RELATIVE HUMIDITY AND TEMPERATURE EFFECTS ON MITE INFESTATIONS ON CHEDDAR CHEESE

Kavitha Krishnan[1], Virell To[1], Gisele Lima[1], Michael Byron[1], Xue Zhang[1], Jasmine Hendrix[1], Yan Campbell[1], Wenjie Shao[1], Christine Cord[1], Courtney Crist[1], Thomas Phillips[2], Wes Schilling[1*]

[1]Department of Food Science, Nutrition and Health Promotion, Mississippi State University, Mississippi State, MS [2]Department of Entomology, Kansans State University, Manhattan, KS

Recent studies demonstrated that food grade ingredient infused nets were effective at controlling *Tyrophagus putrescentiae* (Schrank), commonly referred to as the ham mite, infestations on dry cured ham cubes at temperatures between 24 and 32°C and 55 to 85% relative humidity (RH; Campbell et al., 2017; Zhang et al., 2017; Hendrix et al., 2018). *Tyrophagus putrescentiae* also infests cave aged Cheddar cheese (Carvalho et al., 2018), which is commonly aged at 10-20°C and 75-85% RH. Therefore, this research was conducted to evaluate the effects of using food grade coatings on aged Cheddar cheese as either a surface coating or in nets to control mite growth at 10°C, 15°C and 20°C and 75 and 85% RH. An additional objective of this research was to evaluate the impact of coatings and treated nets on the sensory perception of aged Cheddar cheese at the temperature and RH combinations listed above.

Food grade coating formulations containing 1) xanthan gum (XG) and propylene glycol (PG) and 2) carrageenan (CG), propylene glycol alginate (PGA), and PG were made and infused into ham nets. Control nets without infused coatings were also used. Cave aged Cheddar cheese cubes (2.5 cm × 2.5 cm × 2.5 cm) were either dipped in coatings or wrapped in infused nets, prior to placing them in 216 mL glass jars (n = 4 per treatment). Each cheese cube was inoculated with 20 adult mites. Jars were stored in an environmental chamber for 14 days at temperature and RH combinations of 10, 15, and 20°C and 75±2 and 85±2% RH. Mobile mites on Cheddar cheese cubes and nets were counted using a microscope to determine mite reproduction. Difference from control sensory tests were conducted to determine whether coating, temperature, and RH impacted the sensory properties of non-inoculated cheese. Tukey's HSD test was used to separate treatment means ($P<0.05$).

When averaged over RH, mite counts were fewer ($P<0.05$) on control cheese cubes at 10°C when compared to 15°C and 20°C, regardless of whether nets were used or not. These results indicate that keeping the temperature low, at 10°C, had a greater impact on mite control than adjusting RH. However, mites were still able to reproduce on untreated cheese cubes at any temperature tested.

The CG + PGA + PG coatings controlled mite reproduction, as evidenced by harboring fewer than the initial inoculation level of 20 mites. When averaged over

RH, mite counts for CG + PGA + PG treated nets were fewer ($P<0.05$) on cheese cubes at 20°C than at 10°C, but no differences existed ($P>0.05$) between the 15°C and 20°C treatments. When averaged over temperature, mite counts were fewer ($P<0.05$) at 85% RH when compared to 75% RH for both coatings and CG + PGA + PG nets. Regardless of temperature and RH combination, the CG + PGA + PG coating was effective at controlling mites since mean counts ranged from 2 to 8, which were all fewer than the initial inoculation level of 20 mites.

When averaged over RH, mite counts were fewer ($P<0.05$) on cheese cubes with both XG + PG coatings and nets at 15°C and 20°C than at 10°C, and mite counts did not differ ($P>0.05$) between the 15°C and 20°C treatments. When averaged over temperature, mite counts were fewer ($P<0.05$) at 85% RH than 75% RH. In addition, regardless of temperature and RH combination, the XG + PG coating was effective at controlling mites since mean counts ranged from 1 to 8, which were less than the initial inoculum level of 20 mites.

Sensory results indicated that CG + PGA + PG and XG + PG coated Cheddar cheese at 10°C and 75% RH did not differ ($P>0.05$) from the control with respect to sensory attributes. In addition, use of CG + PGA + PG and XG + PG net treatments at 10°C and 75% RH and 15°C and 75% RH also did not cause differences ($P>0.05$) in sensory attributes. The 15°C and 85% RH and all 20°C treatments caused differences ($P<0.05$) in sensory perception that were described as slightly bitter and softer than control cheese cubes, with the 20°C and 85% RH treatment exhibiting the strongest bitter flavor.

In conclusion, the reproduction of *T. putrescentiae* was not controlled on Cheddar cheese cubes (2.5 cm × 2.5 cm × 2.5 cm) with no coating and with control nets at any temperature and RH combination. However, storage of cubes at 10°C at both 75% RH and 85% RH slowed down mite growth, indicating that aging cheese at 10°C or less can help minimize mite growth. The CG + PGA + 40% PG and XG + 40% PG treatments for both coatings and nets inhibited the growth of mites. Further research is needed to develop methods to incorporate PG into a system to inhibit mite reproduction on cave aged Cheddar cheese during aging without impacting the sensory properties of the Cheddar cheese.

References

Campbell, Y. L., Zhao, Y., Zhang, X., Abbar, S., Phillips, T. W., Schilling, M. W. (2017). Mite control and sensory evaluations of dry-cured hams with food-grade coatings. *Meat and Muscle Biology*, *1*, 100–108.

Carvalho, M. M., Oliveira, E. E., Matioli, A. L., Ferreira, C. L. L., Machado da Silva, N., De Dea Lindner, J. (2018). Stored products mites in cheese ripening: Health aspects, technological and regulatory challenges in Brazil. *Journal of Stored Products Research*, *76*, 116–121.

Hendrix, J. D., Zhang, X., Campbell, Y. L., Zhang, L., Siberio, L., Leick, C., Silva, J. L., Goddard, J., Kim, T., Phillips, T. W., Schilling, M. W. (2018). Effects of temperature, relative humidity, and protective netting on *Tyrophagus putrescentiae* (Schrank) (Sarcoptiformes : Acaridae) infestation , fungal growth, and product quality of dry cured hams. *Journal of Stored Products Research*, *77*, 211–218.

Zhang, X., Campbell, Y. L., Phillips, T. W., Abbar, S. (2017). Application of food-grade ingredients to nets for dry cured hams to control mite infestations. *Meat and Muscle Biology*. 1, 53-60.