

# Microencapsulation of Nicotine for Tobaccoless Oral Administration

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**Advanced Delivery Science**



# Outline

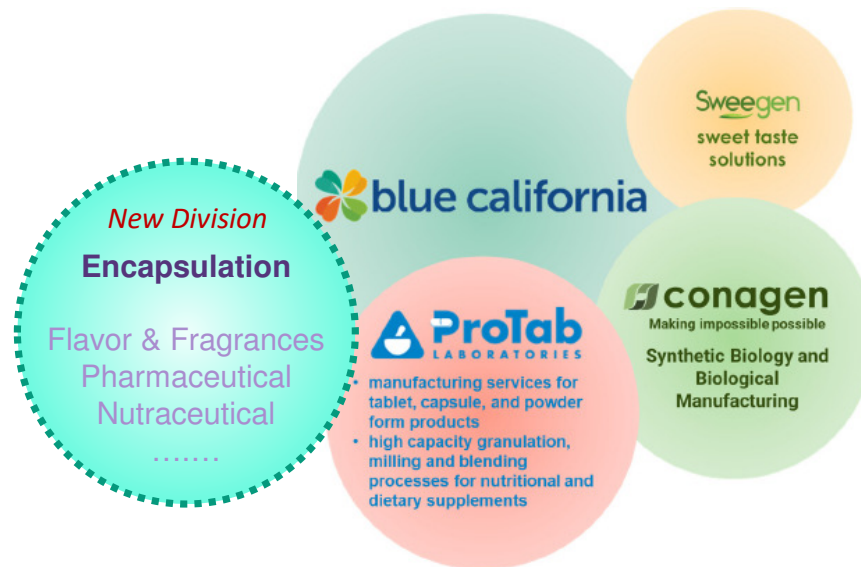


1. Blue California
2. Why Nicotine Delivery?
3. Microencapsulating Nicotine: Complex Coacervation & Spray Drying
4. Microencapsulated Nicotine Release Profile
5. Applications: Tablets, Chewing Gums & Gummies
6. Summary

# Blue California

Blue California is a science-based solutions provider and manufacturer of clean, natural, and sustainable ingredients used in food, beverage, flavor, fragrance, dietary supplements, personal care and cosmetic products. For more than 25 years, Blue California has built a strong reputation for creating value in these diverse natural product and nature-inspired industries.

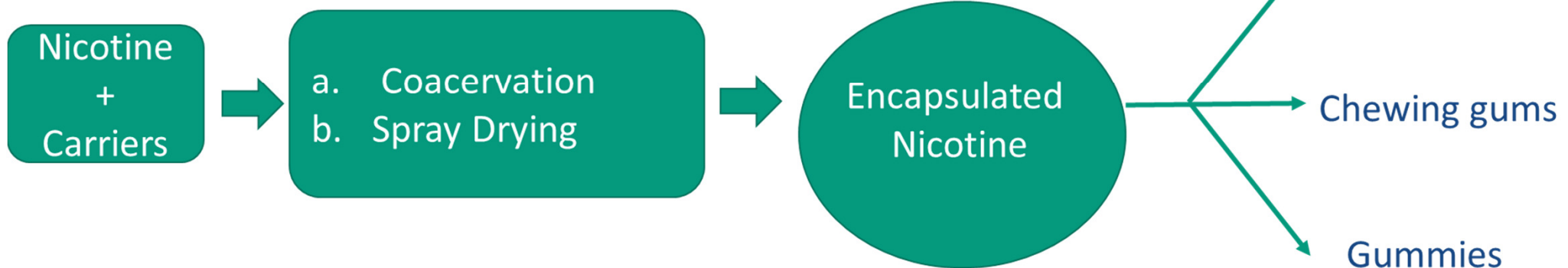
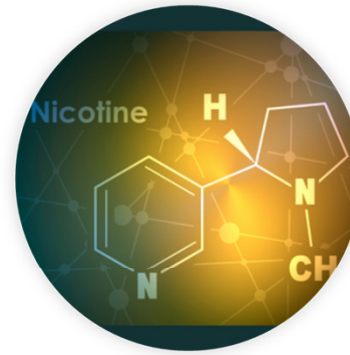
We are one of the few vertically integrated companies in our focus industries. We apply our broad and deep expertise, including regulatory “savoir faire,” to develop novel materials and new clean, green production methods to ensure successful commercialization of products to companies with global reach.



