Controlling Antimicrobial Activity in Orange Juice Using Orange Oil Nanoemulsions

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Introduction

Applications of nanotechnology in the food industry have expanded since the early 2000s, such as improving taste and flavor in foods, increasing the bioavailability of functional foods, innovating food packaging materials, and developing natural food antimicrobials. Among the applications, nanoemulsions are representative examples of developing antimicrobial systems. Plant essential oils are rich in bio-active compounds that have been shown to act as natural preservatives in food products. However, many studies have only tested the antimicrobial activity of essential oil nanoemulsion in beverages, but little research has been done on the product quality effects of adding nanoemulsions to food products.

Objectives

- Determining stable formulation of orange oil in water nanoemulsion compatible to orange juice's shelf life
- Determining optimal concentration of orange oil nanoemulsions for effective antimicrobial properties in orange juice.
- Can orange oil nanoemulsion-blended orange juice maintain consumer acceptance over storage time?

Results

The orange oil nanoemulsion was made using water (continuous phase), orange oil with ester gum (dispersed phase), q-Naturale® (emulsifier). The coarse emulsion was made by a sheer homogenizer at 6000 rpm for 2 mins, and the coarse emulsion was passed through a Microfluidizer at 22000 psi for 5 times to make the nanoemulsion. The Dynamic Light Scattering indicated that the orange oil nanoemulsion can maintain particle size less than 200 nm for more than two weeks (Figure 1), validating the formation of a nanoemulsion. The stability of this nanoemulsion also allowed it to be an ingredient in orange juice which normally has a shelf life of one month

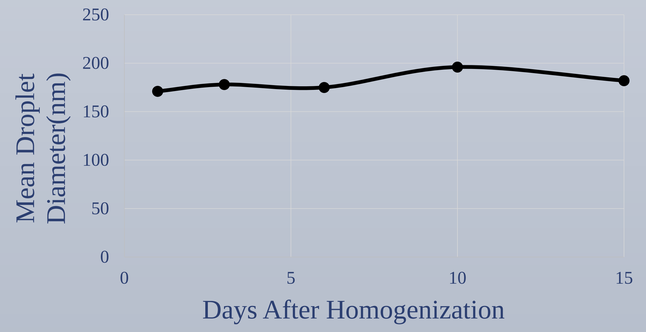

Figure 1. Mean droplet diameter of the orange oil nanoemulsion over 15 days

Different concentrations of nanoemulsion were then added to a yeast growth media to test its antimicrobial ability. The yeast growth media with nanoemulsion were incubated at 37 °C for 18 hours. The optical density of the different media were measured at 600 nm. The experiment indicated that an orange oil nanoemulsion concentration of greater than 1250 ppm had the anti-yeast effect (Figure 2).

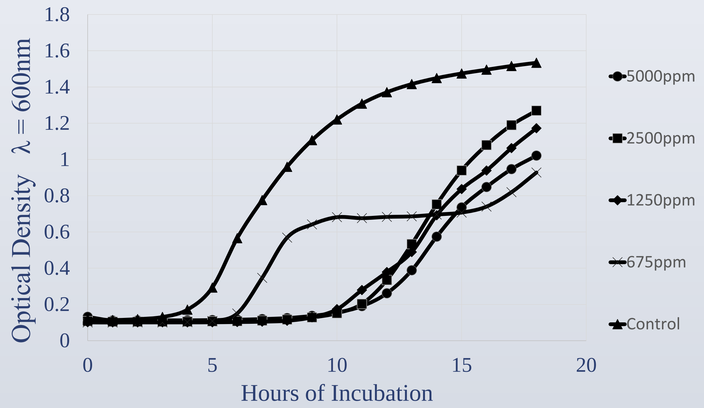

Figure 2. Eighteen hours of incubating *C.Albians* in yeast growth media containing different concentrations of orange oil nanoemulsion

Having confirmed the anti-yeast property of the orange oil nanoemulsion, the nanoemulsion was added to orange juice product to examine the anti-yeast property in product. Five colony forming units of Candida albians (yeast) were inoculated to the juice product, and the juice was incubated at room temperature for 7 days to examine yeast growth. The results showed that orange oil nanoemulsion can control the yeast-growth in juice product similar to the growth media environment (Figure 3).

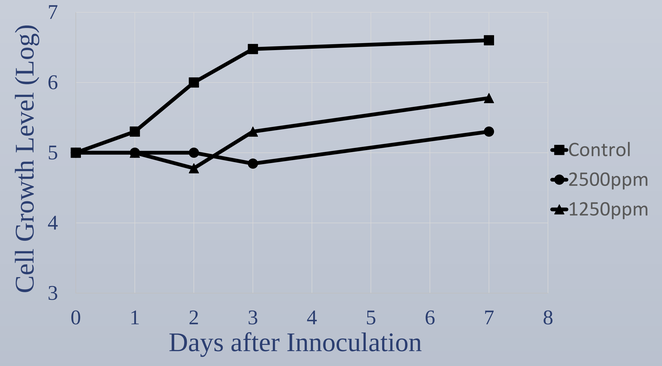

Figure 3. *C. Albians* growth curve in orange juice with orange oil nanoemulsion blended in two concentrations.

Fifty seven participants aged from 18 to 80 participated in a sensory study of orange juice. The liking of each sample was recorded for each juice and showed in Figure 4. The freshly made juice had no significant difference ($\alpha = 0.95$) between the controlled sample and the oil-added sample. However, for the 7 days and 14 days storage samples, the oil-added samples were significantly ($\alpha = 0.95$) more liked than the controlled samples.

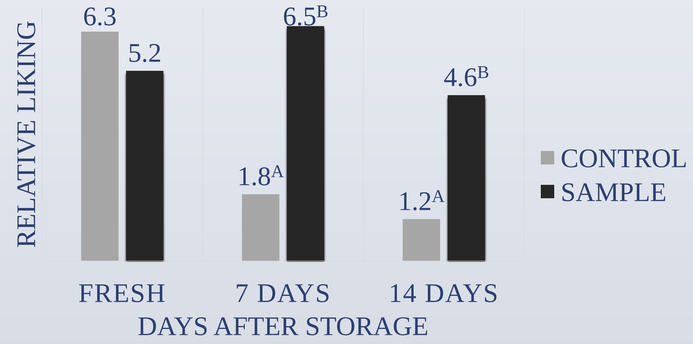

Figure 4. Relative liking of the control and sample products of fresh, 7 days after storage, and 14 days after storage. a and b indicates the significantly different value ($p < 0.05$).

Conclusion

- The orange oil nanoemulsion maintained an average particle diameter less than 200 nm for 15 days.
- 2500 ppm orange oil in water nanoemulsion showed bacteriostatic effects to *Candida albicans* in orange juice product for 10 days.
- An effective formulation of orange oil nanoemulsions can be used as natural antimicrobial ingredient for commercial orange juice product with a negligible effect on consumer acceptance for fresh product.

References

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