



Third COST CA22134 FoodWaStop Meeting  
5-6 February Zadar, Croatia

Sustainable Network for agrofood loss and waste prevention,  
management, quantification and valorisation

# Optimizing fig preservation and valorising pruning biowaste: drying performance and bioactivity of *Ficus carica* L. extracts

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# *Ficus carica* L.

“Fig Tree”

- Family: *Moraceae*
- Top producers: Turkey, Egypt, Morocco, Algeria and Iran

Postharvest losses  
+  
Unharvested figs



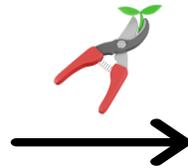
Need for Technology  
Development



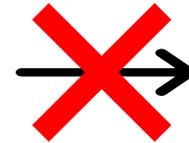
### Drying Technology as a possible solution

- Extends shelf life
- Reduces losses
- Adds value for local farmers

↑  
Fruit production  
Tree development



Pruning Biowaste  
Leaves



↑  
Green Gas  
Emissions

↓  
Biomass rich in  
bioactive  
compounds



### High value bio-based products for industry

- Organic acids
- Flavonoids
- Furocoumarins
- Phenylpropanoids
- Tocopherols



# Fresh, sun-dried and hybrid solar-dried figs

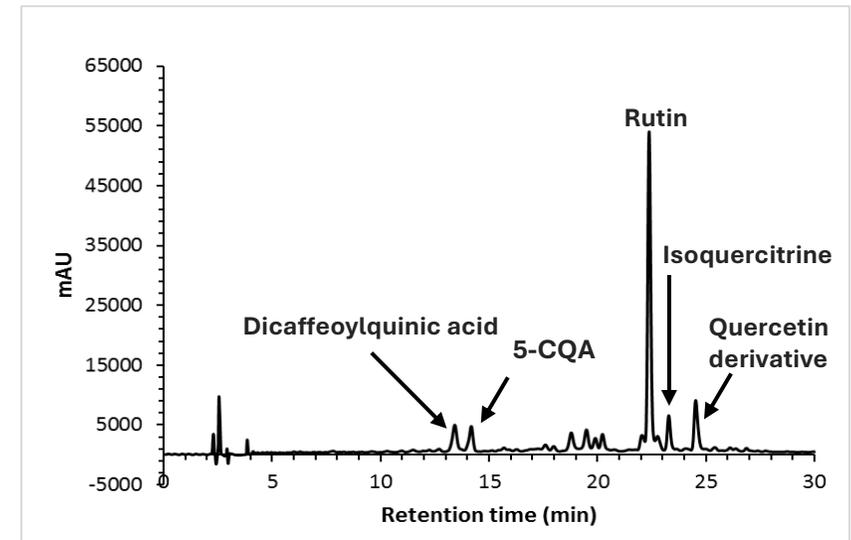
	Fresh	Sun-dried	Hybrid solar dried
<b>Drying Time</b>	-	> 5 days	71 h (≈ 3 days)
<b>Moisture (%)</b>	75.66 ± 0.20	29.43 ± 0.06	28.14 ± 0.08
<b>a<sub>w</sub></b>	ND	0.68 ± 0.01	0.63 ± 0.02
<b>Hardness (N)</b>	ND	2.36 ± 0.48	2.61 ± 0.51
<b>a*</b>	-8.07 ± 3.59	11.54 ± 1.03	10.34 ± 3.11
<b>Color b*</b>	56.72 ± 4.22	31.39 ± 2.77	38.06 ± 7.86
<b>L*</b>	69.08 ± 3.29	60.89 ± 3.48	47.77 ± 8.77

	Fresh	Sun-dried	Hybrid solar-dried
<b>TPC (mg/kg DM)</b>	283.74 ± 18.62	66.58 ± 13.98	88.46 ± 2.56
<b>ABTS (mg TE/100 g DM)</b>	137.7 ± 10.8	44.1 ± 2.0	98.2 ± 6.7
<b>DPPH (mg TE/100 g DM)</b>	50.0 ± 12.1	9.6 ± 2.7	25.5 ± 4.0



