

# Plant-associated bacteria as potential carriers of antibiotic resistance from the environment to humans

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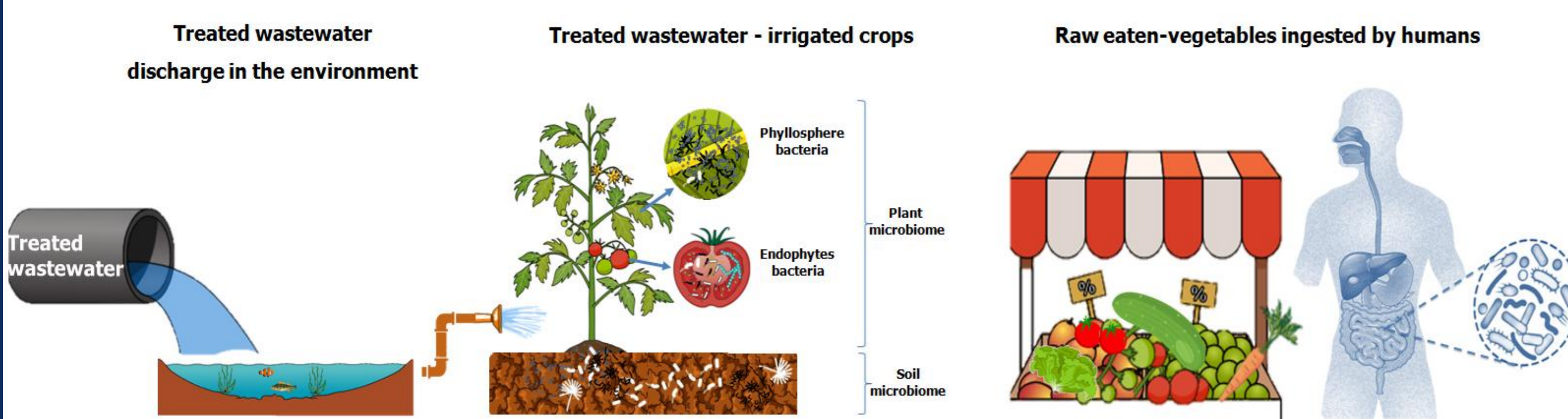


## Background and Objectives

The plants vascular system is inhabited by endophytic bacteria. These include human pathogens and antibiotic resistant bacteria (ARB).

Although the knowledge of ARB uptake by plants is still sparse, there is a growing concern that ARB may reach humans through the consumption of raw vegetables.

The aim of this work is to explore whether plant-associated bacteria might be ARB and potential carriers of antibiotic resistance genes (ARGs) and, thus, be involved in antibiotic resistance transmission from the environment to humans.



## Search strategy

### Literature and database survey of endophytic bacteria in edible plants

**Keywords used:** “endophytic bacteria”, “communities of endophytes”, “diversity of endophytic bacteria”, “bacterial communities associated with vegetables”

