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The effects of plant growth-promoting rhizobacteria (PGPR) on the growth and quality of strawberries

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Providing a definition of "fruit quality" is a difficult task

Dependent on different criteria → economical and commercial factors, and transformation processes

Retailers

Fruit quality is defined by:
- Shelf-life
- Firmness
- Look (Colour and Shape)

Consumers

Fruit quality is defined by:
- Taste
- Smell
- Look (Colour and Shape)
- Healthiness (e.g. antioxidant compounds)

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Fruit quality is influenced by mineral nutrition

1. Fertilization

Nutrient supply is likely to influence quality from morphological, physical, chemical, and organoleptic points of view.

Brunetto et al., 2015

N fertilization → cluster morphology, juice chemical composition, and organoleptic properties, increase in total polyphenols

Chadha and Shikhamany, 1999

Evidence also in other fruit crops (e.g. pear and apple)

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Fruit quality is influenced by mineral nutrition

2. Nutrient starvation

The lack of a specific nutrient induces the imbalanced uptake and allocation of other mineral nutrients

Table 2. Macro- and micronutrients of fruits of strawberries grown in a full nutrient (control), zero iron (−Fe) and zero phosphorus (−P) solution

	Control	−P	−Fe
Fe (μg g^{-1} DW)	44.03 ± 3.39a	46.97 ± 3.04a	24.49 ± 3.35b
Cu (μg g^{-1} DW)	7.95 ± 0.76b	11.35 ± 0.46a	12.01 ± 0.99a
Zn (μg g^{-1} DW)	17.63 ± 1.23b	18.86 ± 1.11b	21.25 ± 1.48a
P (mg g^{-1} DW)	2.97 ± 0.05a	1.49 ± 0.04b	2.72 ± 0.14a
Ca (mg g^{-1} DW)	2.22 ± 0.14b	3.04 ± 0.05a	2.16 ± 0.06b
Mg (mg g^{-1} DW)	1.55 ± 0.06 n.s.	1.52 ± 0.08 n.s.	1.53 ± 0.07 n.s.
S (mg g^{-1} DW)	0.63 ± 0.02 n.s.	0.59 ± 0.03 n.s.	0.66 ± 0.04 n.s.

DW, dry weight; mean ± SE (n = 3); letters following the means indicate significant differences at P < 0.05; n.s., not significant.

Table 4. Total phenol and phenolic compound concentrations of fruits of strawberries grown in a full nutrient (control), zero iron (−Fe) and zero phosphorus (−P) solution; mean ± SE (n = 3)

mg g^{-1} DW	Control	−P	−Fe
Total phenols	6.60 ± 0.06c	8.66 ± 0.33a	7.73 ± 0.01b
Anthocyanins	3.01 ± 0.06b	4.61 ± 0.15a	4.38 ± 0.03a
Pelargonidin-3-glucoside	2.24 ± 0.05c	3.38 ± 0.12a	3.08 ± 0.03b
Flavan-3-ols	2.42 ± 0.07a	2.37 ± 0.02a	1.99 ± 0.02b
Catechin	0.40 ± 0.02a	0.33 ± 0.02b	0.44 ± 0.01a
Epicatechin	0.08 ± 0.00b	0.14 ± 0.02a	0.12 ± 0.01a
Proanthocyanidin B2	0.03 ± 0.01 n.s.	0.03 ± 0.02 n.s.	0.03 ± 0.00 n.s.
Benzoic acids	0.34 ± 0.02b	0.48 ± 0.02a	0.43 ± 0.01a
Hydroxycinnamic acids	0.27 ± 0.01b	0.38 ± 0.01a	0.29 ± 0.00b
Flavonols	0.08 ± 0.00b	0.12 ± 0.01a	0.12 ± 0.01a

Letters following the means indicate significant differences at P < 0.05; n.s., not significant.

