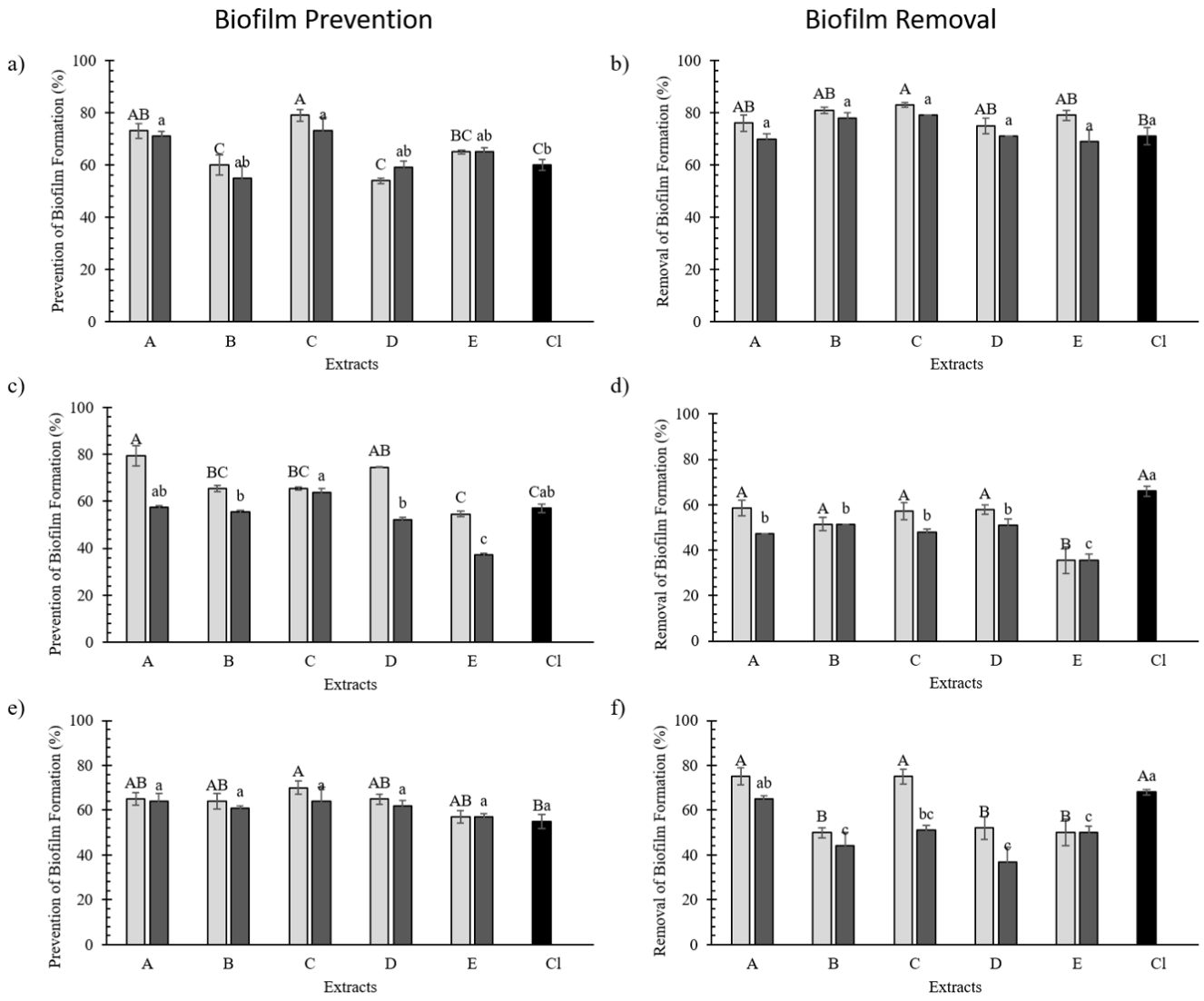


10 g pomegranate peel + 100 mL solvent

Strain	Extracts	Dilutions				
		1	1/2	1/5	1/10	1/25
Bacillus cereus	MeOH + acid	33 (2) ^{Aa}	30 (1) ^{Aa}	22 (2) ^{Ba}	19 (1) ^{BCa}	14 (1) ^{Ca}
	MeOH	25 (2) ^{Abc}	24 (1) ^{Ab}	21 (1) ^{ABa}	17 (1) ^{Ba}	13 (1) ^{Ca}
	EtOH + acid	32 (1) ^{Aab}	25 (1) ^{Bb}	21 (1) ^{Ca}	18 (1) ^{Da}	15 (0) ^{Da}
	EtOH	23 (1) ^{Ac}	21 (1) ^{ABc}	19 (0) ^{BCa}	17 (1) ^{Ca}	14 (1) ^{Da}
	Water	17 (1) ^{Ac}	16 (0) ^{ABd}	14 (1) ^{Bb}	11 (1) ^{Cb}	9 (1) ^{Cb}
Bacillus subtilis	MeOH + acid	34 (1) ^{Aa}	25 (0) ^{Ba}	20 (0) ^{Ca}	14 (1) ^{Da}	10 (0) ^{Da}
	MeOH	23 (1) ^{Ab}	19 (0) ^{Bbc}	14 (1) ^{Cb}	10 (0) ^{Db}	0
	EtOH + acid	32 (1) ^{Aa}	25 (2) ^{Bab}	20 (1) ^{BCa}	15 (0) ^{CDa}	10 (1) ^{Da}
	EtOH	23 (1) ^{Ab}	18 (1) ^{Bc}	15 (2) ^{Bb}	10 (1) ^{Cb}	0
	Water	15 (1) ^{Ac}	10 (0) ^{Bd}	0	0	0
Enterococcus faecalis	MeOH + acid	32 (2) ^{Aa}	28 (1) ^{Aa}	20 (0) ^{Ba}	15 (1) ^{Ca}	0
	MeOH	20 (1) ^{Ab}	18 (2) ^{Ab}	16 (1) ^{Ab}	11 (1) ^{Bb}	0
	EtOH + acid	31 (2) ^{Aa}	26 (0) ^{Ba}	19 (1) ^{Ca}	14 (0) ^{Da}	11 (1) ^{Da}
	EtOH	20 (0) ^{Ab}	18 (1) ^{Ab}	14 (1) ^{Bb}	13 (1) ^{Bab}	9 (1) ^{Cb}
	Water	13 (0) ^{Ac}	10 (0) ^{Bc}	0	0	0

