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Antibacterial and antioxidant activity of waste fractions from the essential oil industry

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Introduction

Tens of millions of tonnes of waste plant mass are generated every year, which in the areas with traditions in the production of essential oils becomes an environmental problem. Due to the presence of volatile organic components and polyphenolic compounds in the waste fractions, they are expected to exhibit antimicrobial and antioxidant activity and their uncontrolled disposal has an adverse effect on the ecological balance due to pollution of surface and groundwater. Moreover, valuable substances with biological activity are lost. The aim of the present work is to study the antibacterial and antioxidant activity of waste materials from the production of Rosa Damascena essential oil. Therefore, nanofiltration of Rosa Damascena waste product was performed. The studied samples were Feed, Permeat and Retentat solutions . The accurate determination of the wastes biological activity enables their valorisation. Gram-negative Escherichia coli K12 407 and Gram-positive Bacillus subtilis 3562 bacterial strains were used to study the inhibitory ability of the studied samples. The method of micro-dilution in broth was used to test the susceptibility of the bacteria against the waste fractions. Antioxidant activity was determined spectrophotometrically using the DPPH method.

Experimental part

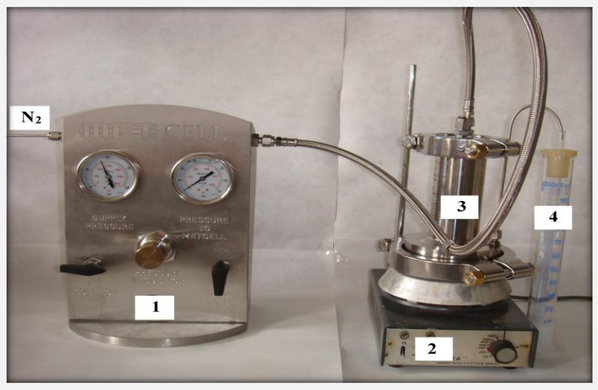

Figure 1. MET cell (Evonik MET, UK) batch dead-end nanofiltration cell.

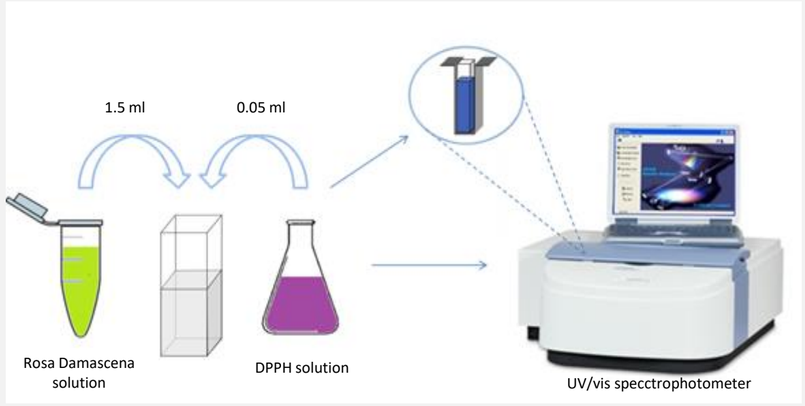

Figure 2. Scheme of DPPH method

Figure 3. Microplate reader

Results

Antioxidant activity

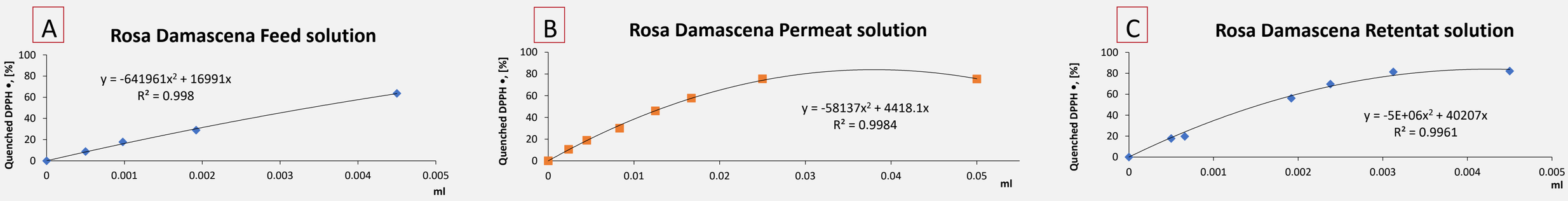

Figure 4. Experimental data and curve fitting for DPPH• quenching for 60 min by Rosa Damascena Feed solution (A), Rosa Damascena Permeat solution (B) and Rosa Damascena Retentat solution (C) versus concentration of antioxidant in the samples.