Valentinuzzi et al., 2015

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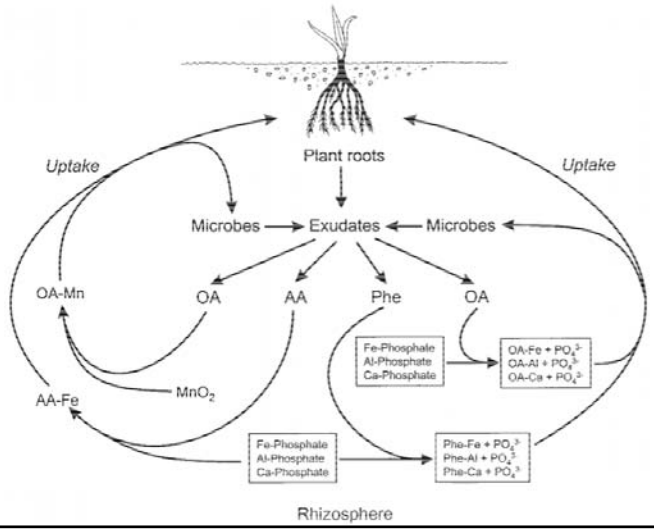
Nutrient availability in the rhizosphere



Dakora and Phillips, 2002

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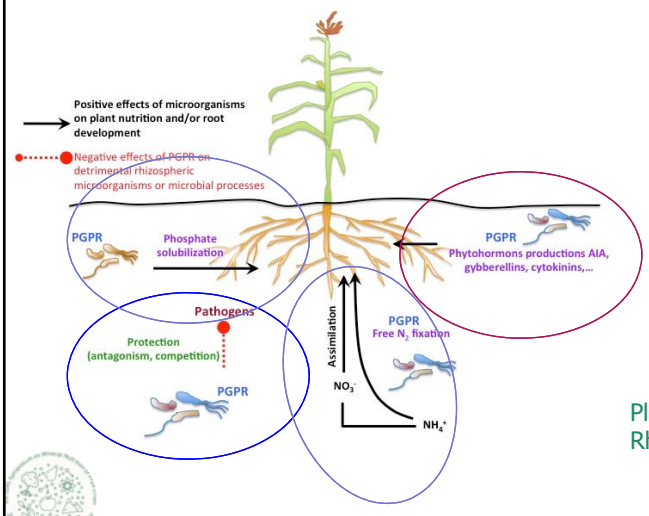
Plant Growth-Promoting Rhizobacteria (PGPR)



Negative Interactions
→ Pathogens

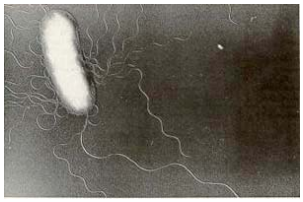
Positive Interactions
→ Biocontrol
→ Root Growth Promotion
→ Biofertilization

Plant Growth-Promoting Rhizobacteria (**PGPR**)

Aim of the research

Do PGPRs have beneficial effects on the growth and quality of strawberries (*Fragaria ananassa* cv. Elsanta) ?

Azospirillum brasilense



Effective Microorganisms ®

https://emrojapan.com/

Experimental design

Strawberry frigo-plants were grown hydroponically for 70 days in a full nutrient solution (NS).

- <u>At flowering stage three treatments have been carried out:</u>
  - NS (control)
  - NS + *A. brasilense* (*A. brasilense*)
  - NS + Effective Microorganisms (EM)
- <u>At harvest:</u>
  1. Plants growth parameters
  2. Yield and fruit features
  3. Quality parameters
  4. Nutraceutical compounds

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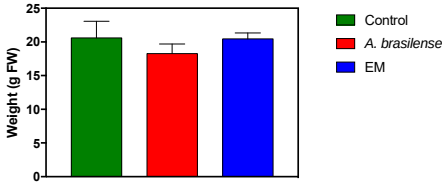
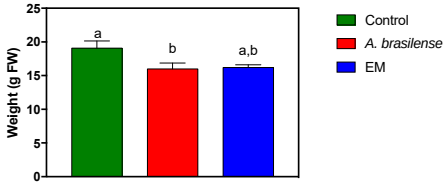
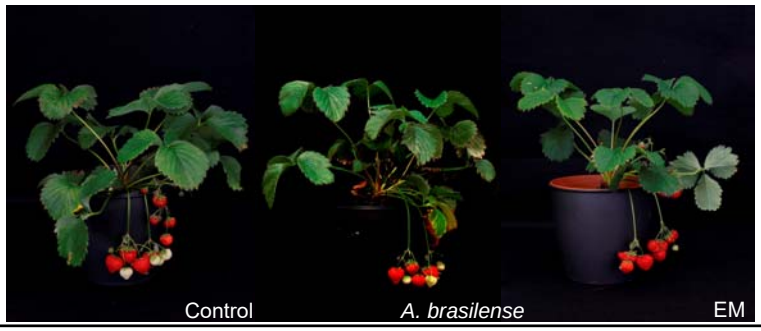
Results – Growth Parameters

