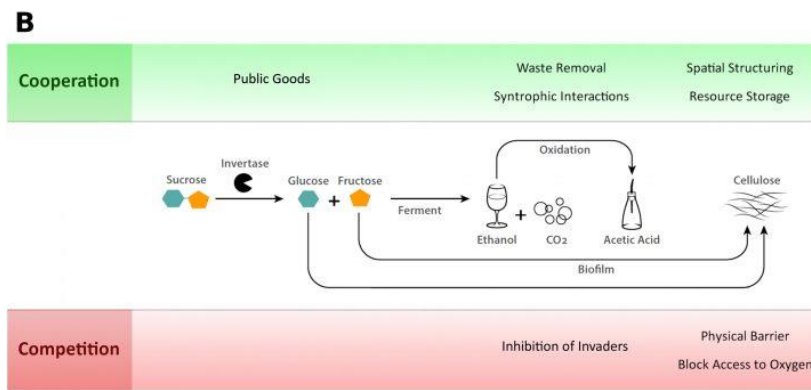
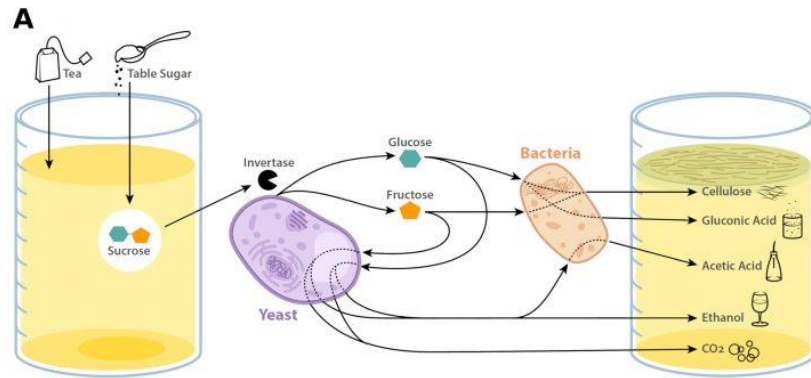


生物策略表

類別	生物策略 (Strategy)
生物策略 Strategy	康普茶：微生物的大都市 Kombucha: A Microbial Metropolis
生物系統 Living system	細菌 Bacteria
功能類別 FUNCTIONS	# 化學性組成有機化合物 # 維持群落系統協調 # 不同物種之間合作/競爭 # Chemically Assemble Organic Compounds # Coordinate Systems # Cooperate/Compete Between Different Species
作用機制標題	細菌和酵母形成一個群落，以確保他們的相互生存並生產發酵茶。(Bacteria and yeast form a community to ensure their mutual survival and produce fermented tea.)

生物系統/作用機制示意圖

(確認版權、註明出處；
畫質)



<https://asknature.org/strategy/kombucha-a-microbial-metropolis/>

作用機制摘要說明 (Summary of functioning mechanisms)

康普茶是一種微泡、酸甜、發酵的茶飲料，被認為是健康的（儘管臨床上未經證實）。2000多年前起源於東亞，近幾十年開始流行於西方。

但在另一個層面上，康普茶完全是另一回事。這是一個奇妙的多元文化微觀大都市。

康普茶是由（並繼續含有）細菌和酵母的共生培養物組成，通常縮寫為"SCOBY" (Symbiotic Culture of Bacteria and Yeast)。

為了製造新的一批康普茶（很像在製作酸麵團），人們將現有的康普茶的樣本放入加糖的茶中，提供微生物新的糖作為其食物來源。

To make a new batch of kombucha (much like making sourdough), people put a sample of existing kombucha into sweetened tea, giving the microorganisms a new supply of sugar to feed on.

首先，酵母是一種真菌，利用茶中的糖和營養素來生長。在這個過程中，稱為發酵，他們將碳轉化為二氧化碳氣體，產生嘶嘶聲，並產生副產物-酒精，通常會在其他發酵飲料中產生嗡嗡聲。

Introduction

Kombucha is a slightly bubbly, sweet-and-sour, fermented tea drink that is reputed (though clinically unproven) to be healthful. It originated in East Asia more than 2,000 years ago, but in recent decades has become popular in the West.

But on another level, kombucha is something else entirely. It's a marvelous multicultural microscopic metropolis.

Kombucha is made by (and continues to contain) a symbiotic culture of bacteria and yeast often abbreviated as "SCOBY."