The antioxidant power was also characterized by the EC_{50} value: EC_{50} (A) = 0.003372 ml(Rosa Damascena Feed solution)/ml(sample); EC_{50} (B) = 0.01384 ml(Rosa Damascena Permeat solution)/ml(sample);EC_{50} (C) = 0.001538 ml(Rosa Damascena Retentat solution)/ml(sample).

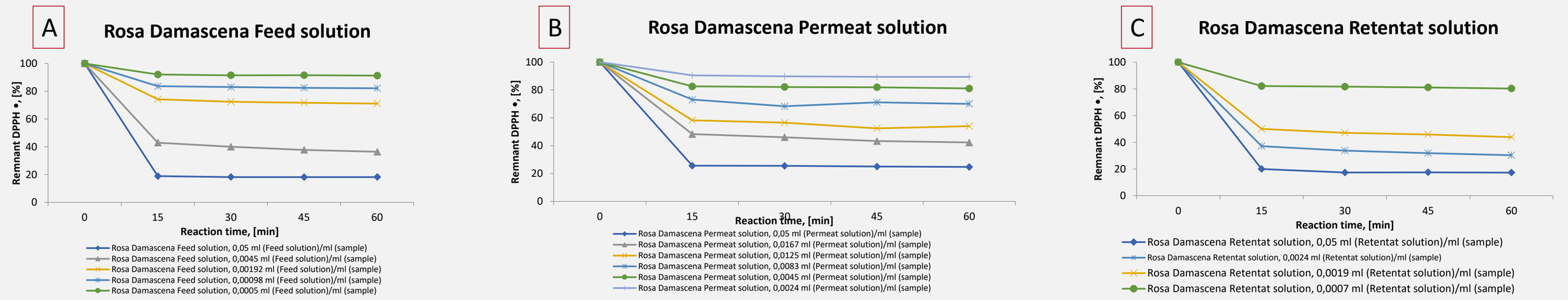

Figure 5. Kinetics of the characteristic radical scavenging reaction of Rosa Damascena Feed solution (A), Rosa Damascena Permeat solution (B), Rosa Damascena Retentat solution (C) with DPPH•

Antibacterial activity

Table 1. Microdilution test results

Bacterial strain	Rosa Damascena Feed solution						Rosa Damascena Permeat solution						Rosa Damascena Retentat solution					
	µl(lRosa Damascena Feed solution)/µl(sample)						µl(lRosa Damascena Permeat solution)/µl(sample)						µl(lRosa Damascena Retentat solution)/µl (sample)					
	0.67		0.55		0.44		0.67		0.55		0.44		0.67		0.55		0.44	
	4 h	24 h	4 h	24 h	4 h	24 h	4 h	24 h	4 h	24 h	4 h	24 h	4 h	24 h	4 h	24 h	4 h	24 h
	Growth reduction [%]																	
B. subtilis 3562	93	42	94	29	78	15	97	72	89	70	79	68	97	0	96	0	81	22
E. coli K12	0	77	0	73	0	70	0	98	0	88	0	74	60	39	0	44	38	44

Conclusions

- All of the Rosa Damascena solutions have relatively high biological activity.
- The microdilution assay indicated more prominent inhibition activity against *E. coli* K12 strain in comparison to *B. subtilis* 3562 for all three solutions.
- Significant antioxidant activity was observed for the Rosa Damascena Feed and Retentat solutions.
- The antioxidant activity of Rosa Damascena waste fractions can be used as an indicator of their essential oil concentration.
- The nanofiltration process can be used as an effective method for concentrating antioxidant waste products in the production of Rose Damascene essential oil.

Acknowledgements

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