Fungal Attraction: Introducing the BG-CO_2 Generator

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Abstract

Carbon dioxide (CO_2) is the most important long-range attractant for almost all haemophagic insects and is widely used in traps to collect host-seeking adult mosquitoes. However, CO_2 supply options are not readily available in some locations and currently available alternatives may prove cumbersome or even dangerous to the operator. Biogents AG has developed and tested the BG-CO_2 Generator, a standardized CO_2 source for 24 h applications based on ethanolic fermentation by *Saccharomyces cerevisiae*. The BG-CO_2 Generator can be supplied with a variety of locally sourced carbohydrates and water. Its output was quantified at 50-140 mL/min over the entirety of the intended runtime, yielding a total output of 230 g (roughly 120 liters) of CO_2 from 500 g of household sugar under laboratory conditions. Its performance was assessed in field studies, where it reached between 60 and 85% of the capture success mediated by 200 mL/min of pure CO_2 from a pressure cylinder.

Material & Methods

The BG-CO_2 Yeast Generator is based on a combination of different yeast strains and nutrients. When combined with water and sugar in a plastic fermentation container inside a thermo-insulated bag (Fig.1), the yeast mixture provides a steady flow of CO_2 for 24 hours. The produced CO_2 is released via a plastic tubing which is attached to the lid of the cultivation container. Cultures are prepared with 500 g of household sugar and 2000 mL of tempered tap water (38°C) to quickly prompt culture growth. All laboratory experiments were conducted at 30°C ambient temperature. Field experiments were performed at maximum temperatures of 36 °C at daytime and minimum temperatures of 8° C at nighttime.

Schematic depiction of the setup of the BG-CO_2 Generator. The culture container is filled with 2 liters of water and 500 g of household sugar and placed inside an insulation bag. The freeze-dried yeast starter culture is available under the brand name "BG-Powder".

Fig.1

The CO_2 production capability of the combined product and the individual strains were assessed gravimetrically. To make sure that culture weight losses were predominantly an effect of the CO_2 produced, these results were verified using a custom-built infrared cell CO_2 flow meter, which provided detailed production profiles. The BG-CO_2 Generator's effects on the capture efficacy of BG-Sentinel and BG-Pro traps were assessed in randomized Latin square design experiments near Regensburg, Southern Germany. The experiments were conducted in three semiurban or rural locations with known strong seasonal mosquito populations.

Results

CO_2 Production of the BG-CO_2 Generator

Figure 2 shows the volumes of CO_2 produced by different yeast strains over time, based on weight loss. The BG-CO_2 Powder's (indigo) near linear production profile is the result of a combination of three strains of *S. cerevisiae* with individual properties. Individual component strains (green, yellow and orange) of the BG-Powder either displayed extended lag phases, low metabolic base activity or insufficient ethanol tolerance resulting in low total CO_2 production. The BG-Powder's production profile observed suffered none of these drawbacks.

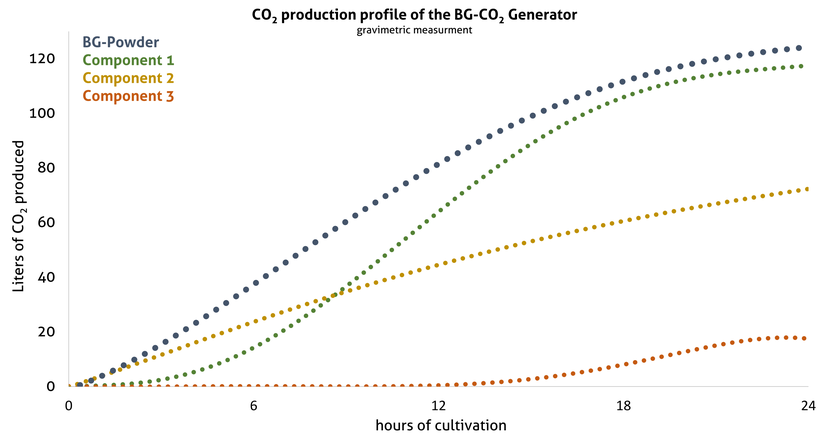

Fig.2

The gravimetric data concerning the amount of CO_2 produced were confirmed using the infrared cell measurement of a custom-built CO_2 flow meter. Figure 3 shows the production profile of the BG-CO_2 Generator over 24 hours. The BG-CO_2 Generator's CO_2 output's peak was reached after approximately 5 hours, slowly declining over the course of the intended runtime.

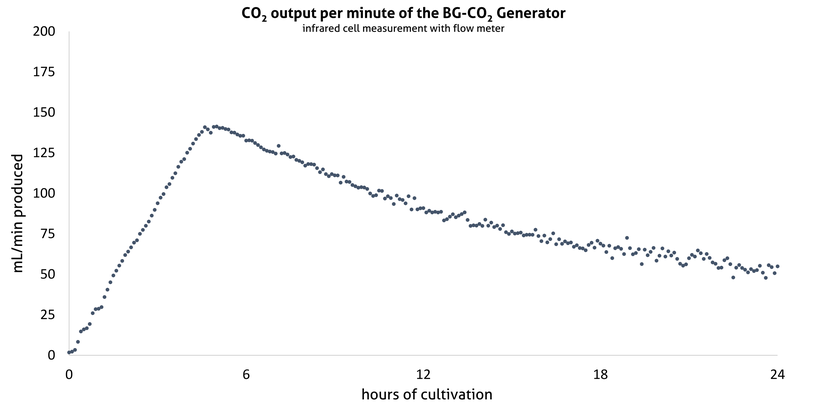

Fig.3

Both methods showed a prompt start of CO_2 production after the BG-CO_2 Generator's activation. A production of at least 50 mL/min was achieved after less than 2 hours and kept up until the end of the projected runtime. A maximum output with a peak performance of about 130 mL/min can be expected in the inital 12 hours of cultivation. During the cultivation, the BG-CO_2 Generator produced approximately 235 g of CO_2, equaling about 120 L of CO_2 released, from the 500 g of sucrose supplied to the culture.

Field test performance

In total, about 4000 mosquitoes were caught between mid of July until end of September 2020. In all three sites, the BG-CO_2 Generator captured between 60 and 85% of the number of mosquitoes caught with 200 mL/min of pure CO_2. No obvious impact of the trap system (BG-Sentinel or BG-Pro) was discernible. Figure 4 shows the average number of mosquitoes caught per day for each experiment. Considering the BG-CO_2 Generator's relatively low output of pure CO_2 (a maximum of 130 mL/min), it appears likely, that other semiochemicals produced by the culture have a synergistic attractive effect.

Fig.4

Conclusion

In field tests in a temperate environment, the BG-CO_2 Generator captured up to 85% of the number of mosquitoes caught with 200 mL/min of pure CO_2 from cylinders.

The BG-CO_2 Generator with its mix of yeast strains ("BG-CO_2 Powder") can provide a consistend CO_2 source for 24 hours. It is thus a cost-efficient and easily transportable alternative to CO_2 from dry ice or cylinders. The required additional ingredients (sugar and water) can be sourced locally.