The Strategy

過多的酒精可能對細菌和酵母有害，但對康普茶中的細菌不會。他們利用酒精生長，將其轉化為酸，像是醋酸，它讓康普茶有酸味。而酸又可以抑制那些可能對SCOBY和康普茶飲用者有害的競爭細菌的生長。

為了進一步阻止入侵者，細菌也會使用過量的糖來製造纖維素纖維——植物和樹作為結構材料的相同物質。纖維上升到茶的頂部，沉積成一個大的多層生物膜，稱為薄膜。薄膜是釀造康普茶頂部的橡膠狀層特徵。它常常被稱為SCOBY本身，因為它具有足夠的微生物做為新的康普茶的起始物（所以它的另一個名稱叫做"母親"）。

薄膜作為保護屏障，可以阻擋競爭對手也能防止微生物群落變乾。它甚至可以提供保護免於受到紫外線的傷害。細菌鑲嵌在這層漂浮的生物膜中，可以在茶的頂端附近持續獲取維持代謝所需的氧氣。

這些纖維素還可以作為細菌和酵母需要時將其轉為糖的物質倉庫。當酵母死亡時，他們又會釋放出可以被微生物群落回收的維生素和營養素。總而言之，康普茶中的各種微生物共存、合作並創造了一個營養循環和可以讓他們共存的物理結構。

First, the yeast, which are a type of fungi, use the sugars and nutrients in the tea to grow. In this process, called fermentation, they turn carbon into carbon dioxide gas, creating the fizz, and produce alcohol as a byproduct, which usually creates the buzz in other fermented drinks.

Too much alcohol can be harmful to bacteria and yeast, but the bacteria in kombucha get rid of it. They use alcohol to grow, converting it into acids, such as acetic acid (vinegar), which gives kombucha its sour taste. The acids in turn inhibit the growth of competing bacteria that could be harmful to both the SCOBY and the kombucha drinkers.

To deter invaders further, the bacteria also use excess sugars to make long, thin fibers of cellulose—the same substance that plants and trees use as structural material. The fibers rise to the top of the brew, depositing layers that glom into a big multilayered biofilm called a pellicle. The pellicle is the characteristic rubbery-looking layer on top of brewing kombucha. It's often simply referred to as "SCOBY" itself because it contains enough microorganisms to serve as a starter for new batches of kombucha (hence its other name, "mother").

The pellicle acts as a protective shield that blocks out competitors and keeps the microbial community from drying out. It may even offer protection from harmful ultraviolet rays. Embedded in this floating biofilm, the bacteria can maintain access to oxygen near the top of the brew that they need to do their metabolic business. The cellulose also serves as a storehouse of material that the bacteria and yeast can convert back to sugar when needed. When yeast die, they in turn release vitamins and nutrients that are recycled by the microbial community.

All in all, the various microorganisms in kombucha coexist and cooperate to create a cycle of nutrients and a physical structure that ensures their mutual survival.

文獻引用 (REFERENCES)

“康普茶是一種可能源自於滿洲的飲料，由幾種細菌和酵母菌組成的微生物聯合體從發酵製成。這種混合的聯合體形成了一種強大的共生體，能夠抑制潛在污染細菌的生長。由於某些醋桿菌屬菌株的作用，還導致發酵過程形成聚合纖維素薄膜。”

“康普茶是一種具有酸味和氣泡的發酵茶飲，由多物種微生物生態系統組成，具有複雜的相互作用，主要包括合作和衝突。...因此，康普茶可以作為一個用於解決有關不同多物種系統中合作和衝突演變的重要問題的模型系統。此外，它有可能被人為選擇用於特定的人類用途，包括開發抗菌生態系統和新材料。”

“Kombucha is a beverage of probable Manchurian origins obtained from fermented tea by a microbial consortium composed of several bacteria and yeasts. This mixed consortium forms a powerful symbiosis capable of inhibiting the growth of potentially contaminating bacteria. The fermentation process also leads to the formation of a polymeric cellulose pellicle due to the activity of certain strains of *Acetobacter* sp.”

(Journal of Food Science | March 6, 2018 | Silvia Alejandra Villarreal-Soto, Sandra Beaufort, Jalloul Bouajila, Jean-Pierre Souchard, and Patricia Taillandier)

“Kombucha, a fermented tea beverage with an acidic and effervescent taste, is composed of a multispecies microbial ecosystem with complex interactions that are characterized by both cooperation and conflict. ... Thus, kombucha can serve as a model system for addressing important questions about the evolution of cooperation and conflict in diverse multispecies systems. Further, it has the potential to be artificially selected to specialize it for particular human uses, including the development of antimicrobial ecosystems and novel materials.”

(PeerJ Life & Environment | Sept. 3, 2019 | Alexander May, Shrinath Narayanan, Joe Alcock, Arvind Varsan, Carlo Maley, and Athena Aktipis)

參考文獻清單與連結 (REFERENCE LIST) Harvard 或 APA 格式

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

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<https://asknature.org/strategy/kombucha-a-microbial-metropolis/>