*Affiliated companies of Blue California*

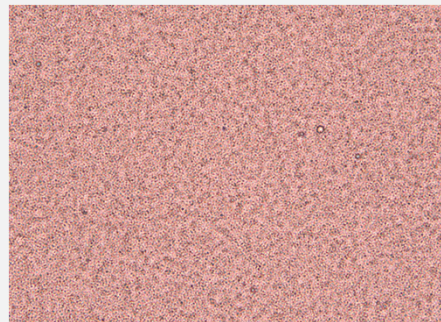
# Why Nicotine Delivery?

- Nicotine replacement therapy (NRT)– Stop smoking
- Nicotine prone to degradation
- Dose control



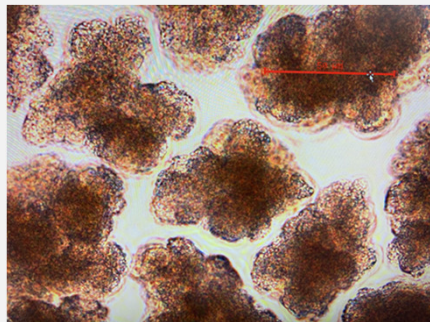
# Complex Coacervation

3-9% nicotine in powder



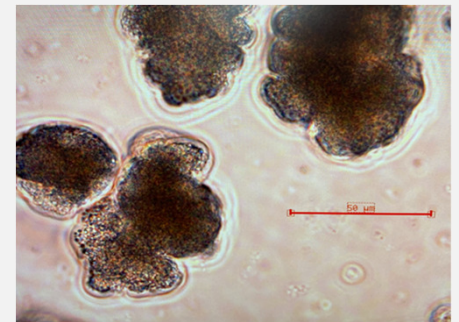
Emulsion

Coacervation



Coacervates

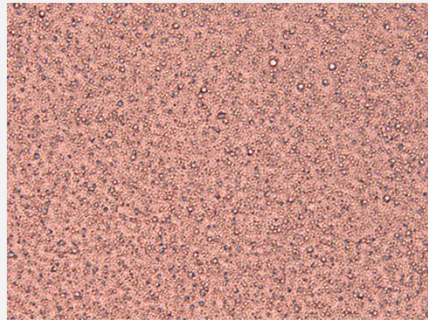
Spray drying



Redispersed microcapsules