Shoot biomass



Root biomass





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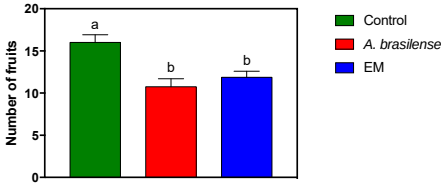
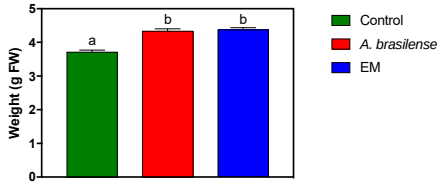
Results – Yield and Fruit Features

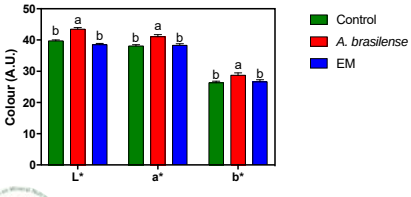
Number of fruits



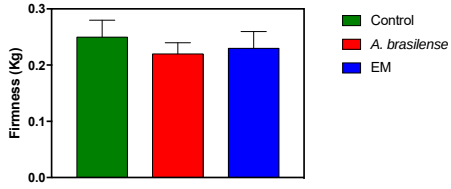
Fruit Weight



Fruit Colour

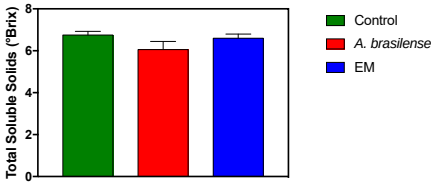


Firmness

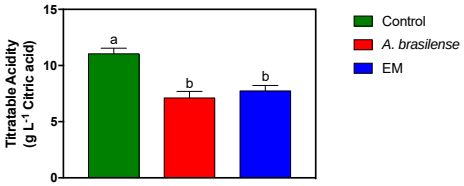


Results – Quality Parameters

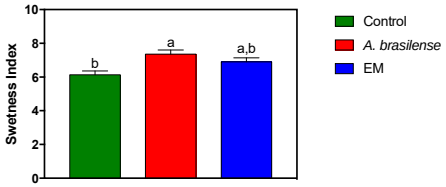
✧ Total Soluble Solids



✧ Titratable Acidity



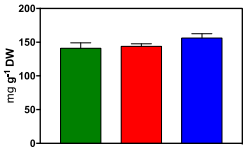
✧ Sweetness Index



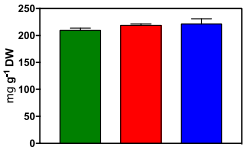
Results – Nutraceutical Compounds

✧ Sugars

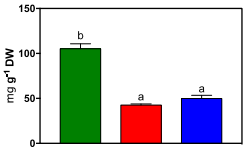
- Glucose

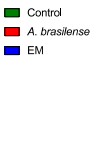


- Fructose



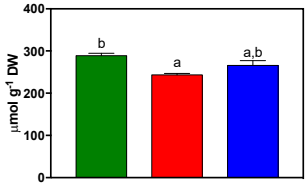
- Sucrose



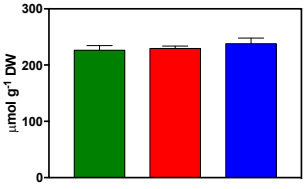


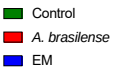
✧ Organic Acids

- Citric acid



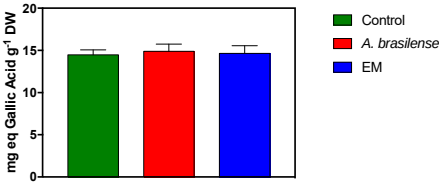
- Malic acid



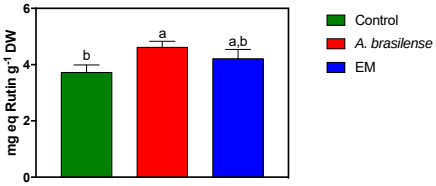