# Fresh, sun-dried and hybrid solar-dried figs – Phenolic Compounds

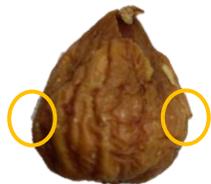
[M-H] <sup>-</sup>	UVmax	Compound	Fresh	Sun-dried	Hybrid solar-dried
515	293sh, 324	Dicaffeoylquinic acid	5.04 ± 0.11	1.81 ± 0.13	0.80 ± 0.22
353	290sh, 324	5-O-caffeoylquinic acid	32.49 ± 2.09	5.30 ± 0.36	11.33 ± 0.23
609	256, 352	Rutin	191.45 ± 12.07	48.00 ± 10.91	68.48 ± 1.57
463	256, 352	Isoquercitrin	17.89 ± 1.71	4.09 ± 0.91	3.43 ± 0.43
505	256, 350	Quercetin derivative	36.87 ± 2.63	7.38 ± 1.68	4.41 ± 0.10
Total Phenolic Compounds			283.74 ± 18.62	66.58 ± 13.98	88.46 ± 2.56



# Fresh, sun-dried and hybrid solar-dried figs –Microbiologic Analysis



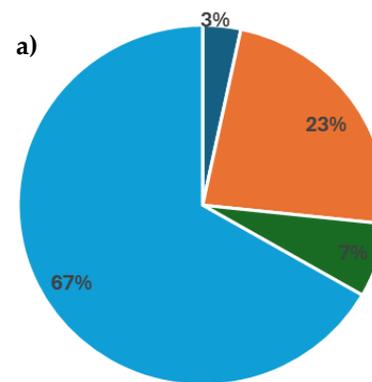
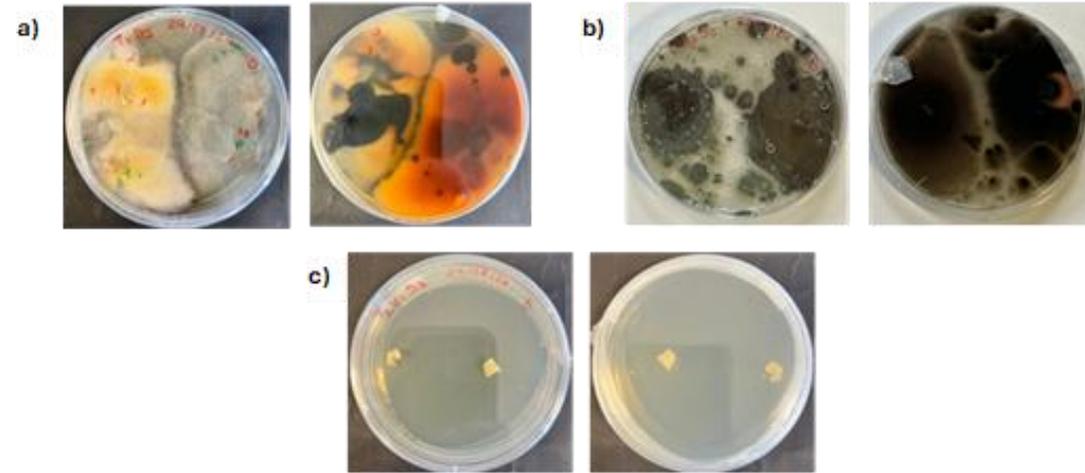
Desinfect the instruments