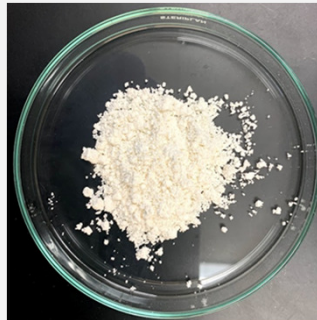
# Straight Spray Drying

3-6% nicotine in powder

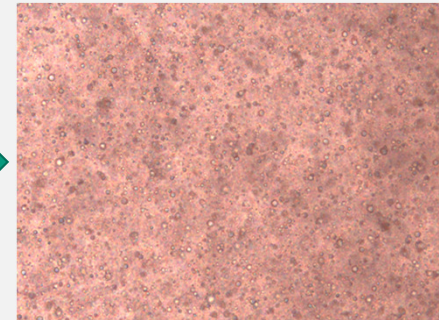


Emulsion

Spray drying



Add water



Redispersion

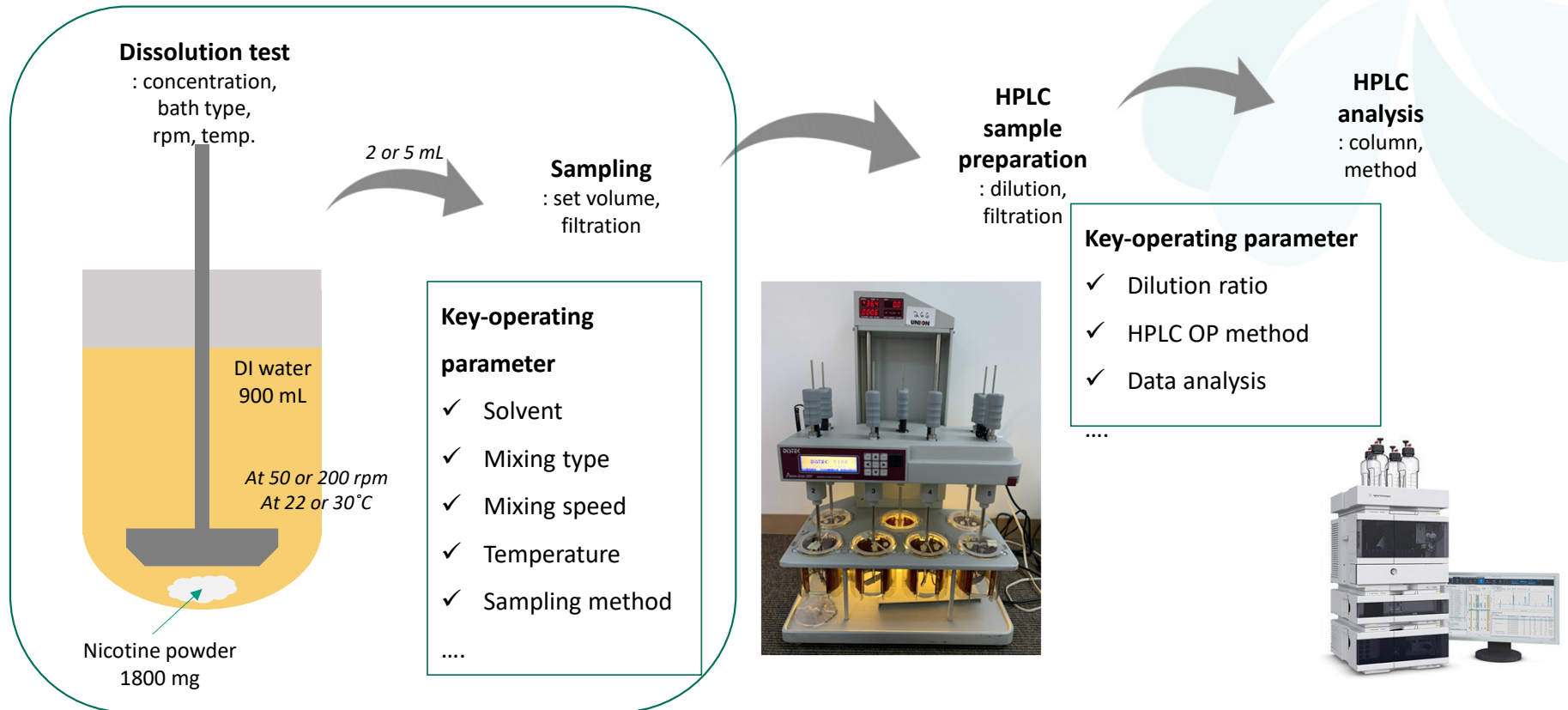
## Nicotine Retention after Encapsulation

*Analyzed by Agilent HPLC 1260 Infinity II*

Sample name	Nicotine Conc. (ug/mL)	Nicotine Retention(%)
SD MCT	93.6	70.9
SD Sunflower	125.3	94.9
SD Canola	95.2	72.1
Coacervation Canola	133.5	80.4
Coacervation Sunflower	132.9	80.0