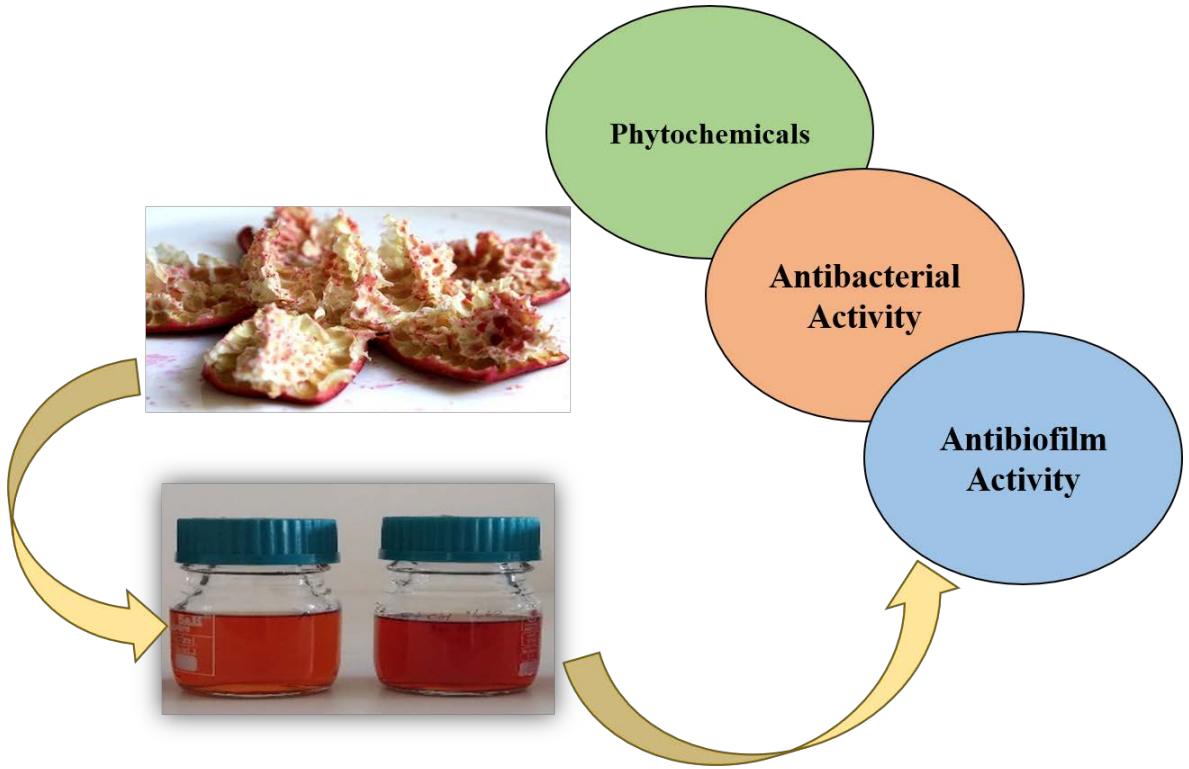

Fruit Processing Industry
Extraction of Biocompounds
Antibiofilm Activity
Biofilm Formation
Biofilm Prevention
Biofilm Removal
Without Pomegranate Extracts
With Pomegranate Extracts

5 g pomegranate peel + 100 mL solvent



Strain	OD_{570nm}
Bacillus cereus	0.537 (0.003)
Bacillus subtilis	2.445 (0.090)
Enterococcus faecalis	0.889 (0.001)

A. Methanol-acid;
B. Methanol;
C. Ethanol-acid;
D. Ethanol
E. Water
Cl. Chlorine (200 ppm)



- Extracts from pomegranate peels represent a good source of **bioactive compounds**.

- **Methanol-acid** and **ethanol-acid** extracts exhibited the highest antimicrobial effects on all tested microorganisms, giving inhibition zones ranging in size from 17 mm to 36 mm.

- All extracts were generally more effective against **Gram-positive bacteria** than **Gram-negative ones**

- All PPL extracts diluted at different ratios inhibited and removed biofilms and the highest **antibiofilm** effects were up to **80%** by acid-treated extracts

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Screening for Bioactive Compound Rich Pomegranate Peel Extracts and Their Antimicrobial Activities

Extraction methods for increased antibacterial and antifungal properties

International Journal of Food Science +Technology

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International Journal of Food Science and Technology 2021, 56, 4915–4924

Original article

Antibiofilm effects of pomegranate peel extracts against *B. cereus*, *B. subtilis*, and *E. faecalis*

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HÖGSKOLAN
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Thank you!

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