Cut two pieces from each fig

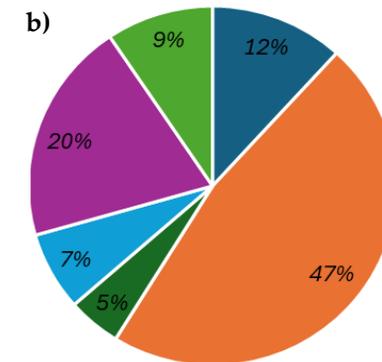


Place in the Petri dish and keep in the incubator at 22 °C



Fresh

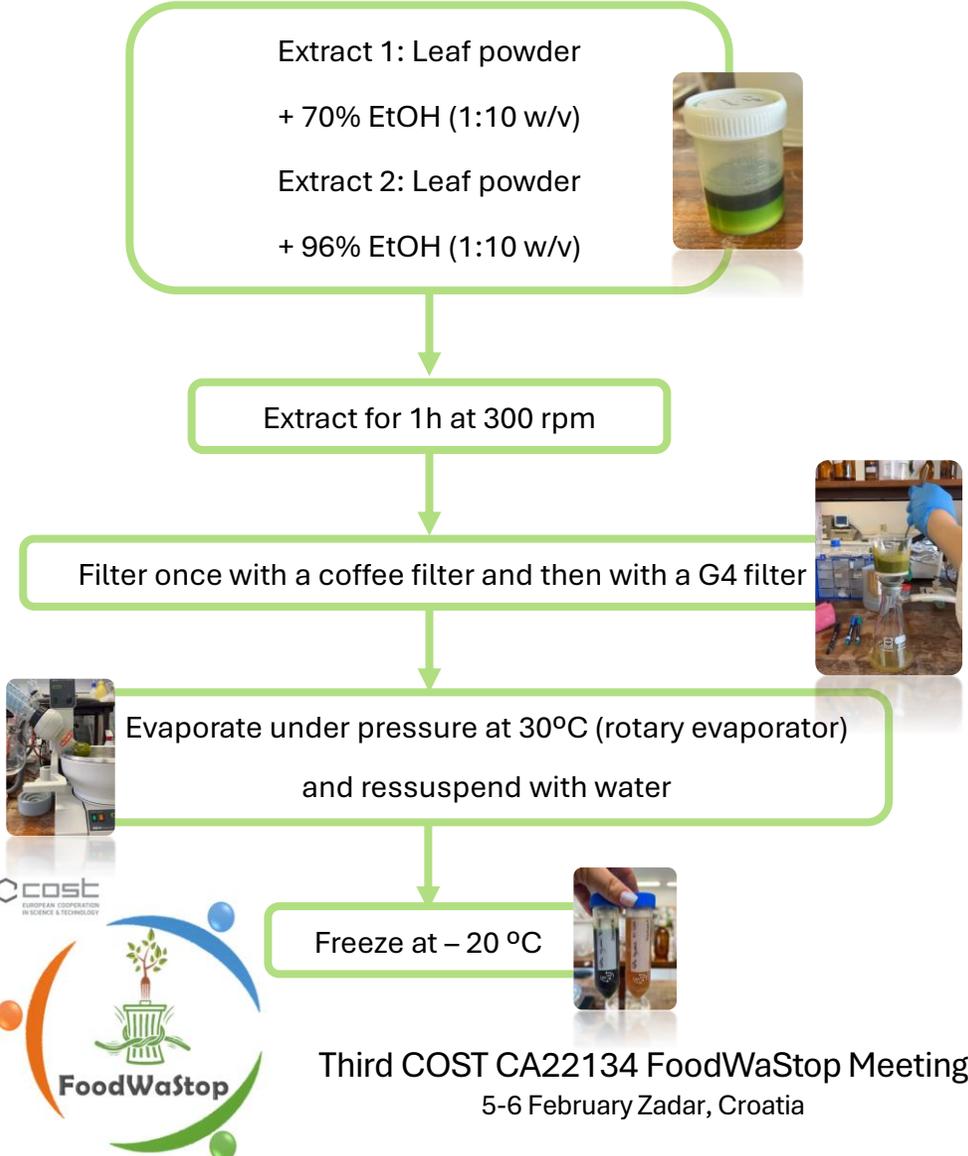
- *Alternaria spp.*
- *Alternaria alternata*
- *Aspergillus niger*
- *Cladosporium spp.*



Sun-dried

- *Alternaria spp.*
- *Alternaria alternata*
- *Aspergillus niger*
- *Cladosporium spp.*
- *Fusarium spp.*
- Mixed

# Preparation and characterization of the biowaste extracts



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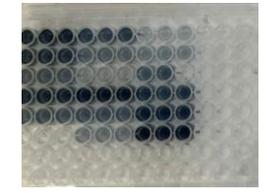
## PHYTOCHEMICAL ANALYSIS



Phenolic Content (Folin-Ciocalteu)  
Antioxidant Activity (ABTS and DPPH)

### FOLIN-CIOCALTEU

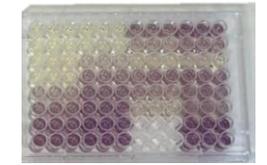
	mg GAE/ 100 g dry mass	SD	CV (%)
Leaf <i>Ficus carica</i> 70% EtOH	722,6	57,5	8,0
Leaf <i>Ficus carica</i> 96% EtOH	182,0	4,2	2,3