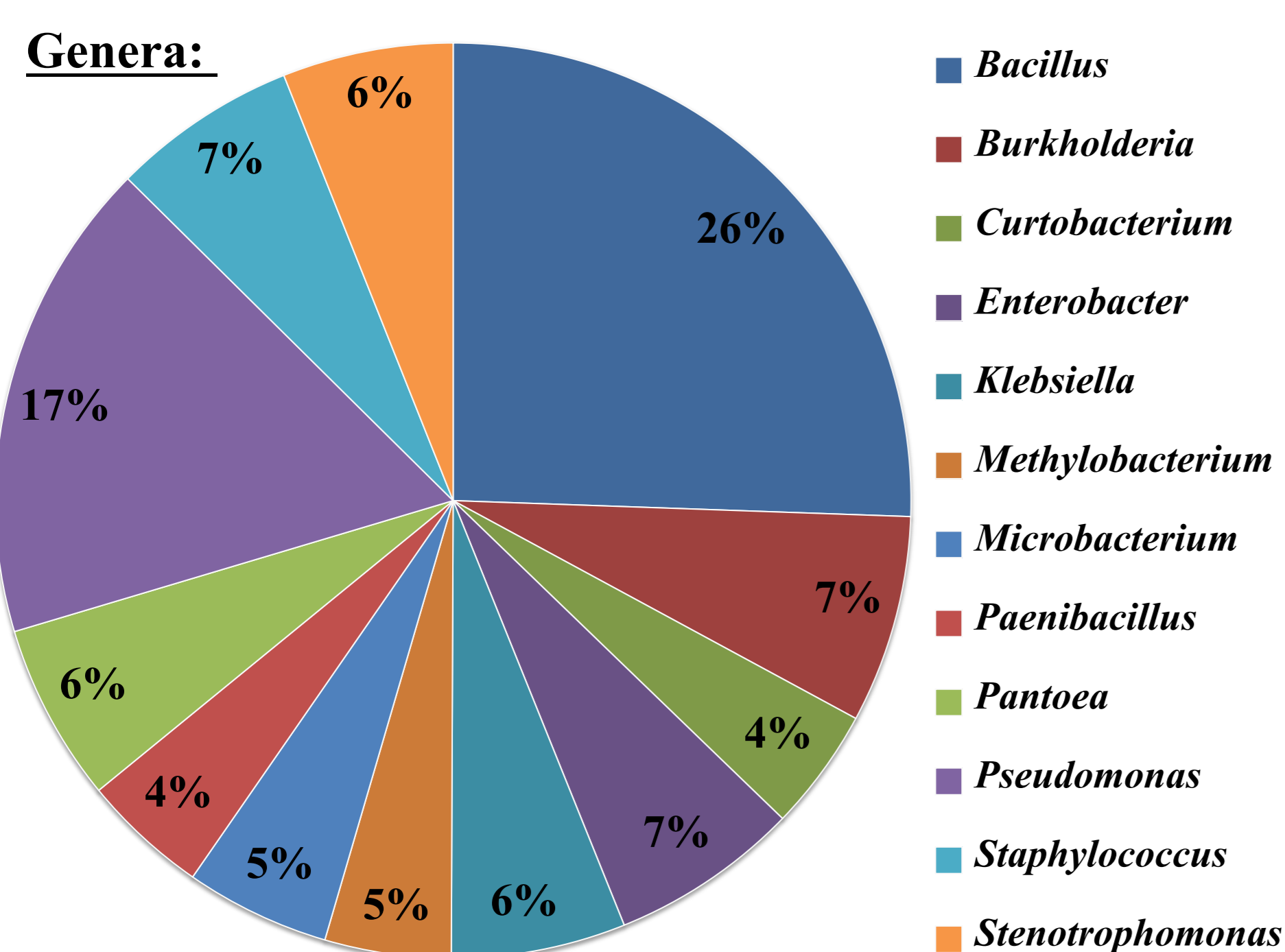
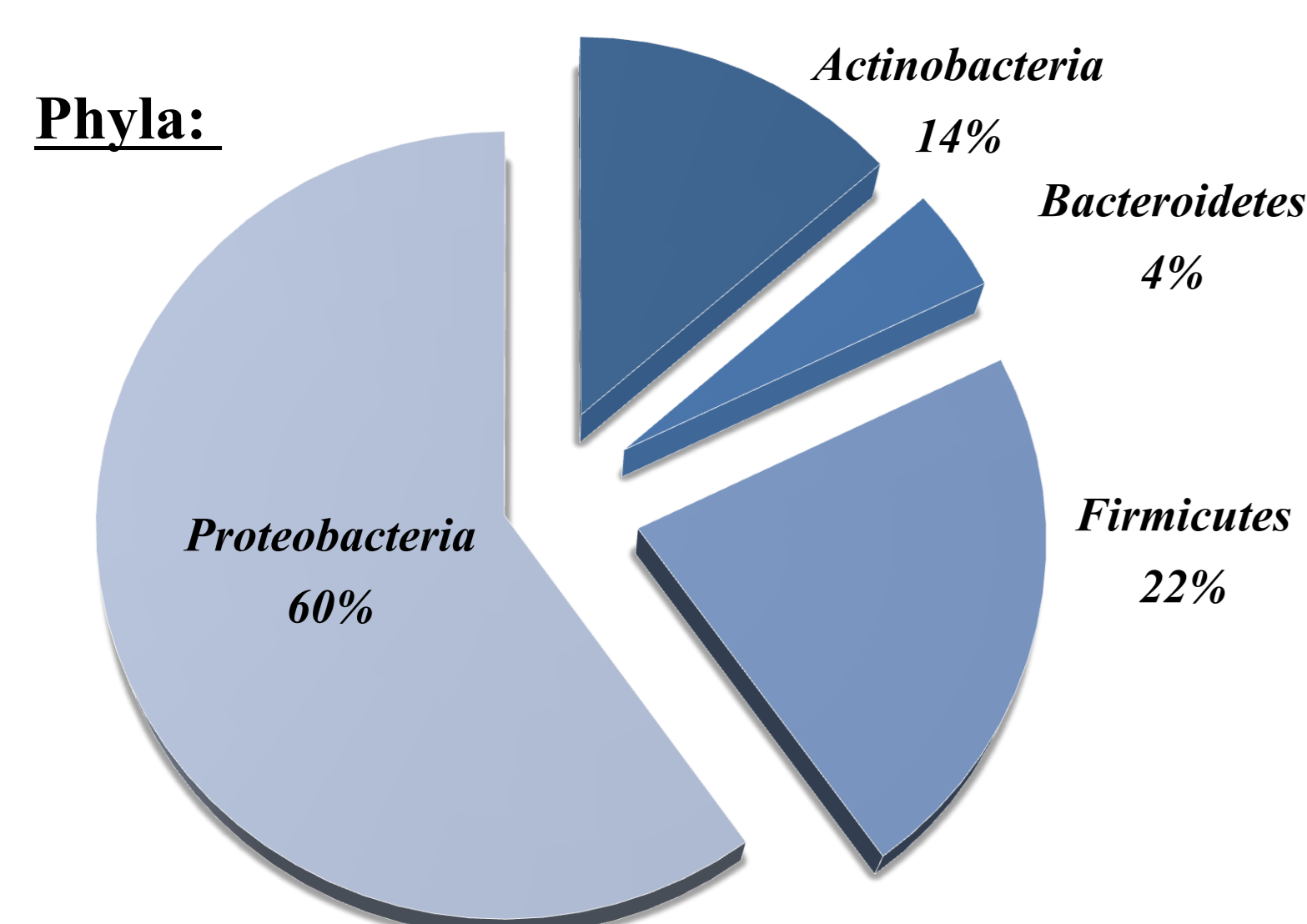
### Inclusion criteria:

