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# Influence of organic and conventional agricultural practices on chemical profile, *in vitro* antioxidant and anti-obesity properties of *Zingiber officinale* Roscoe

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## INTRODUCTION

Spices have been in use for thousands of years in cooking to enhance the sensory quality of food (flavour, colour, pungency, food additiv etc.). In recent years, the physiological functionality of food spice, used in traditional cooking, has received much attention due to th increasing interest in human health and has been studied *in vitro* and *in vivo* by many research groups.

*Zingiber officinale* Rosc. (ginger) is a rhizomatous herb belonging to the family Zingiberaceae. The rhizome is extensively used around th world as spice in culinary, beverages and herbal medicinal practices to treat a wide range of diseases such as rheumatic disorders, col symptoms, fevers, gastrointestinal complications, motion sickness, bronchitis, diabetes, cancer, etc. [1]. Moreover, it was used to treat wide range of diseases including metabolic syndrome (MetS). MetS is a group of risk factors, including insulin resistance an consequently impaired glucose tolerance, dyslipidaemia, obesity, hypertension and the oxidative stress plays an important role. It is estimated that MetS affects 25% of the population [2]. The efficacy of natural products especially derived from vegetables and spice, largely consumed worldwide, is a topic of great interest not only to cure but also to prevent the onset of the disease.

In this study the influence of organic (OR) and conventional (CONV) agricultural practices on chemical profile and nutraceutical properties of *Zingiber officinale* Roscoe spice was evaluated.

## MATERIALS AND METHODS

### Sample and extraction procedure

Commercial dried ginger powders from conventional (CONV) (Z1-Z4) and organic (OR) (Z5) agricultural practices were bought in the market in Cosenza, Calabria (Italy). Ginger powder (5 g) were exhaustively by ultrasound assisted maceration process with ethanol (48h x 3 times). The resultant solutions were dried under reduced temperature and pressure using a rotary evaporator to give extraction yield in the range 0.24-0.85 g for Z4 and Z1, respectively.

### Total Phenols, flavonoids and carotenoids content

Total phenols, flavonoids and carotenoids content was determined as previously reported by Leporini et al. [3]

### In vitro antioxidant activity

Antioxidant compounds may act *in vivo* through different mechanisms of action. For this reason, no single method can fully evaluate the antioxidant capacity of food since levels of single antioxidant in food do not necessarily reflect their antioxidant activity. Therefore, to investigate the antioxidant activity of chemicals choosing an adequate assay based on chemicals of interest is critical. In a multi-target approach was used to test the antioxidant activity by using DPPH, ABTS, β-carotene bleaching, and FRAP assays [3]. DPPH and ABTS test are used to evaluate the radical scavenging activity, the β-carotene bleaching assay as a mimetic model of lipid peroxidation in biological membranes while, FRAP test to evaluate the effect on iron, one of the most important ions involved in oxidation process. RACI and GAS approaches were used to evaluate samples with the highest antioxidant potential.

### In vitro hypoglycaemic and hypolipidemic effects

The hypolipidemic potential was investigated through inhibition of lipase while, the inhibition of carbohydrate hydrolysing enzymes, α-amylase and α-glucosidase, was used to evaluate the hypoglycaemic activity [3].


*Lipase (a), α-Amylase (b) and α-Glucosidase (c)*

## RESULTS AND DISCUSSION

OR Ginger (Z5) showed the highest TPC and TFC with values of 39.27 and 15.38 mg/g dried weight (DW). Similar values were found for the CONV sample Z3. However, the following rank was found for TCC: Z1>Z5>Z2>Z3>Z4.

### TPC, TFC and TCC in ginger samples

| Samples | TPC mg/g DW | TFC mg/g DW | TCC mg/g DW |
|---|---|---|---|
| Z1 | 21.84 ± 1.87$^{d}$ | 8.42 ± 0.98$^{c}$ | 17.05 ± 1.73$^{a}$ |
| Z2 | 17.58 ± 1.78$^{e}$ | 6.11 ± 0.79$^{d}$ | 10.30 ± 1.83$^{c}$ |
| Z3 | 35.66 ± 2.3$^{b}$ | 13.84 ± 1.01$^{b}$ | 6.38 ± 0.74$^{d}$ |
| Z4 | 22.64 ± 1.93$^{c}$ | 8.36 ± 0.83$^{c}$ | 5.37 ± 0.71$^{e}$ |
| Z5 | 39.27 ± 2.4$^{a}$ | 15.38 ± 1.08$^{a}$ | 14.67 ± 1.56$^{b}$ |
| Sign. | ** | ** | ** |

Data are express as ± S.D. ($n$= 3). Differences were evaluated by one-way ANOVA followed by a multicomparison Turkey's **$p$< 0.05. Means in the same column with different small letters differ significantly ($p$< 0.05). Sign: significant

Sample from OR agricultural practices resulted the most active in all applied antioxidant test with particular reference to ABTS test where Z5 showed a stronger activity with $IC_{50}$ value of 0.81 μg/mL in comparison to the positive control ascorbic acid (1.70 μg/mL). The same observation was noted in FRAP assay.