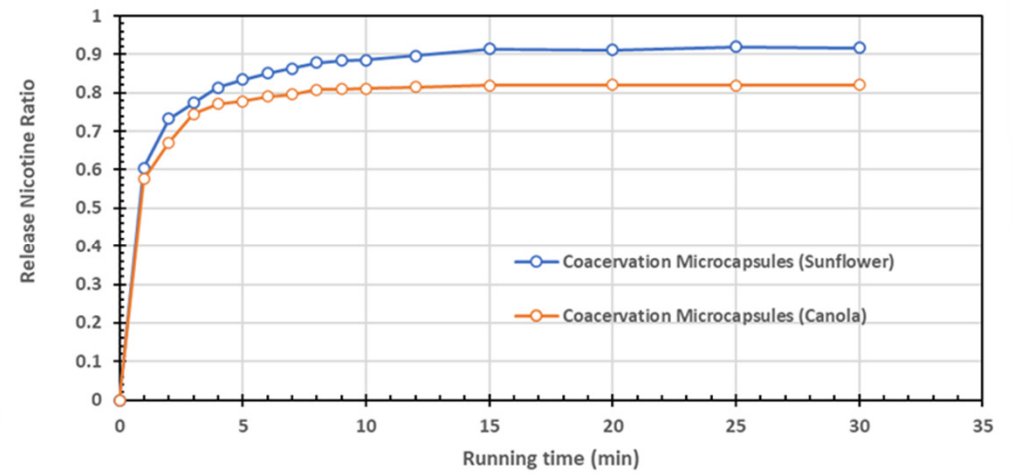
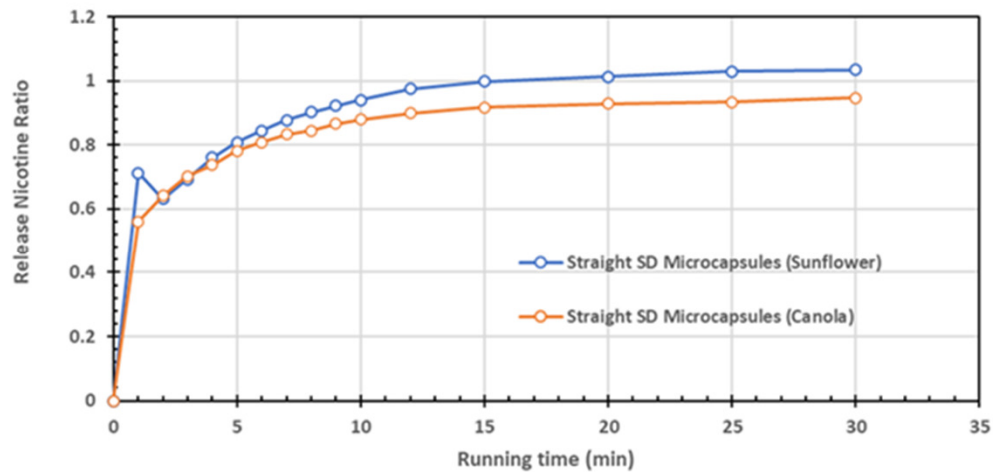