- ✓ List of endophytic bacteria published after 1995;
- ✓ Surface-sterilized procedures used;
- ✓ Raw eaten plants or fruits with exception of some agricultures crops.

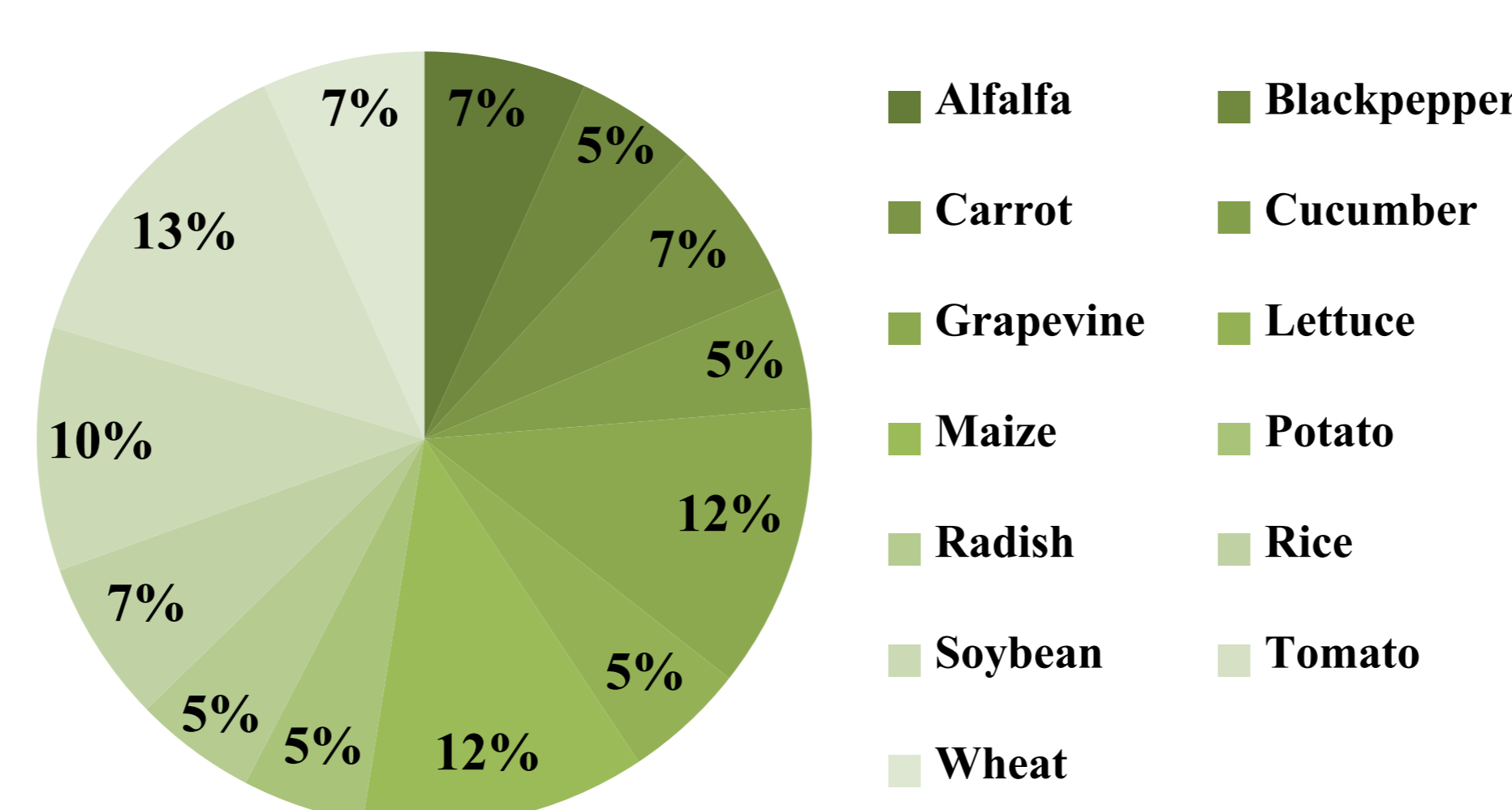
- Bacterial taxa frequently associated with edible plants were listed.
