

# Beneficial microbes application on tomato significantly improves accumulation of metabolites with nutraceutical value

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Tomato (*Solanum lycopersicum*) is an important crop and is consumed worldwide. This vegetable is an excellent source of natural compounds (i.e antioxidants including vitamins C and E, lycopene, b-carotene, lutein and flavonoids) and minerals useful for human health.

## AIM OF THE WORK:

Investigate the impact of beneficial microorganisms application on tomato metabolome.

## MATERIALS AND METHODS:

*Streptomyces fulvissimus*, *Bacillus subtilis* and *Trichoderma afroharzianum* were applied on tomato plants in a field trial either as single inoculants or as microbial consortia. After the treatments, plants were harvested and subjected to organic extraction (Figure 1) followed by metabolomic analysis (LC-MS qTOF).

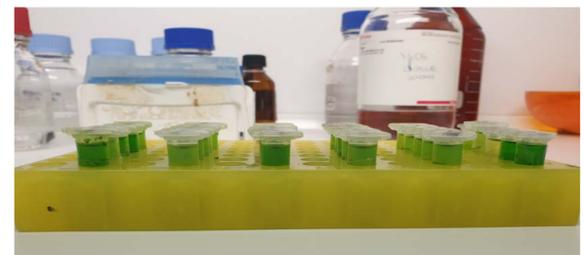


Figure 1. Extraction of metabolites from tomato leaves.

## IDENTIFICATION OF PLANT METABOLITES:

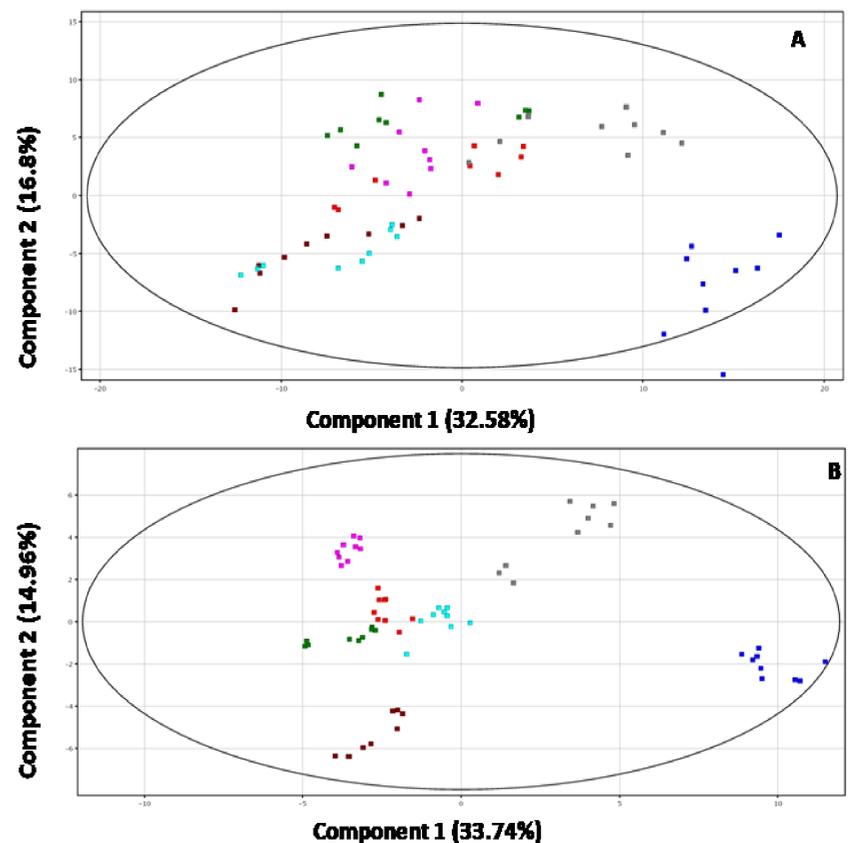
Spectrometric analysis led to the identification of several secondary metabolites (i.e. tomatine, solasodine, etc.) belonging to different classes of natural compounds (Table 1).

## METABOLOMIC ANALYSIS:

Metabolomic analysis highlighted several differentially accumulated compounds, whose abundance is dependent on the treatment (PCA on Figure 2).

Compound	RT (min)	Experimental Mass (Da)	Regulation					
			B vs C	S vs C	T vs C	B+T vs C	B+S vs C	S+T vs C
Tomatine	5.270	1033.55	↑	↓	↑	↑	↑	↓
Solafloridine	6.693	415.3462	↓	↓	↑	↑	↑	↑
Apo-13-zeaxanthinone	8.855	274.1939	↓	↓	↓	↓	↑	↓
Deoxy phytprostane J1	6.813	290.1891	↓	↓	↓	↓	↓	↓
Colneleic acid	9.726002	294.2206	↓	↓	↓	↓	↓	↓
Solasodine	5.232685	413.3294	↑	↓	↑	↓	↑	↓
Isoorientin 2"-O-glucopyranoside	5.007	610.1537	↓	↓	↓	↓	↓	↓
Quinic acid	1.291	192.0632	↓	↓	↓	↓	↓	↓
Quercetin 3-(2G-apiosylrutinoside)	4.842	742.1949	↑	↑	↑	↑	↑	↑
beta1-Tomatine	5.322	901.5028	↑	↑	↑	↑	↑	↑
Kaempferol 3-galactoside-7-rhamnoside	5.166999	594.1582	↓	↓	↓	↓	↓	↓

**Table 1.** Putatively identified metabolites differentially accumulated in plants treated with *Streptomyces fulvissimus* (S), *Trichoderma afroharzianum* (T) and *Bacillus subtilis* (B) or as mix (B+S, B+T, S+T) compared to control (group C, untreated plants).  
 In black = putatively identified molecule from LC-MS analysis performed in positive mode  
 In red = putatively identified molecule from LC-MS analysis performed in negative mode  
 ↑ Up-regulated vs control (C). ↓ Down-regulated vs control (C).



**Figure 2.** Principal components analysis (PCA) score plots of the LC-MS data acquired in positive (B) and negative (A) mode. Each group of replicates subjected to different treatments is depicted with a different color: control group (C) in blue; *Streptomyces fulvissimus* group (S) in brown; *Trichoderma afroharzianum* group (T) in pink; microbial consortium *Streptomyces fulvissimus* and *Bacillus subtilis* group (S+B) in grey; *Bacillus subtilis* group (B) in red; microbial consortium *Streptomyces fulvissimus* and *Trichoderma afroharzianum* group (S+T) in green; microbial consortium *Trichoderma afroharzianum* and *Bacillus subtilis* group (T+B) in light blue.

## Conclusion:

Field applications of *Streptomyces fulvissimus*, *Bacillus subtilis* and *Trichoderma afroharzianum* induced changes in the metabolic profile of tomato. In particular, a certain accumulation of molecules has been observed, such as tomatin, with demonstrated antioxidant, antitumoral and fungicidal properties. The accumulation of these metabolites with nutraceutical value represents a starting point for further future studies to investigate the efficacy of these beneficial strains.