OZONE FUMIGATION TO CONTROL QUARANTINE PESTS IN GREEN COFFEE

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Importation of green coffee into Hawaii is the foundation for the roasting, blending, and brewing sectors of the Hawaii coffee industry, with 6 million pounds of green coffee valued at approximately $8.4 million imported in 2007. The wholesale and retail values of imported green coffee greatly increase after roasting, and again after blending with other roasted coffee beans. The 2007 wholesale and retail values for imported green coffee after roasting sold through retail marketing channels in Hawaii were in excess of $120 million. Additionally, this sector of the Hawaii coffee industry represents over 1,000 jobs in the state.

Green coffee imported into Hawaii must be fumigated before entry with methyl bromide (MB) at a rate of 48 mg/liter MB for 8 h to kill potential infestations of coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae), life stages and coffee leaf rust (CLR), *Hemileia vastatrix* Berkeley & Broome (Basidiomycota: Pucciniales), urediniospores. CBB and CLR are two of the most destructive pests of coffee production worldwide and are found in all coffee producing areas except the Hawaiian Islands and Queensland, Australia. Although MB for phytosanitary use is protected under the Montreal Protocol, MB fumigation of green coffee may become severely restricted and/or prohibitively expensive in the future, therefore alternatives to MB fumigation are needed. Additionally, the market for organic coffees is growing rapidly.

From 2000 - 2008, ARS studied fumigation with ozone gas (O_3) under vacuum as a MB alternative against CBB eggs, larvae, pupae, and adults and CLR urediniospores (*syn*. uredospores). Research included coffee quality studies to determine the effects of O_3 fumigation on flavor and aroma, a pest-risk analysis to determine the impact of coffee processing on CBB survival, studies to determine the affect of green coffee moisture content on CBB survival and reproduction, and O_3 fumigation efficacy tests against CBB life stages and CLR urediniospores. We report here the results of these studies, which include:

1. The results of our risk analysis studies agree with the literature that coffee processing eliminates CBB from coffee. The results further agree with the

literature that, although flotation, soaking, and removal of skin and pulp may reduce the numbers of infested coffee berries, the results demonstrated that the mechanical- or sun-drying methods used internationally to dry coffee to the green stage at 9-12% MC are the only step in coffee processing responsible for eliminating CBB. Moreover, the risk analysis shows that green coffee should be free of CBB infestations. Therefore, the CBB issue of concern for green coffee is potential adult CBB hitchhikers.

2. The results of studies on the effect of coffee moisture content on CBB corroborated the preponderance of literature that CBB is a field pest and not a stored product pest because CBB cannot survive or reproduce on green coffee at the international standard of 9-12% moisture content. Therefore, the CBB issue of concern is eliminating any CBB adult hitchhikers that may be in the green coffee or coffee bag material.

3. The results of O_3 fumigation efficacy tests with CBB demonstrated that fumigation with 10,000 ppm O_3 gas under -32 mm Hg vacuum at 13.0 ± 3.0°C for 6.0 h killed all CBB larvae, pupae, and adults, but did not kill all CBB eggs. However, because the drying methods used in coffee processing eliminate CBB from coffee, and because CBB cannot survive or reproduce in green coffee with a 9-12% moisture content, adult CBB hitchhikers would be the only life stage encountered in green coffee, and they would be eliminated by O_3 fumigation. The combination of drying methods used in coffee processing, maintaining green coffee MC at 9-12%, and fumigation with 10,000 ppm O_3 gas under -32 mm Hg vacuum at 13.0 ± 3.0°C for 6.0 h is a systems approach.

4. The results of O_3 fumigation efficacy tests with CLR urediniospores demonstrated that fumigation with 10,000 ppm O_3 gas under -32 mm Hg vacuum at 13.0 ± 3.0°C killed all urediniospores within 1 h. Therefore, the O_3 fumigation at 6 h for CBB is more than adequate to ensure quarantine security against CLR urediniospores.\

5. The results of coffee quality studies demonstrated that fumigation with 10,000 ppm O_3 gas under -32 mm Hg vacuum at 13.0 ± 3.0°C for 6.0 h did not adversely affect coffee flavor or aroma, the two most important organoleptic properties of brewed coffee.

Based on the results of our research, fumigation with 10,000 ppm O_3 under -32 mm Hg vacuum at 13.0 ± 3.0°C for 6.0 h is recommended as an efficacious quarantine treatment for green coffee against any CLR urediniospores and CBB larvae, pupae and adults. For CBB, O_3 fumigation is part of a systems approach to eliminate any potential CBB that includes: (1) elimination of CBB life stages by the drying methods used during standard processing of coffee, (2) reduction of moisture content to the 9-12% international standard for green coffee, and (3) O_3 fumigation to ensure quarantine security.