# Nicotine Release Profile Test



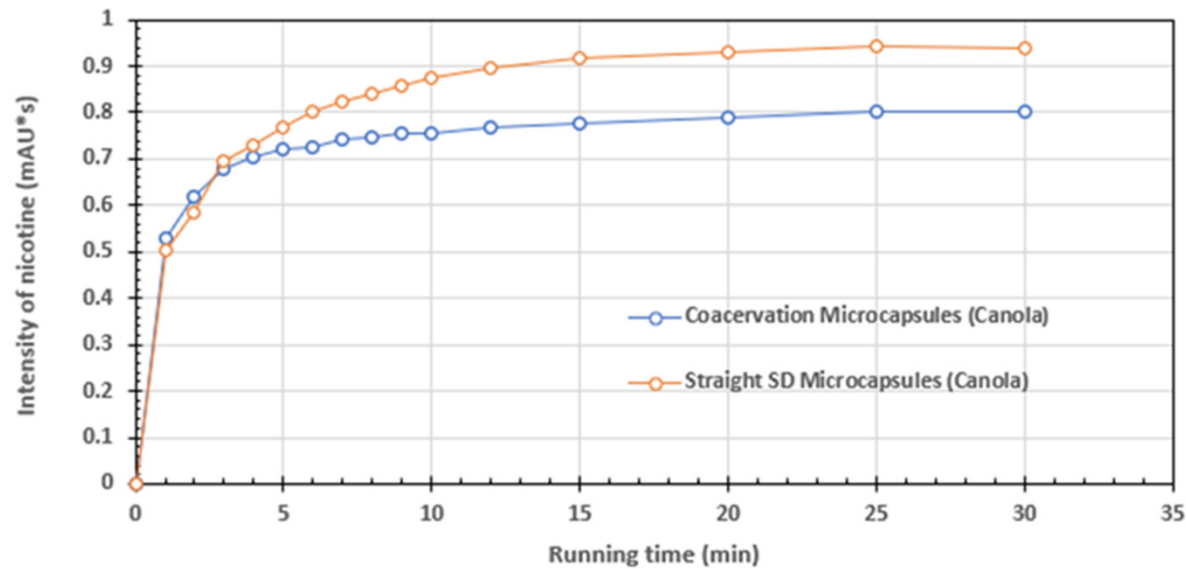


## Nicotine Release Profile by Carrier Oil



✓ For both straight SD and Coacervation, nicotine release faster in sunflower oil than canola oil

## Microencapsulated Nicotine Release Profile



- ✓ Both Straight SD and Coacervation release nicotine fast within the first 5 mins
- ✓ Coacervates release nicotine slower than straight SD

## Application: Nicotine Tablet



4 mg nicotine per  
1.5 g tablet  
(coacervated)  
**Taste good**



3.3 mg nicotine per  
170 mg tablet  
(coacervated)

**Too Spicy**

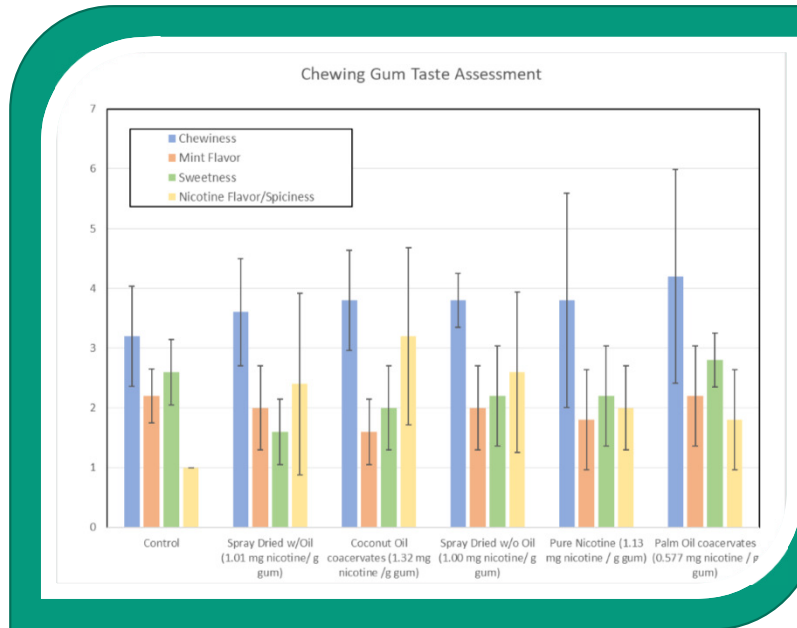


4 mg/235 mg serving  
**Very Spicy**

Acacia, acesulfame potassium, calcium polycarbophil, lime oil, magnesium stearate, maltodextrin, mannitol, citrus flavor, potassium bicarbonate, sodium alginate, sodium carbonate, sucralose, xanthan gum