Folin-Ciocalteu

### DPPH

	mg TE / 100g dry mass	SD	CV (%)
Leaf <i>Ficus carica</i> 70% EtOH	1857,4	617,7	33,3
Leaf <i>Ficus carica</i> 96% EtOH	3697,1	801,7	21,7



DPPH

### ABTS

	mg TE / 100g dry mass	SD	CV (%)
Leaf <i>Ficus carica</i> 70% EtOH	2271,1	843,8	37,2
Leaf <i>Ficus carica</i> 96% EtOH	5003,6	619,6	12,4



ABTS



Leaf *Ficus carica* 70% EtOH ↑ Phenol Content

Leaf *Ficus carica* 96% EtOH ↑ Antioxidant Activity





# Tuta absoluta

“Tomato leaf miner ”

- *Tuta absoluta* originated in South America but quickly spread to Europe, Africa and Asia.
- Significant threat mainly against tomato crops, but can also affect potatoes, wild tomatoes, eggplants, and apples.



Leaves and stems



Flowers



Fruits



Synthetic Insecticides



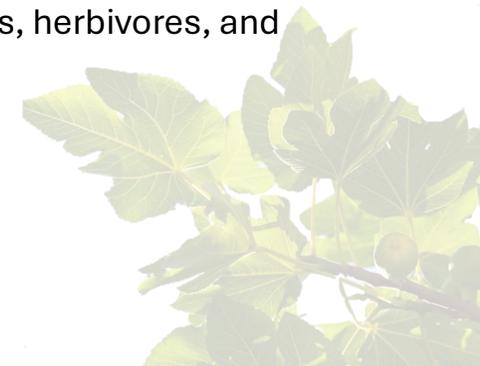
Insect resistance  
Control failures



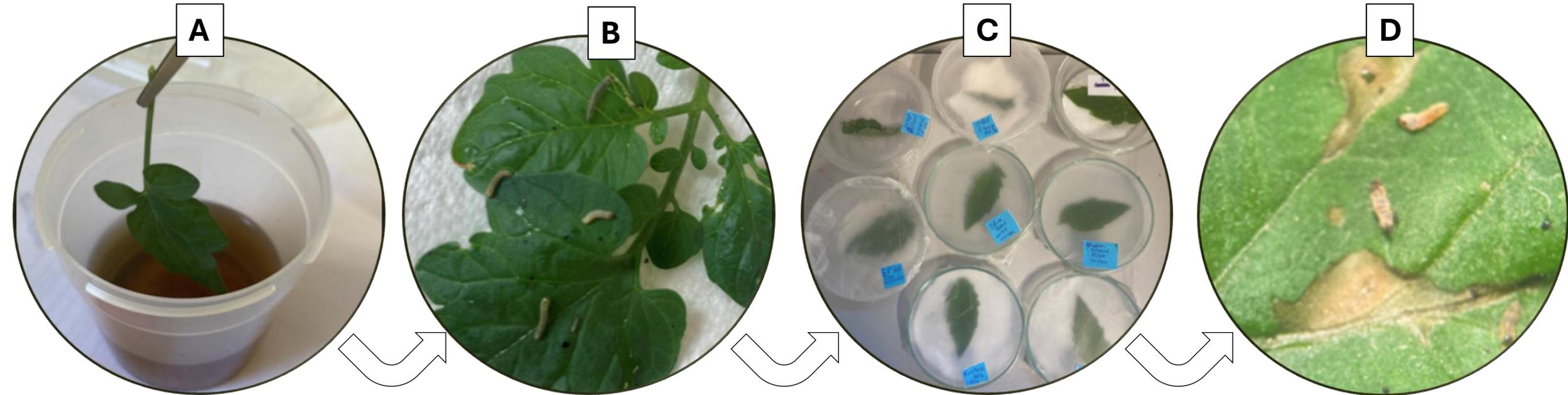
Production of botanical insecticides



Lower environmental toxicity  
Compounds with defense mechanisms against pathogens, herbivores, and predators



# Biowaste Extracts - Insecticide Activity Tests



**A** - Tomato leaflets **dipped for 10 seconds in the solution of each plant extract** and then positioned in a Petri dish lined with a moistened filter paper;

**B** - Each leaflet was **infested with eight-third instar caterpillars** of *T. absoluta*, promoting the **contact** and **ingestion** of botanical extract. Each treatment was **replicated 5 times**. A negative control group was treated with distilled water;

