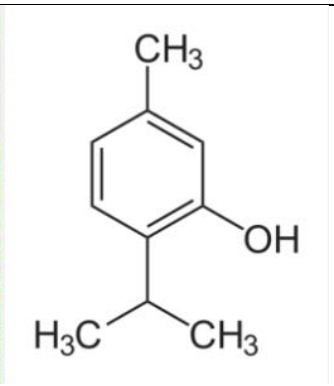
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	奧勒岡中的化學物質作為殺真菌劑 (Chemicals in oregano act as fungicide)
生物系統 LIVING SYSTEM	奧勒岡 *Origanum vulgare* (Oregano)
功能類別 FUNCTIONS	#生物性控制族群/蟲害/病害 #化學性分解有機化合物 #分配氣體 #改變氧化態 #保護免受真菌危害 #傳遞化學訊號（氣味、味道等） #感應化學訊號（氣味、味道等） #Biological control of population, pest, diseases #Chemically break down organic compounds #Distribute gases #Modify oxidation state #Protect from fungi #Send chemical signals (odor, taste, etc.) #Sense chemicals (odor, taste, etc.) from the environment
作用機制標題	奧勒岡中發現的揮發性化合物透過分解細胞膜來破壞真菌 (Volatile compounds found in oregano destroy fungi by breaking down their cell membranes)
生物系統/作用機制示意圖	 

作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)

如果你曾經打開冰箱時發現你的新鮮農產品已經變成糊狀、發霉的一團髒東西，那你一定很清楚真菌的破壞力量。如果缺乏對抗這些微生物的保護措施，成千上萬的蔬果將會腐敗，甚至在到達食品雜貨店之前就會變質並浪費掉。奧勒岡 (oregano) 已作為有效的植物保護分子的來源，能產生防止真菌感染及使食物腐敗的精油及香氣。

事實證明，奧勒岡及許多其它植物（桉樹 eucalyptus、迷迭香 rosemary、百里香 thyme）具有內建的機制來抵抗真菌攻擊。這些通常是以在植物汁液中的訊息分子 (messenger molecules) 的形式存在，能容易地揮發到周圍空氣中。如果植物受到真菌攻擊，它會釋放這些「揮發性有機化合物」 (volatile organic compounds, VOCs) 來警告周圍植物；周圍的植物接收到這些揮發性有機化合物後會啟動其固有的防禦反應 (natural defense responses)。

這種防禦機制是基於這些揮發性有機化合物如何與真菌細胞膜互相作用。在奧勒岡中

發現的百里酚 (thymol) 及香芹酚 (carvacrol)，被證實會從要形成細胞膜的脂質分子中竊取電子，導致細胞膜崩解。當奧勒岡精油應用到葡萄藤時，能減少真菌生長達 95%。奧勒岡亦被證實可以有效地保護玉米、番木瓜、胡瓜、南瓜、芒果以及番茄。

對於在商業上應用奧勒岡揮發性有機化合物於食品防腐引起了大家濃厚的興趣。在過往的數十年間，合成殺真菌劑已被用於防止食品腐敗。然而，這些合成化合物在土壤及地下水中不容易降解，並可能對多種生物有劇毒。另外，真菌可對合成殺真菌劑發展出抗性，使得需要使用更多的化學藥劑才會有效，最終帶來更嚴重的環境影響。從另一方面來看，從植物中提煉精油的危害性較低，因為它們不會長期殘留在土壤或水中，而且需要少量就有效。

現在有多家公司正進行將植物衍生 (plant-derived) 揮發性有機化合物結合到食品包裝上，作為合成防腐劑的替代品。這種創新可以為我們的食品系統帶來徹底的轉型，減少浪費以及對人類及環境帶來更少害處。

If you've ever opened your refrigerator to find that your fresh produce has turned into a mushy, moldy mess, then you're familiar with the destructive power of fungi. Without some sort of protection against such microorganisms, thousands of tons of fruits and vegetables would spoil and go to waste before they even made it to our grocery stores. Oregano has emerged as a source of potent plant-protection molecules, producing oils and vapors that prevent fungal infection and food spoilage.

As it turns out, oregano and a number of other plants (eucalyptus, rosemary, thyme) have built-in defense mechanisms to fight off fungal attacks. These are usually in the form of messenger molecules present in the plant's fluids that easily evaporate into the surrounding air. If one plant is attacked by a fungus, it will release these "volatile organic compounds" to alert surrounding plants; the reception of the VOCs will then initiate the surrounding plants' natural defense responses.

The mechanism of defense has to do with how these VOCs interact with fungal cell membranes. It has been shown that thymol and carvacrol, both found in oregano, steal electrons from the lipid molecules forming the cell membrane, causing the membranes to break apart. When applied to grapevines, oregano essential oils decreased fungal development by 95%. Oregano has also proven effective in protecting corn, papaya, cucumber, squash, mango, and tomato plants.

There is keen interest in using VOCs from oregano commercially for food preservation. In previous decades, synthetic fungicides have been used to prevent food spoilage. However, these synthetic compounds do not degrade easily in soil and groundwater, and can be toxic to a broad range of organisms. Furthermore, fungi can develop resistance to synthetic fungicides, requiring

even more of the chemicals to be applied to be effective, which in turn worsens environmental impacts. Essential oils extracted from plants, on the other hand, are much less harmful, since they do not remain in soil or water for long, and very low amounts are needed to be effective.

Several companies are now working on integrating plant-derived VOCs into food packaging, as an alternative to artificial preservatives. Such innovation could radically transform our food system, making it less wasteful and less harmful for both humans and the environment.

文獻引用 (REFERENCES)

「轉錄組學 (transcriptomic) 的數據清楚地顯示了該處理觸發了植株的先天免疫系統 (innate immune system)，其基因牽涉水楊酸 (salicylic acid)、茉莉酸 (jasmonic acid) 及乙烯 (ethylene) 生合成及訊號傳遞基因，活化病原菌相關蛋白質 (Pathogenesis-Related-proteins) 以及植物防禦素 (phytoalexin) 的生合成。這些結果首次闡明了精油-宿主-病原菌的互相作用，並顯示了精油的抗真菌效率主要是歸因於宿主植物內部抗性途徑的觸發。這對於生物農藥、植物刺激產品的生產及研究，以及抗性育種策略有非常大的重要性。」

"Transcriptomic data clearly showed that the treatment triggered the plant's innate immune system with genes involved in salicylic, jasmonic acid and ethylene synthesis and signaling, activating Pathogenesis-Related-proteins as well as phytoalexin synthesis. These results elucidate EO-host-pathogen interactions for the first time and indicate that the antifungal efficiency of EO is mainly due to the triggering of resistance pathways inside the host plants. This is of major importance for the production and research on biopesticides, plant stimulation products and for resistance-breeding strategies."

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延伸閱讀

生物系統延伸資訊連結 (LEARN MORE ABOUT THE LIVING SYSTEM/S)

https://en.wikipedia.org/wiki/origanum_vulgare
https://www.onezoom.org/life/@origanum_vulgare
https://eol.org/pages/579367

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AskNature 原文連結

https://asknature.org/strategy/chemicals-in-oregano-act-as-fungicide/