

# **Innovative Packaging Technologies To Enhance the Safety and The Quality of Fresh Raspberry**

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The goal of this project is to develop innovative packaging systems for fresh raspberry and other fruit to enhance quality and safety, and to extend shelf-life for the small grower. We are developing a science-based approach to extend the shelf life of fresh raspberry, and other small fruit using packaging as a delivery system to minimize microbial contamination through the controlled release of natural antimicrobials, and to extend shelf life using modified atmosphere packages (MAP).

The major postharvest pathogen of raspberry is *Botrytis cinerea*, the causal agent of gray mold disease. Essential oils (EO) from common herbs such as thyme and oregano have been known for centuries to have anti-microbial activity, and are generally regarded as safe (GRAS). The problem with using them is that they are volatile and difficult to handle. We solved this problem by incorporating the EO's into controlled release packaging (CRP) that releases the active compounds at differentiable rates suitable for short-term or intermediate-term inhibition of microorganisms in fresh fruits. For our delivery system, we encapsulated the EO's into cyclodextrin (CD), which stabilizes them, and then we wrap these capsules into a Tyvek™ sachet, which can be placed inside the packaging. CRP can prolong shelf life without overloading the fruit with additives and can continually replenish the active compounds from the packaging to maintain freshness of the fruit. When the fruit release water vapor naturally inside the package, the water vapor displaces the EO from the sachet, attached to the bottom of the package, into the package and the fruit, so the EO can inhibit the growth of microorganisms.

In table 1 are our results from last summer's raspberry experiment. We picked fresh raspberries from a commercial farm in Milford, NJ and cooled the fruit to 5°C when we got back to the lab. Fruit were placed in 6 oz clamshell packages with sachets that contained either food grade thyme (*Thymus vulgaris*) essential oil encapsulated in cyclodextrin, or cyclodextrin alone as a control. We used 12 clamshells/treatment. Each of the above treatments were either packaged in a commercially available MAP bag designed to maintain a low oxygen, high carbon dioxide atmosphere inside the package, to lower the respiration rate of the fruit and inhibit the growth of microbial organisms, or the clamshells were simply placed in open cardboard shipping boxes. The raspberries were stored at 1°C for 5 days, followed by 1 day at 10°C to simulate storage on a supermarket shelf. We evaluated weight loss of fruit, disease incidence, soluble solid (TSS), anthocyanin and fruit firmness, before and after cold and supermarket shelf storage.

Table 1. Effects of thyme oil (TO) sachets and MAP bags on raspberry fruit quality after 5 d storage at 1°C<sup>a</sup>

Treatment	Disease Incidence (%)	Change in wt (% initial wt)	Firmness (N/cm <sup>2</sup> )	TSS (° Brix)	Anthocyanin (mg/100 g)
-TO +MAP	13.8 a	99.8 a	1.7 b	10.6 a	57 a
+TO +MAP	3.9 b	99.2 a	2.8 b	11.2 a	65.7 a
-TO -MAP	10.5 a	97.7 b	5.4 a	10.2 b	63.3 a
+TO -MAP	16.5 a	97.8 b	3.7 b	11.1 a	57.7 a
Initial			3.9 b	11.9 a	59.6 a

<sup>a</sup> Means in the same column with the same letter are not significantly different ( $P \leq 0.05$ ).

Table 2. Effects of thyme oil (TO) sachets and MAP bags on raspberry fruit quality after 5 d storage at 1°C and 2 days at 10°C<sup>a</sup>

Treatment	Disease Incidence (%)	Change in wt (% initial wt)	Firmness (N/cm <sup>2</sup> )	TSS (° Brix)	Anthocyanin (mg/100 g)
-TO +MAP	27.8 a	97.9 a	3.8 a	10.8 a	59.1 a
+TO +MAP	15.5 b	97.3 b	3.5 a	11.3 a	52 a
-TO -MAP	22.6 ab	96.0 c	0.8 b	11.2 a	41.6 b
+TO -MAP	26.8 a	95.9 c	1.3 b	10.5 b	44.4 a
Initial			3.9 a	11.9 a	59.6 a

<sup>a</sup> Means in the same column with the same letter are not significantly different ( $P \leq 0.05$ ).

The results demonstrate the effectiveness of thyme oil sachets when combined with MAP to reduce disease incidence and maintain the fresh quality of raspberries during storage and initial placement on supermarket shelves.