# FOOD GRADE COATING USE TO PREVENT MITE INFESTIONS IN DRY CURED HAM PRODUCTION

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Ham mites, *Tyrophagus putrescentiae* (Schrank), also known as the cheese mite or mold mite is the predominant target pest for dry cured ham. Ham mites are frequently found in a wide variety of stored food products, particularly those with high fat and protein contents, such as hams, dried eggs, bacon, flour, herring meal, cheese, and different kinds of nuts. Ham mites feed on the surface of dry cured meat and follow the seams between muscles to the interior of the hams. A female can produce up to 800 eggs in her lifetime, deposit these on the surface of the hams and elsewhere in a building, and can develop from egg to adult in as few as 10 days during the summer months (Townsend, 2007). Methyl bromide has been used by dry cured ham processing plants to control and prevent the infestation of ham mites, ham beetles, cheese skippers and dermestid beetles for greater than 50 years (EPA, 2006). There are at least 35 dry cured ham plants in Kentucky, Missouri, North Carolina, Virginia, Tennessee, and Georgia, and 22 of them used methyl bromide as a fumigant between one to 5 times a year according to the severity of infestation prior to 2008 (Rentfrow *et al*., 2008). This reveals the critical importance of methyl bromide fumigation for the dry cured ham industry, which leads to the necessity of research for alternatives to replace methyl bromide to control mite infestations.

Food grade coatings have been used on a variety of food products, such as, candies, fresh fruits, vegetables and processed meats to enhance appearance, texture, stability or quality and reduce water loss (Baldwin, 2007). For dry cured hams, at least 18% of the original ham weight must be lost during the production process (USDA, 1999). Zhao *et al.* (2014) developed food grade coatings that prevented ham mite infestations under laboratory conditions. Recent research has been conducted to test the application of these coatings in commercial ham plants to evaluate their effects on the sensory quality of the hams. For some plants during the first trial (submerging the whole ham in a coating, aging for 2 - 6 months), the hams that were treated with coatings did not differ ($P>0.05$) in sensory properties when compared to control hams. Coated hams were rated slightly to moderately different ($P<0.05$) from the control hams in other plants with respect to sensory perception, but all hams were excellent quality (Zhao e*t al.*, 2015). The second trial was conducted in August 2015 by spraying with a paint gun for convenience of application and to decrease application costs. Sensory evaluation will be conducted on these hams in the spring of 2016 after 3-6 months of aging has taken place.

Whole hams treated with coatings were inoculated with 900 mites after 6 weeks and 12 weeks of aging for mite residency observations at 6 hours after inoculation. Hams treated with carrageenan coatings had an average of 2 mites per sampled ham surface after 24 hours of infestation, and after 12 weeks there were no countable mites sampled from the coated hams and an average of 35 mites on untreated control hams (Zhao *et al.*, 2014). Propylene glycol (1, 2-propanediol) is commercially synthesized from propylene oxide and is the limiting cost factor for the production of these ham coatings, at approximately $ 4.60/liter. *Lactobacillus, pediococcus,* and *micrococcus* have been used as commercial starter cultures to develop flavor and extend shelf life through the production of lactic acid. *Lactobacillus buchneri* can degrade lactic acid to acetic acid and 1,2 –propanediol under anaerobic conditions through silage fermentation (Oude *et al.,* 2001). To decrease formulation costs, additional research has focused on using lactic acid bacteria to produce 1,2-propanediol in ham coatings as a means to prevent mite infestations. Currently, the greatest challenge in this process is to maintain bacterial growth in oxygen permeable coatings due to the anaerobic nature of the bacterial strains.

