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Sustainable green synthesis of silver nanoparticles from ***Hippophae Rhamnoides*** **and** ***Viburnum Opulus*** **plant by-products** extract and their antimicrobial activity and photochemical analysis

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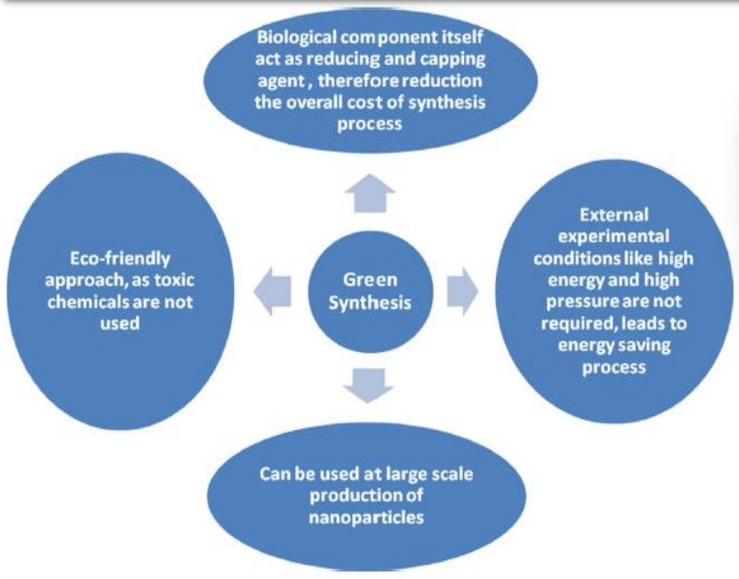
INTRODUCTION & AIM

As an alternative to conventional antimicrobial therapy, nanoparticles of metals such as Ag, Au, Zn, Ti, etc. have become known. Of these, the green synthesis of silver nanoparticles (AgNPs) received considerable attention due to their strong efficiency and the high spectrum of antimicrobial activity. Green synthesis is economical, environmentally friendly and does not require the use of high pressure, temperature, and toxic chemicals. Plant metabolites such as terpenoids, phenols, tannins, flavonoids, terpenoids, alkaloids and polysaccharides have been shown to contribute to reducing Ag ion levels in AgNPs. The novelty of studies is the secondary use of by-products from the processing of fruit and berries. After extraction and use of biologically active compounds, the remaining substance will be used as a raw material to produce organic NPs. By-products extracts of *Hippophae Rhamnoides (H. Rhamnoides)* and *Viburnum Opulus* berries were used in this work. The aim of this study was to synthesize AgNPs using an aqueous extract of by-products of *H. Rhamnoides* and *Viburnum Opulus*.