**C** - The Petri dishes were sealed with parafilm and kept at a temperature of  $25 \pm 2$  °C and  $60 \pm 5$  % R. H., 16:8 h L:D photoperiod;

**D** - Mortality of *T. absoluta* caterpillars was recorded at **24, 48, and 72 h** after treatment application.



# Biowaste Extracts - Insecticide Activity Tests

Treatment groups	Mortality (%) of <i>T. absoluta</i> caterpillar (mean ± SD)		
	24h	48h	72h
Control	3,33±7,45 <sup>a</sup>	6,67±9,13 <sup>a</sup>	10,00±9,13 <sup>a</sup>
<i>F. carica</i> 70% EtOH (1:10 w/v)	30,00±21,73 <sup>b</sup>	40,00±25,28 <sup>b</sup>	43,33±19,00 <sup>b</sup>
<i>F. carica</i> 96% EtOH (1:10 w/v)	20,00±8,33 <sup>a,b</sup>	23,33±9,62 <sup>a,b</sup>	26,67±9,13 <sup>a,b</sup>

Plant extracts exhibited a notable capacity to kill *T. absoluta* caterpillars for the *F. carica* extract [70% EtOH (1:10 w/v)] whose application has led to a higher caterpillar mortality when compared with the group control at 24, 48 and 72 h exposure.



# Testing of leaf extract against *botritus cinerea*

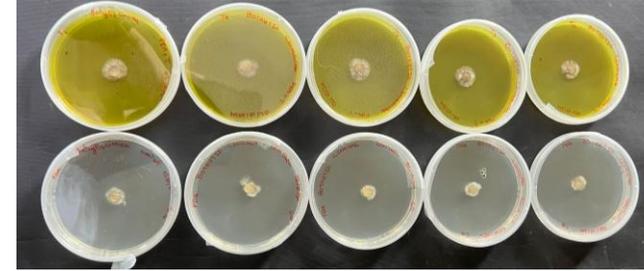
## In vitro



Add 15 mL of PDA + T to 5 Petri dishes and 15 mL of PDA to another 5 Petri dishes



Make small round cuts in a *Botrytis* cultivar with the bigger part of a micropipette tip



Add them in the center of each of the Petri dishes. Put them in the incubator to grow.