- ✓ At a high dose without a carrier, more prone to oxidation
- ✓ 4 mg/170 mg too spicy, and 4mg/1.5g tastes good

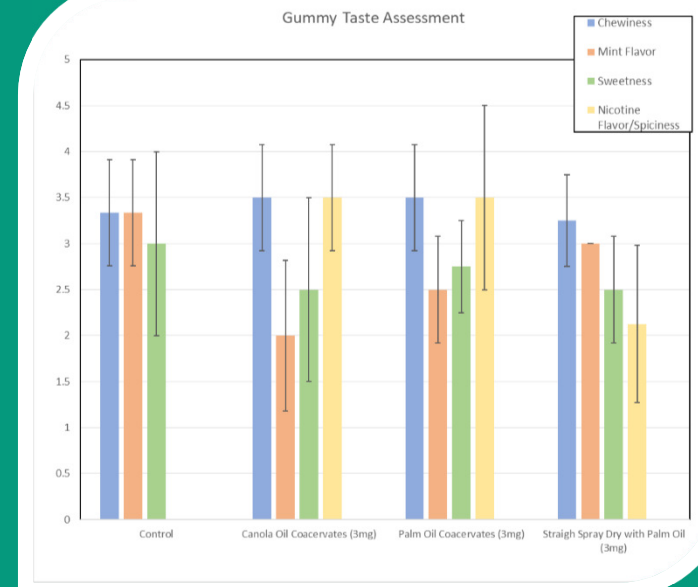
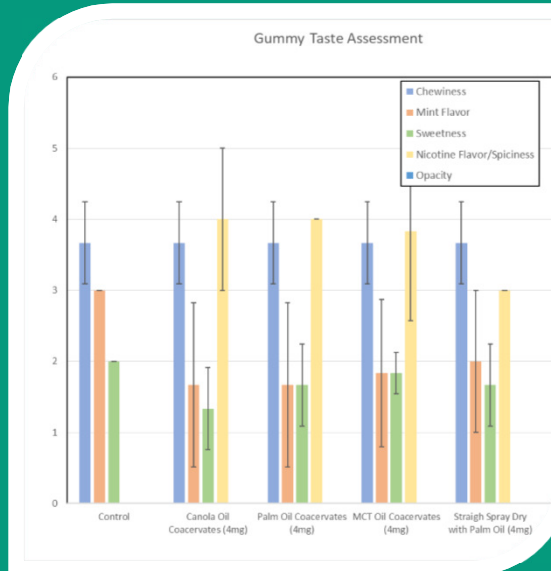
## Application: Nicotine Chewing Gum



Acesulfame potassium, calcium carbonate, carnauba wax, yellow #10, gelatin, gum base, mannitol, menthol, mint flavor, sodium bicarbonate, sodium carbonate, sorbitol, sucralose,  $\text{TiO}_2$ , xylitol

- ✓ Good chewy texture
- ✓ Spiciness increases with nicotine level increase (1.5-4.3 mg per serving)
- ✓ Spicier than commercial product at 4 mg per serving (3-4 g vs 1.26 g), which means its integrity & intensity being preserved well by microencapsulation

# Application: Nicotine Gummy



- ✓ Nicotine spiciness is acceptable at 3-4 mg/serving (2.5g)
- ✓ Coacervated nicotine shows extended release and tastes stronger than those spray dried

## Summary

- ✓ **Microencapsulation protects nicotine well in both intensity & integrity**
- ✓ **Coacervation demonstrates high retention**
- ✓ **Release profile& dose controlled by methods & carrier oils**
- ✓ **Easy to make oral formats, like tablets, chewing gums and gummies**
- ✓ **Quickly develop line of flavor extension**



# Thank you For Your Attention



**Contact us**

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