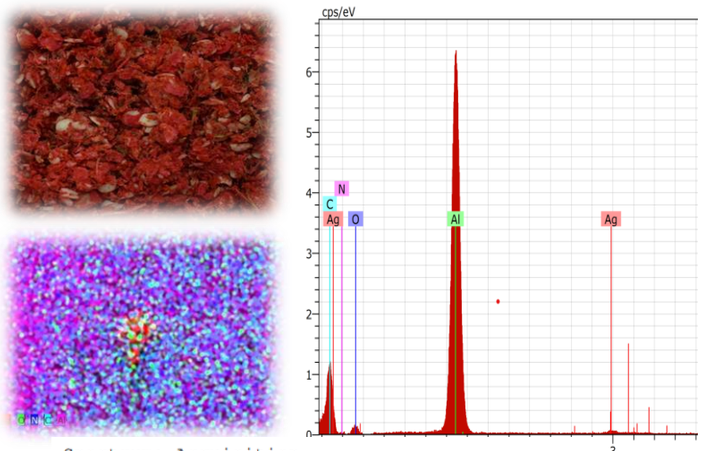
METHOD

1. The size and structure of AgNPs were studied from images obtained using a transmission electron microscope (TEM) Tecnai G2 F20 X-TWIN (FEI, Lausanne, Switzerland), equipped with a field emission electron gun at the accelerating voltage of 200 kV. For a microscopy study, samples were deposited on the TEM grids. AgNP diameter was measured with software ImageJ-win32.
2. In addition, the microstructure of the sample was analyzed using a Scanning Electron Microscope SEM FEI Quanta 200 FEG (FEI, Hillsboro, OR, USA). The extracts samples were examined in a low-vacuum mode operating at 20.0 kV using an LDF detector.
3. The total polyphenol content in the extracts was determined according to the Folin– Ciocalteu method, using gallic acid (GA) as the standard, according to the method of Bobinaite et al.
4. Antioxidant activity analysis was performed for the raw and *H. Rhamnoides* /AgNPs and *Viburnum Opulus*/AgNPs extracts by different methods: ABTS, DPPH•, CUPRAC, and FRAP assays.

RESULTS & DISCUSSION



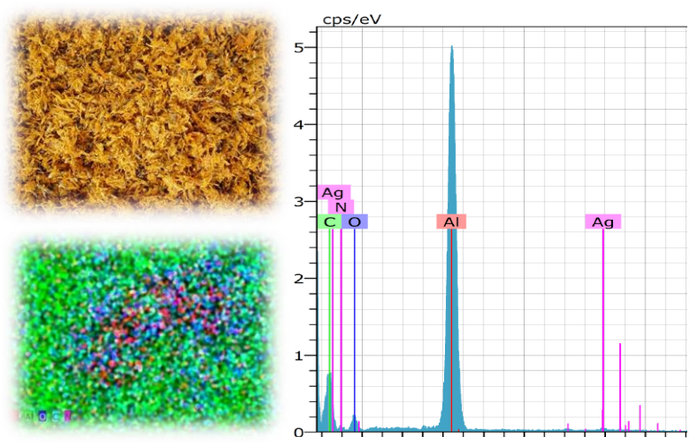
Green Synthesis - a reliable, sustainable, and eco-friendly protocol for synthesizing a wide range of materials/nanomaterials.



Spectrum: Acquisition

Element	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error [%]
Silver	L-series	3.16	2.64	0.46	0.1
Aluminium	K-series	67.84	56.62	39.43	3.2
Oxygen	K-series	7.92	6.61	7.76	1.5
Carbon	K-series	35.31	29.47	46.10	4.5
Nitrogen	K-series	5.58	4.66	6.25	1.8
Total:		119.81	100.00	100.00	

Viburnum Opulus/AgNPs



Element	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error [%]
Aluminium	K-series	71.28	62.62	47.16	3.2
Carbon	K-series	25.18	22.12	37.43	3.7
Oxygen	K-series	5.69	5.00	6.35	1.3
Silver	L-series	5.26	4.62	0.87	0.3
Nitrogen	K-series	6.42	5.64	8.18	2.1
Total:		113.83	100.00	100.00	

H. Rhamnoides/AgNPs

By-products of *H. Rhamnoides*	Polyphenols, mg GAE/100g Average	By-products of *Viburnum Opulus*	Polyphenols, mg GAE/100g Average
H. Rhamnoides	2288,83	*Viburnum Opulus*	3396,9
H. Rhamnoides AgNPs	1854,97	*Viburnum Opulus* AgNPs	3016,83

Raw and by-products of H. Rhamnoides/AgNPs and V.Opulus/AgNPs

CONCLUSION

- The raw and *H. Rhamnoides*/AgNPs and *Viburnum Opulus*/AgNPs aqua extracts contain hydroxycinnamic acid, flavonoids, and phenolic acid derivates that provide antimicrobial and antioxidant activity.
- *H. Rhamnoides* /AgNPs were spherical, 10 - 25 nm in size, The raw and *Viburnum Opulus*/AgNPs were spherical, ~ 45 nm in size.
- *H. Rhamnoides* /AgNPs and *Viburnum Opulus*/AgNPs inhibit the viability of Gram-positives and Gram-negative bacteria strains.

FUTURE WORK / REFERENCES

It's concluded that AgNPs synthesized in extracts have a wide variety of biological uses, activity and can be used as an organic substance without adverse effects.