It is necessary to measure the growth every day at the same time

PDA + T = PDA with Treatment

## In vivo



1% on top and 10% on the bottom

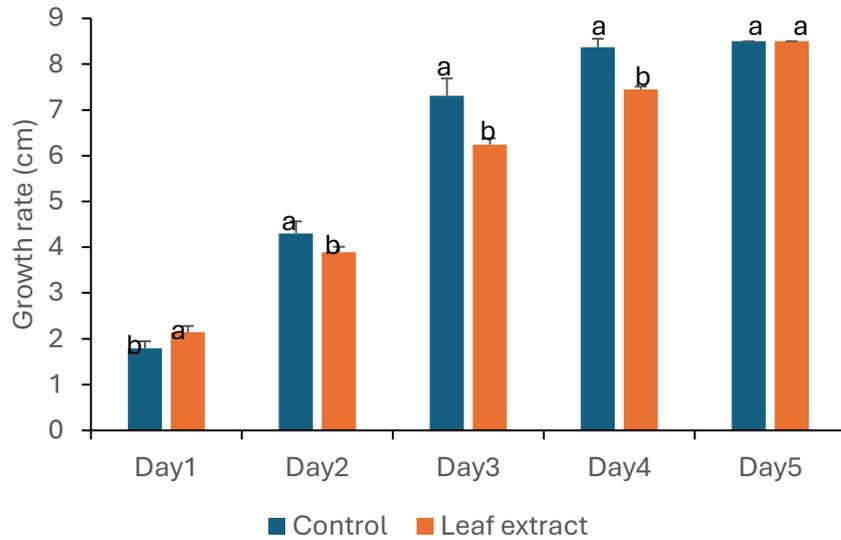


Control

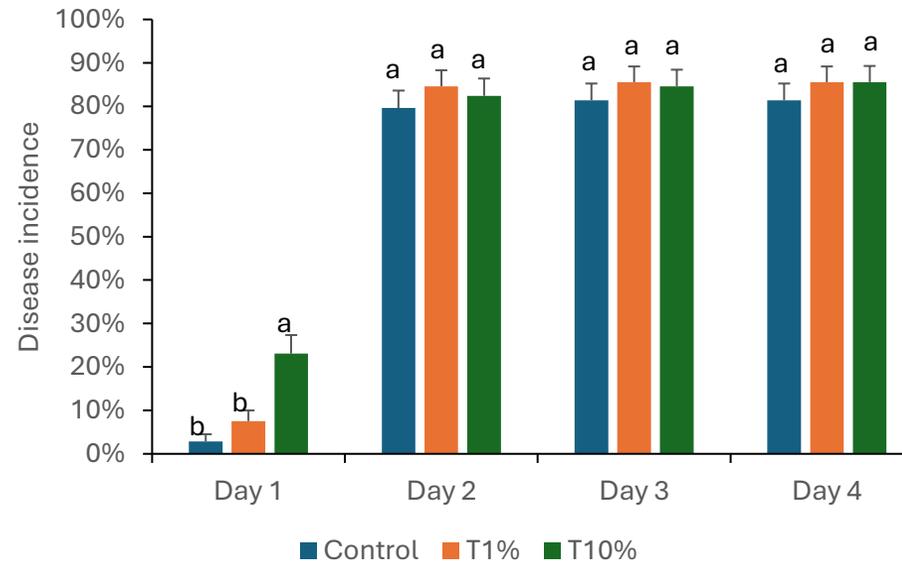
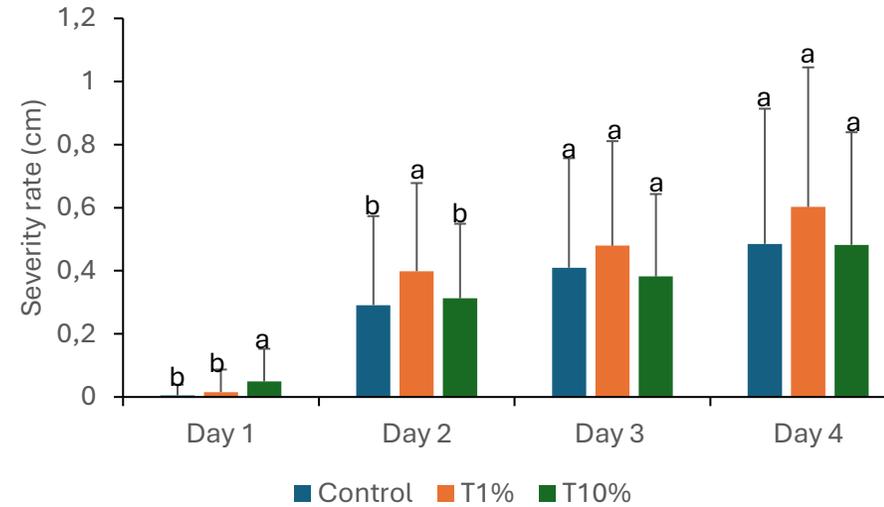
1. Make a small hole in each grape with the help of a needle covered in tape (to make the hole wider)
2. In the three containers labeled 1%, inject 20uL of 1% (w/V) extract in each grape. Repeat the process in the three containers labeled 10% but use the extract 10% (w/V). In the containers labeled control do not inject anything
3. Leave for 24h before proceeding to the next step
4. Inject 20uL of the liquid with the *Botrytis* spores to each grape and let it incubate

# In vivo and in vitro testing against *botritus cinerea*

## Statistical Analysis – In vitro



## Statistical Analysis – In vivo



# Conclusion

The hybrid solar drying system proved to be an effective and safe alternative to traditional sun-drying, successfully drying figs within 71 hours while ensuring suitable moisture content, water activity, and long-term microbiological stability.

Dried figs retained relevant bioactive compounds, namely rutin, isoquercitrin, 5-O-caffeoylquinic acid, and dicaffeoylquinic acid, supporting their potential for value-added applications.

Regarding the application of fig leaf extracts, the 70% ethanolic extract of fig leaves showed a significant effect against *Tuta absoluta* compared to the control.

These results highlight the relevance of optimizing extraction strategies and compound purification to enhance bioinsecticidal efficacy, reinforcing the potential of fig by-products within a sustainable valorization framework



# ACKNOWLEDGEMENTS

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## Thanks for your attention



Dulcineia Wessel



Susana Cardoso



Cláudia Neves



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