

Microencapsulation of Nicotine for Tobaccoless Oral Administration

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Division of Encapsulation at Blue California

CRS 2022 Annual Meeting & Expo

July 11 – 15, 2022 | Montreal Congress Center, Montreal Canada

Advanced Delivery Science



Outline

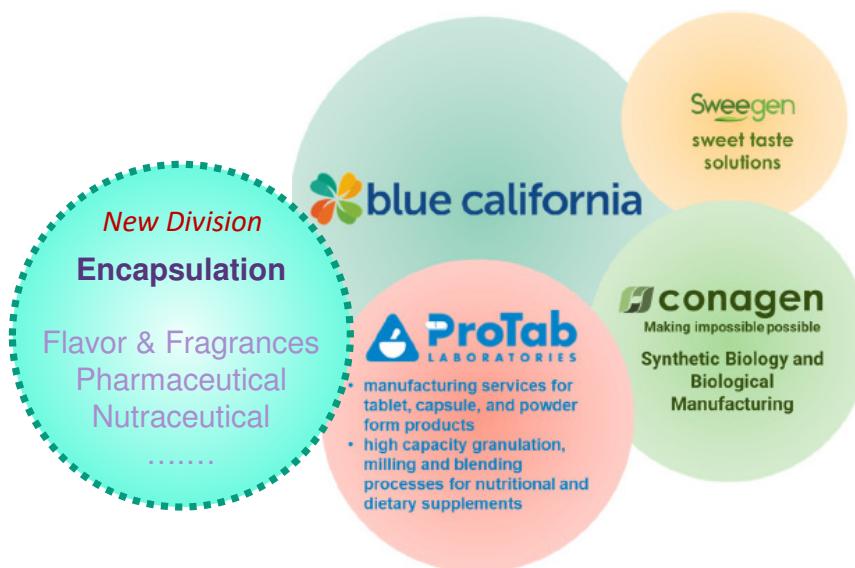


1. Blue California
2. Why Nicotine Delivery?
3. Microencapsulating Nicotine: Complex Coacervation & Spray Drying
4. Microencapsulated Nicotine Release Profile
5. Applications: Tablets, Chewing Gums & Gummies
6. Summary

Blue California

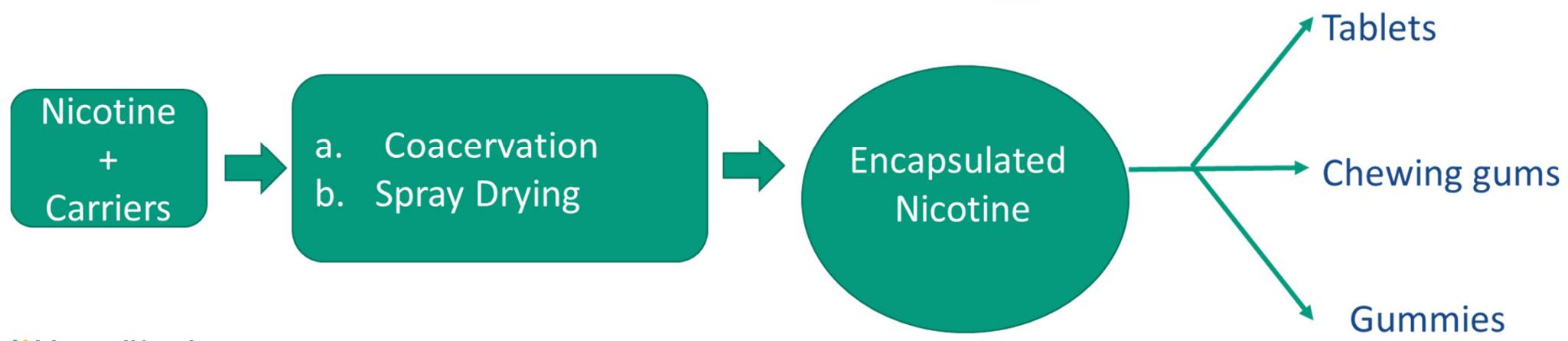
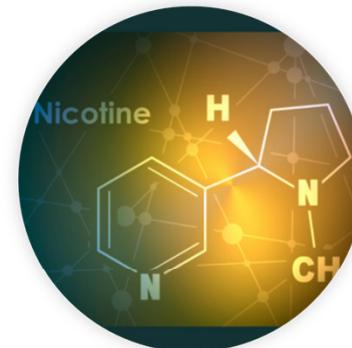
Blue California is a science-based solutions provider and manufacturer of clean, natural, and sustainable ingredients used in food, beverage, flavor, fragrance, dietary supplements, personal care and cosmetic products. For more than 25 years, Blue California has built a strong reputation for creating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



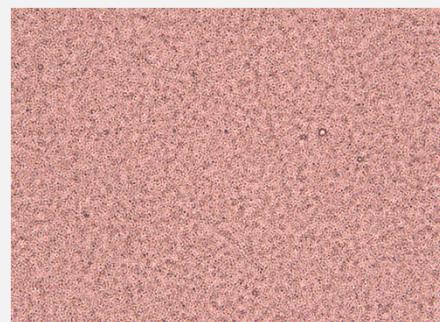
Why Nicotine Delivery?

