Development of Food Grade Coatings to Prevent Mite Infestation on Dry Cured Ham

Y. Zhao[1], S. Abbar[2], T.W. Phillips[2], M.W.Schilling[1*]

[1]Department of Food Science, Nutrition and Health Promotion, Mississippi State University, Mississippi State, MS

[2]Department of Entomology, Kansas State University, Manhattan, KS

Tyrophagus putrescentiae (Schrank), also known as the mold or cheese mite, is a cosmopolitan pest that infests high-moisture grains and stored food products that have high fat and protein contents (Gulati and Mathur, 1995), including dry-cured ham. A female can lay an average of 437 eggs under favorable temperatures and 90-100% relative humidity (Rodriguez and Rodriguez, 1987). At 60%-80% relative humidity and 20-30 C, the mold mite can complete one generation in 8 to 21 days. Dry-cured ham is very susceptible to mite infestations after 4-6 months of aging due to its high fat and protein content and its moldy surface. Mold mites have been reported as a problem for dry-cured ham both in Spain (Sánchez-Ramos and Castañera, 2000) and the United States (Rentfrow et al., 2008). A survey of 34 dry cured ham plants in the United States revealed that 22 of the plants surveyed used methyl bromide fumigation between one to five times a year, a number that was determined based on the number of times that hams were infested with mites during the year (Rentfrow et al., 2008). This demonstrates that methyl bromide fumigation is important to the economic viability of the dry cured ham industry, which justifies the need for research on alternative methods to methyl bromide fumigation to prevent and control mite infestations.

Edible coatings have been applied for different purposes on a variety of food products including fresh fruits and vegetables, confections and meat products. For meat products, edible films and protective coatings have been used to prevent off-flavor due to oxidation, discoloration, quality loss such as shrinkage, and microbial contamination (Ustunol, 2009). Edible coatings may be used to control ham mite infestations if they do not negatively affect flavor and the aging process and are effective at controlling mites. Previous study on dipping ham slices/cubes directly into mineral oil, propylene glycol, 10% potassium sorbate, glycerin, and hot lard indicated that both lard and propylene glycol were effective ($P<0.05$) at controlling mite reproduction under laboratory conditions. However, lard is not permeable to moisture and oxygen. In addition, no differences were detected in sensory characteristics between hams treated with food grade ingredients and non-treated control hams (Zhao et al., 2012). Follow-up studies were carried out to study the effect of propylene glycol based coatings on mite mortality.

In order to reduce the cost of the food grade coating by minimizing the amount of propylene glycol, polysaccharides were used to form uniform and consistent film coatings on the surface of ham cubes. Xanthan gum, agar, propylene glycol alginate, and carrageenan+propylene glycol alginate were tested by using proprietary formulations with water and 50% (w/w) of propylene glycol. Coatings were applied by dipping the cubes into the gel solutions. Twenty large (mostly adult female) mites were placed on each cube of ham, and the cube was placed in a mite-proof, ventilated glass container and incubated for 2 weeks. All treatments with 50% PG were effective at controlling mite reproduction. To further investigate the minimum propylene glycol needed to control mite infestations, 10%-50% (w/w) propylene glycol were tested further with xanthan gum and carrageenan + propylene glycol alginate to due to their film-forming abilities at various concentrations of propylene glycol. Results demonstrated that xanthan gum+20% propylene glycol and carrageenan/propylene glycol alginate+10% propylene glycol were the lowest concentrations of propylene glycol that were effective at controlling mite reproduction on ham cubes.

American dry cured ham products need to lose at least 18% of their original weight during the production process. Therefore, the water vapor permeability (WVP) of the film coatings must be considered when choosing a proper coating for dry cured ham. WVP of films formed with carrageenan/propylene glycol alginate + 0-50% propylene glycol and xanthan gum + 10-50% propylene glycol were carried out by ASTM method E96-95(1995) with some modifications (Ghanbarzadeh et al., 2011). For films made from xanthan gum, the WVP range was from 1.17×10^{-7} gPa^{-1} $h^{-1}m^{-1}$ to 1.84×10^{-7} gPa^{-1} $h^{-1}m^{-1}$ as the amount of propylene glycol increased from 10% to 50% in the gel solution. For films made from carrageenan/propylene glycol alginate, the WVP range was from 2.08×10^{-7} gPa^{-1} $h^{-1}m^{-1}$ to 3.6×10^{-7} gPa^{-1} $h^{-1}m^{-1}$ as the amount of propylene glycol increased from 0% to 50% in the gel solution. For a 0.045mm thick film made from carrageenan/propylene glycol alginate+50% propylene glycol, about 24g of water vapor is able to penetrate through a one square meter area at room temperature per hour. Weight loss of whole hams coated with 100% propylene glycol, 50% propylene glycol, 2% carrageenan+50% propylene glycol, hot lard dip, and diatomaceous earth were studied after hams were treated for 48 days. Compared with control hams which lost 7.4% of its total weight, hams coated with 2% carrageenan+50% propylene glycol lost 6.4% of its total weight. In addition, both ham treatments lost greater than 18 % of moisture during the entire aging process.

Results indicate that xanthan gum and carrageenan+ propylene glycol alginate can be effective at preventing mite infestations. Therefore current research, is being conducted on scaling up these coatings to both experimental (mite inoculated hams) and commercial treatment (natural conditions) of whole dry cured hams.

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