Phillips and Abbar (2015) reported that 1,3- propanediol (1, 3 PD) was effective at controlling mites under laboratory conditions. Members of the Lactobacillaceae family (GRAS organisms known commonly as "lactic acid bacteria") convert glycerol to 1,3-PD, which can be safely used for food applications, cosmetic and health care (Vaidyanathan *et al.,* 2011). *Lactobacillus reuteri* produces small amounts of 1,3-propanediol when producing the antimicrobial reuterin (Talarico and Dobrogosz, 1990); *Lactobacillus diolivorans* can be used for the industrial production of 1,3-propanediol from glycerol (Pflugl *et al.,* 2012). Research is being conducted to screen *Lactobacillus* strains for their efficacy at naturally producing 1,3 PD on the ham surface in current coatings. Mold growth in ham aging houses is common. There are species of *Penicillium* that do not produce toxins and are favorable for mold growth, which also attract mites and lead to infestations, such as *Penicillium expansum* and *P. roqueforti* (Racovitza, 1969). Some lactic acid bacteria strains (e.g. *Lactobacillus plantarum*) have the potential to suppress yeast and mold growth (Schillinger and Villareal, 2010). Thus, the mold inhibiting effects of lactic acid bacteria strains will also be investigated during 1,3-propanediol production research through fermentation.

References:

Baldwin, E. A. (2007). Surface Treatments and edible coatings in food preservation. *Handbook of Food Preservation, Second Edition* (pp. 477-507): CRC Press.

Oude-Elferink, S. J.W.H, Krooneman, J., Gottschal, J. C., Spoelsra, S.F., Faber, F. and Driehuis, F. 2001 Anaerobic conversion of lactic acid to acetic acid and 1,2-propanediol by *Lactobacillus buchneri*. Applied and Environmental Microbiology. 67 (1) 125-132.

Pflugl, S., Marx, H., Mattanovich, D., Sauer, M. (2012). 1,3-propanediol production from glycerol with *Lactobacillus diolivorans*. Bioresour Technology 119:133-40.

Phillips, T. W.,Abbar, S. (2015). Personal communications.

Raacovtiza, A. (1969). The influence of various molds on the multiplication of some Mycophagus mites. Journal of General Microbiology. 57: 379-381.

Rentfrow, G., Hanson, D.J., Schilling, M.W., Mikel, W.B. (2008). The use of methyl bromide to control insects in country hams in the Southeastern United States. Extension Publication. University of Kentucky Extension/National Country Ham Association. Publication # ASC-171.

Schillinger, U., Villareal, J. V. (2010). Inhibition of Penicillium nordicum in MRS medium by lactic acid bacteria isolated from foods. Food Control 21:107-111

Talarico, T.L., Dobrogosz, W.J. (1990). Purification and characterization of glycerol dehydratase from *Lactobacillus reuteri*. Applied Environmental Microbiology. 56, 1195-1197

Townsend, L.H. (2007). Protecting home-Cured meat from insects and mites. Department of Entomology, University of Kentucky College of Agriculture, S-225 Agricultural Science Center North, Lexington, KY 40546-0091.

United States Environmental Protection Agency. (2006). Final Rulemaking: The 2006 Critical Use Exemption from the Phase-out of Methyl Bromide. January 30th. http://www.epa.gov/spdpublc/mbr/.

USDA. (1999). "Country ham", Country style Ham", "Dry Cured Ham", "Country Pork Shoulder", "Country Style Pork Shoulder", and "Dry Cured Pork Shoulder" (Meat and Poultry Inspection Regulations).

Vaidyanathan, H., Kandasamy, V. Ramakrishnan, G., Ramachandran, K-B., Jayaraman, G., and Ramalingam, S. (2011). Glycerol conversion to 1,3-propanediol is enhanced by the expression of a heterologous alcohol dehydrogenase gene *in Lactobacillus reuteri*. AMB Express. 1, 37.

Zhao Y., Phillips T., Abbar S., Schilling M. (2014). Development of food grade coatings to control mite infestation on dry cured ham. Annual International Research Conference on Methyl Bromide Alternatives and Emission Reduction, Orlando, FL, November 4$^{th}$ – 6$^{th}$.

Zhao, Y., Abbar, S., Campbell, Y., Phillips, T., and Schilling, M. (2015). Tools for preventing and controlling ham mite infestations. National Country Ham Association Annual Meeting, Raleigh, NC, April 23$^{rd}$-26$^{th}$.