OZONE VACUUM FUMIGATION AS A METHYL BROMIDE ALTERNATIVE FOR GREEN COFFEE

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Imported green coffee is the foundation for the roasting, blending, and brewing sectors of the Hawaii coffee industry. Together, they are valued at $116.7 million and provide about 500 jobs in the state. The amount and value of imported green coffee averaged 5.1 million pounds worth $6.6 million for the two year period ending in 2002. The 2002 wholesale and retail values of imported green coffee in Hawaii, which greatly increase after roasting and again after blending, were $18.1 million and $33.0 million, respectively, sold through retail marketing; and $25.1 million and $83.7, respectively, sold through food service marketing.

Green coffee imported into Hawaii must be fumigated with 48 mg/l methyl bromide (MB) for 8 h at ambient conditions to kill any infestations of coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari), and coffee leaf rust, *Hemileia vastatrix* Berk. & Br., two of the most destructive pests of coffee production worldwide not found in Hawaii.

The Hawaii coffee industry determined that the future of green coffee importation was at risk because of continued reductions in MB use following the Montreal Protocol and political attempts within the state to ban imported MB-fumigated green coffee. The loss of imported green coffee would translate into economic and job losses to the Hawaii coffee industry, including a unilateral destabilizing effect on the price of green Kona coffee because nearly half (≈500,000 kg) of the annual Kona coffee crop is purchased by roasters for blending. Reductions in green Kona coffee purchases by roasters/blenders directly impact the supply and demand equilibrium for growers. Therefore, the Hawaii coffee industry requested that ARS, in cooperation with the University of Hawaii, develop an alternative quarantine treatment to MB fumigation for imported green coffee.

Our goal is to develop ozone (O_3) vacuum fumigation as a MB alternative for green coffee under a Cooperative Research and Development Agreement between USDA and Cosmed Group, Inc., using PureOx® Sterilization and Fumigation Services O_3 technology and equipment. The use of O_3 as a MB alternative would be environmentally-friendly and can be certified as an organic treatment. In addition to Hawaii, Puerto Rico also fumigates imported green coffee with MB

for coffee berry borer, and green coffee is fumigated with MB by producing and importing countries for both coffee berry borer and stored product insect pests.

The O_3 fumigation parameters used were 10,000 ppm O_3 under –30.5 cm Hg of vacuum at 13±3°C for 6 h. Preliminary Cosmed Group data indicated these treatment parameters were more than adequate to control the target insect and plant pathogen pests. Fumigations were done in PureOx® commercial or experimental chambers for both cupping (coffee quality) and CBB mortality tests.

Preliminary cupping tests with Hawaii-grown coffee green beans included 'Yellow Caturra' and 'Red Catuai' from Maui and Molokai, respectively. Cupping tests with green coffee representing varieties imported into the U.S. included 'Kenyan', 'Ethiopian' and 'Sumatran'. Green coffees were fumigated and stored three or six weeks under industry conditions before the cupping tests to determine the combined effects of O_3 treatment and storage. Fumigated coffee was roasted and ground using standard industry practices, mixed with boiling water and served to trained coffee tasters in controlled sensory evaluation laboratories at University of Hawaii or at ARS-WRRC. A triangle test was used to determine significant differences in coffee quality, i.e., coffee aroma or flavor. Tests were replicated 3 times and results were analyzed using SAS PROC GLM.

Because CBB is a "brood" insect, all life stages were treated together in culture. This work was done at ARS-SVASC. Treated insects were held 3 days to observe larval, pupal or adult mortality, and 5 days to observe egg mortality.

Results of preliminary cupping tests with Hawaii-grown coffee in 6 tests were 9/19, 12/19, 7/19, 10/21, 5/21, and 8/21 correct identifications of the O_3-fumigated coffee in tests 1 through 6, respectively. With the exception of test 2 (Significant, $P = {}^{3}0.01$), there were no significant differences between the control and O_3-treated coffees. Results of the 'Kenyan', 'Ethiopian', and 'Sumatran' cupping tests showed no significant difference between control and O_3-treated coffees, whether stored at 3 or 6 weeks after fumigation.

Results of preliminary CBB mortality tests (3 replications) found no survival from 1,009 treated eggs, 116 first instars, 208 second instars, 232 pupae, and 3,085 adults, indicating that O^3 vacuum fumigation will control this quarantine pest.

Further CBB mortality tests are planned to determine the most treatment-tolerant life stage, and whether the O_3 concentration, vacuum or exposure time can be reduced. Confirmatory tests will be needed to provide quarantine security data. Additionally, mortality tests with coffee leaf rust must be initiated.