- The resultant bacterial taxa were screened for i) the occurrence in the human and wastewater microbiome and for ii) the presence of ARGs.
- Plants able to acquire bacteria from the environment were listed alike.

## Results

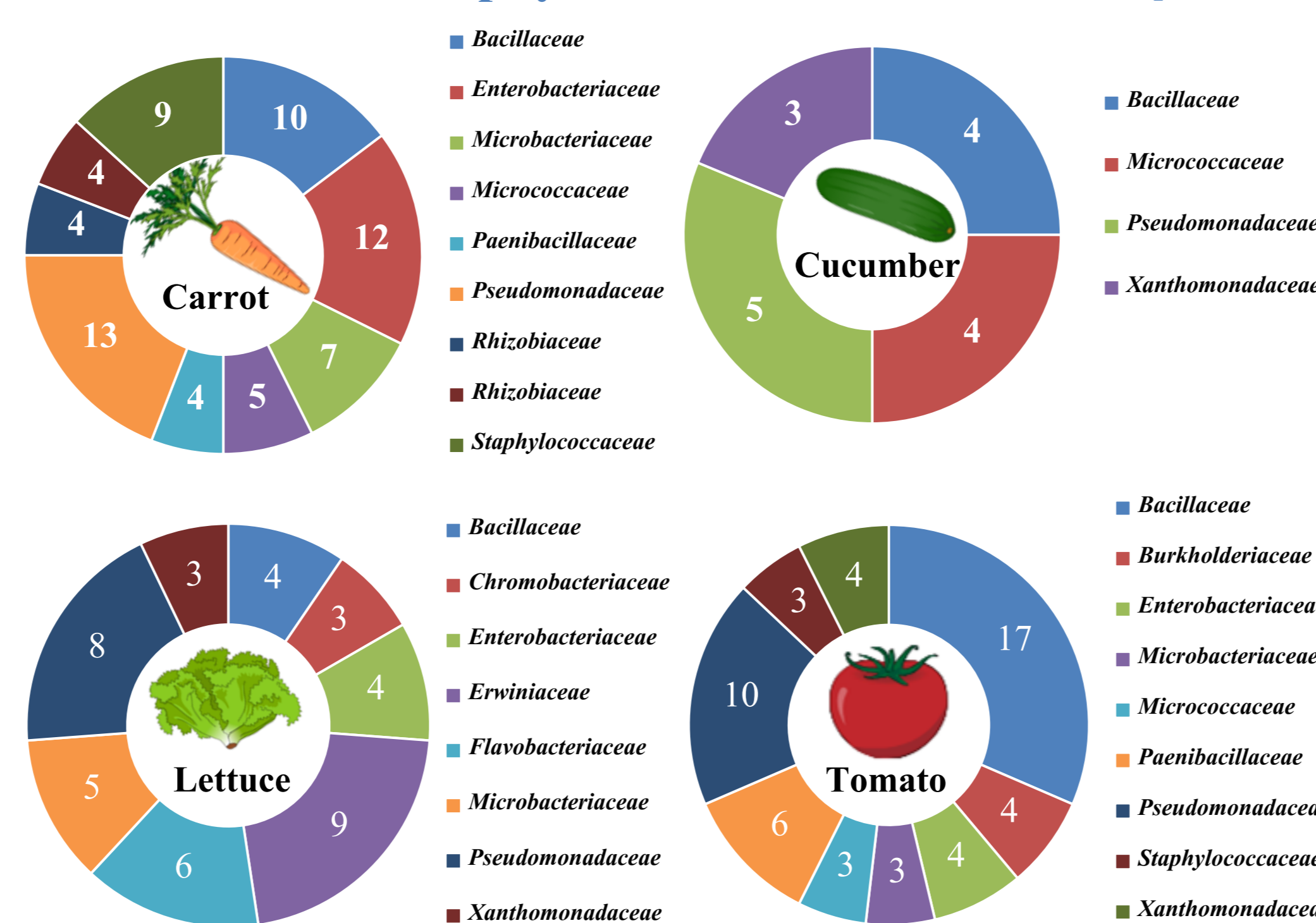
### Most cited endophytic bacteria in edible plants