Results – Nutraceutical Compounds

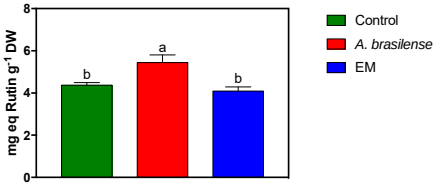
✧ Phenolics Compounds



✧ Total Flavonoids

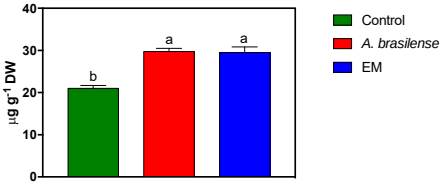


✧ Total Flavonols

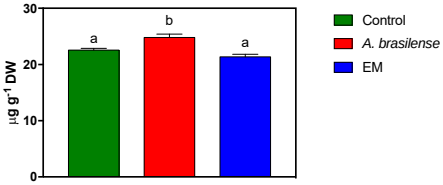


Results – Mineral Nutrients

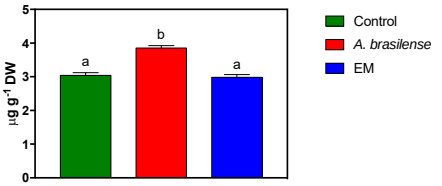
✧ Iron (Fe)



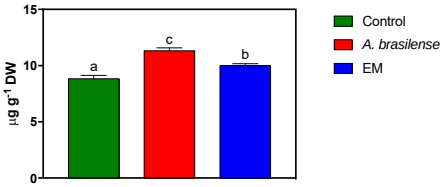
✧ Manganese (Mn)



✧ Copper (Cu)



✧ Zinc (Zn)



Conclusions

- The inoculation with PGPR slightly reduced the yield (number of fruits), but increased the dimension strawberries;
- Plants inoculated with *A. brasilense* produced fruits showing a more intense red colour;
- PGPR-inoculation induced an increase in the nutraceutical properties of strawberry fruits;
- *A. brasilense* resulted more effective than EM in improving fruit quality parameters.

…future perspectives...

→ Soil-based experiments

Acknowledgments

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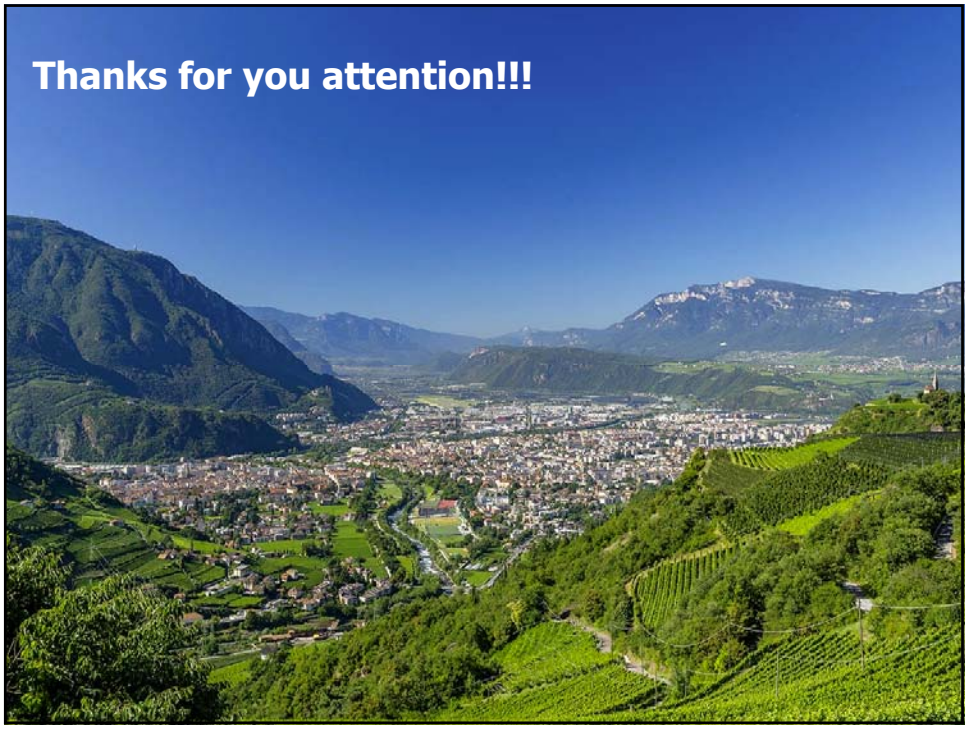
Dott. Laura Marastoni


Dott. Mauro Maver

Special credit: Hannes Graf


Thanks for you attention!!!