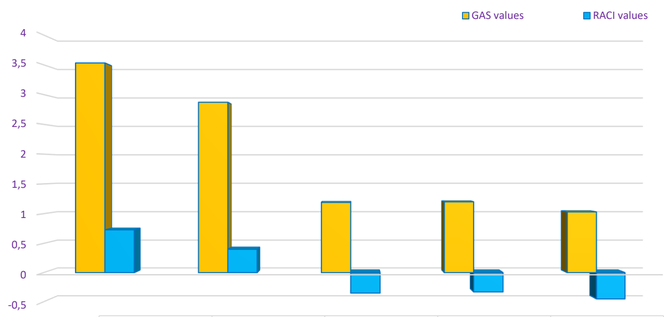
RACI and GAS statistical approach confirmed the Z5 highest antioxidant potency followed by the CONV sample Z3.

### In vitro antioxidant activity of ginger samples

| Samples | DPPH $IC_{50}$ (μg/mL) | ABTS $IC_{50}$ (μg/mL) | FRAP μMFe (II)/g | β-carotene bleaching test $IC_{50}$ (μg/mL) | |
|---|---|---|---|---|---|
| | | | | t=30min | t=60min |
| Z1 | 232.27 ± 4.3**** | 3.78 ± 0.9** | 32.71 ± 2.3**** | 54.11 ± 2.0**** | 59.80 ± 3.1**** |
| Z2 | 215.38 ± 4.2**** | 6.28 ± 1.0**** | 47.68 ± 2.9*** | 27.08 ± 1.8**** | 22.92 ± 3.0**** |
| Z3 | 10.79 ± 1.0** | 1.76 ± 0.7 | 102.50 ± 3.9**** | 6.63 ± 0.9*** | 6.81 ± 2.9*** |
| Z4 | 9.80 ± 0.9** | 0.79 ± 0.06 | 91.21 ± 3.5**** | 16.57 ± 1.4**** | 13.95 ± 2.9**** |
| Z5 | 7.91 ± 0.7* | 0.81 ± 0.05 | 100.95 ± 3.9**** | 8.13 ± 1.0**** | 7.80 ± 2.9**** |
| Positive control | | | | | |
| Ascorbic acid | 5.01 ± 0.8 | 1.70 ± 0.06 | | | |
| BHT | | | 63.2 ± 2.3 | | |
| Propyl gallate | | | | 0.09 ± 0.04 | 0.09 ± 0.04 |

Data are express as ± S.D. ($n$= 3). DPPH Radical Scavenging Activity Assay; Antioxidant Capacity Determined by Radical Cation (ABTS+); Ferric Reducing Antioxidant Power (FRAP). Ascorbic acid. BHT and Propyl gallate were used as positive control in antioxidant tests. Differences within and between groups were evaluated by one-way ANOVA followed by a multicomparison Dunnett's test (α= 0.05): ****$p$< 0.0001. ***$p$< 0.001. **$p$< 0.01. compared with the positive controls.

### RACI and GAS parameters




| | Z1 | Z2 | Z3 | Z4 | Z5 |
|---|---|---|---|---|---|
| GAS values | 3,53 | 2,87 | 1,19 | 1,2 | 1,03 |
| RACI values | 0,73 | 0,4 | -0,35 | -0,33 | -0,45 |

Moreover, the sample Z5 exhibited a promising lipase inhibitory activity with $IC_{50}$ value quite similar to the positive control orlistat ($IC_{50}$ values of 34.48 vs 37.42 mg/mL). Interesting were also, the results obtained for the sample Z4 against α-amylase and α-glucosidase enzymes with values statistically comparable with positive control acarbose.

### In vitro hypoglycaemic and hypolipidemic effects of ginger samples

| Samples | α-Amilase $IC_{50}$ (μg/mL) | α-Glucosidase $IC_{50}$ (μg/mL) | Lipase $IC_{50}$ (μg/mL) |
|---|---|---|---|
| Z1 | 66.15 ± 1.4**** | 55.49 ± 1.5**** | 93.46 ± 1.7**** |
| Z2 | 98.16 ± 2.3**** | 72.94 ± 1.8**** | 70.83 ± 1.5**** |
| Z3 | 74.88 ± 1.8**** | 61.31 ± 1.4**** | 32.37 ± 1.4 |
| Z4 | 55.49 ± 1.6** | 43.85 ± 1.3*** | 39.57 ± 1.8* |
| Z5 | 68.09 ± 1.5**** | 78.76 ± 1.9**** | 34.48 ± 1.9 |
| Positive control | | | |
| Acarbose | 50.12 ± 1.3 | 35.51 ± 0.9 | |
| Orlistat | | | 37.42 ± 1.0 |

Data are expressed as means ± S.D. ($n$= 3). Acarbose used as positive control in α-amylase and α-glucosidase tests. Orlistat used as positive control in lipase test. Differences within and between groups were evaluated by one-way ANOVA followed by a multicomparison Dunnett's test (α= 0.05): ****$p$< 0.0001. ***$p$< 0.001. compared with the positive control.

## CONCLUSION

Collectively, our results demonstrated the impact of agricultural practices on ginger health properties. Moreover ginger may serve as a potential dietary nutraceutical supplement to keep human beings healthy. Furthermore, it holds promise for becoming a natural food additive as an antioxidant agent. However, further *in vivo* studies will be needed to confirm the potential in humans and prove the safety of the products.

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