### Edible plants most found in literature



### Families of endophytic bacteria cited in edible plants



### Most common endophytic bacterial genera in raw eaten vegetables

Genus	Presence in raw eaten vegetables	Habitat	Pathogenicity and AR
<i>Microbacterium</i>	✓	HM, WM	-
<i>Arthrobacter</i>	✓	HM, WM	ARGs, P
<i>Kocuria</i>	✗	HM, WM	P
<i>Micrococcus</i>	✗	HM, WM	P
<i>Chryseobacterium</i>	✓	HM, WM	ARGs, P
<i>Bacillus</i>	✓	HM, WM	ARGs, P
<i>Paenibacillus</i>	✓	HM, WM	ARGs, P
<i>Staphylococcus</i>	✓	HM, WM	ARGs, P
<i>Agrobacterium</i>	✓	WM	ARGs, P
<i>Stenotrophomonas</i>	✓	HM, WM	ARGs, P
<i>Xanthomonas</i>	✗	WM	ARGs
<i>Burkholderia</i>	✗	HM, WM	ARGs, P
<i>Enterobacter</i>	✗	HM, WM	ARGs, P
<i>Erwinia</i>	✗	WM	ARGs, P
<i>Pseudomonas</i>	✓	HM, WM	ARGs, P

**Legend:** HM, human microbiome; WM, wastewater microbiome; ARGs, described harbours of ARGs; P, members described as human pathogens.  
**In blue,** ESKAPE bacteria, pathogenic bacteria causing nosocomial infections that have already been recognized as ARB.

## Conclusions

The data analysis conducted so far, revealed the presence of more than 20 phyla in 22 different edible plants. Phyla of endophytic bacteria most frequently cited (>50) were: *Proteobacteria* (60%), *Firmicutes* (22%) and *Actinobacteria* (14%). Genera most cited were: *Microbacterium*, *Micrococcus*, *Bacillus*, *Staphylococcus*, *Stenotrophomonas* and *Pseudomonas*.

Tomato, carrot, cucumber and lettuce were the most cited edible plants.

These results support the hypothesis that bacteria with potential to harbor ARGs are able to colonize plants and thus, when consumed raw those plants may play a role on antibiotic resistance transmission to humans from the environment. This may be especially relevant in the case the consumers are immunocompromised, under antibiotherapy, or debilitated in any way.

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