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



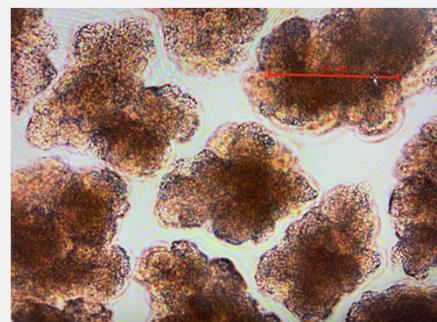
Complex Coacervation

3-9% nicotine in powder



Emulsion

Coacervation



Coacervates

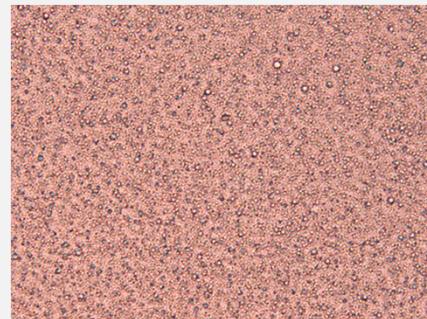
Spray drying



Redispersed microcapsules

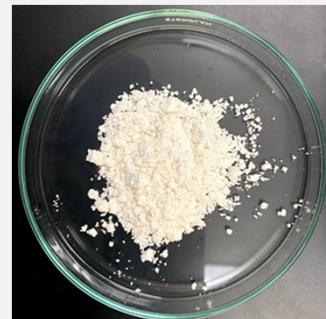
Straight Spray Drying

3-6% nicotine in powder



Emulsion

Spray drying
→



Add water
→



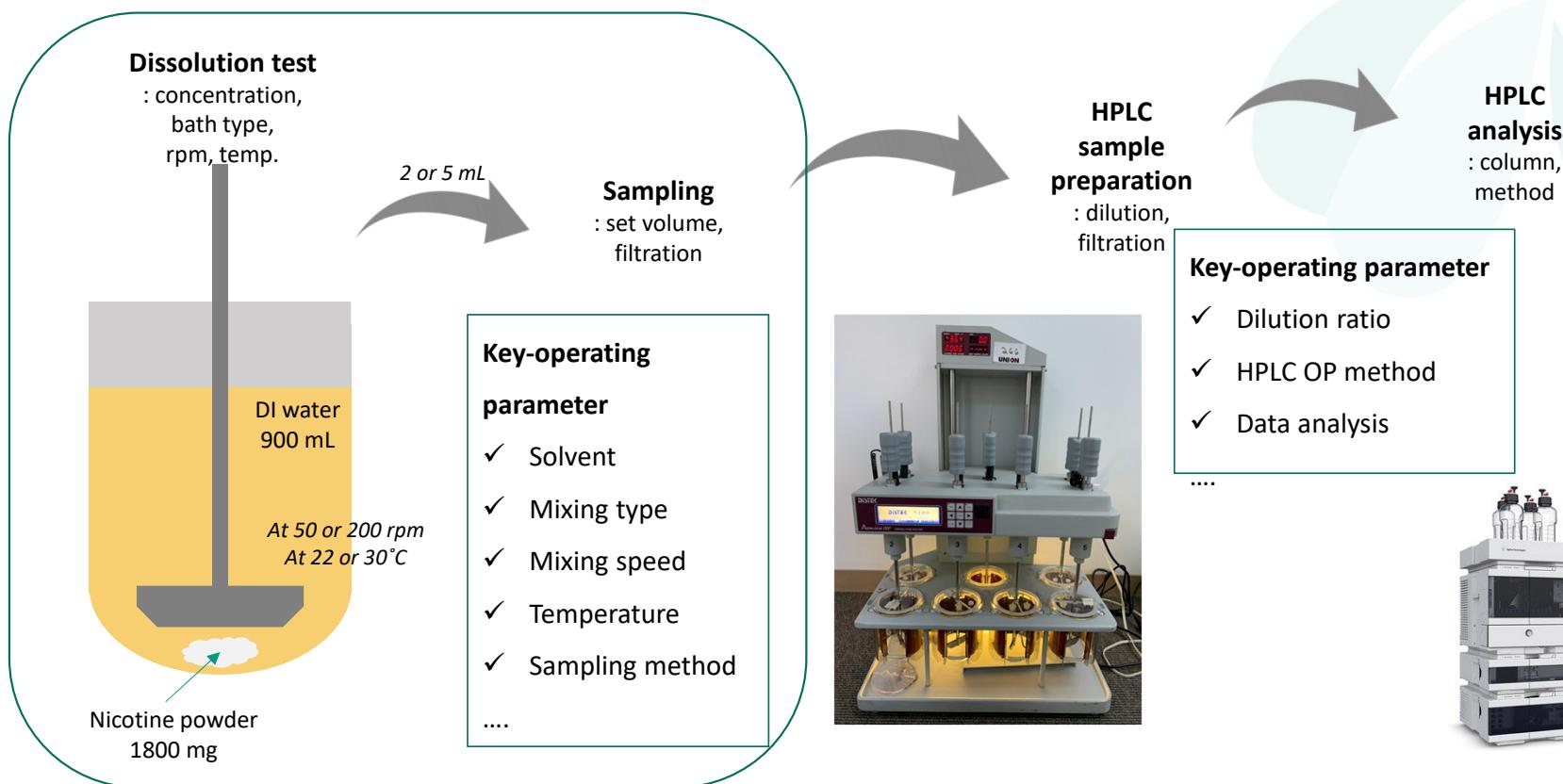
Redispersion

Nicotine Retention after Encapsulation

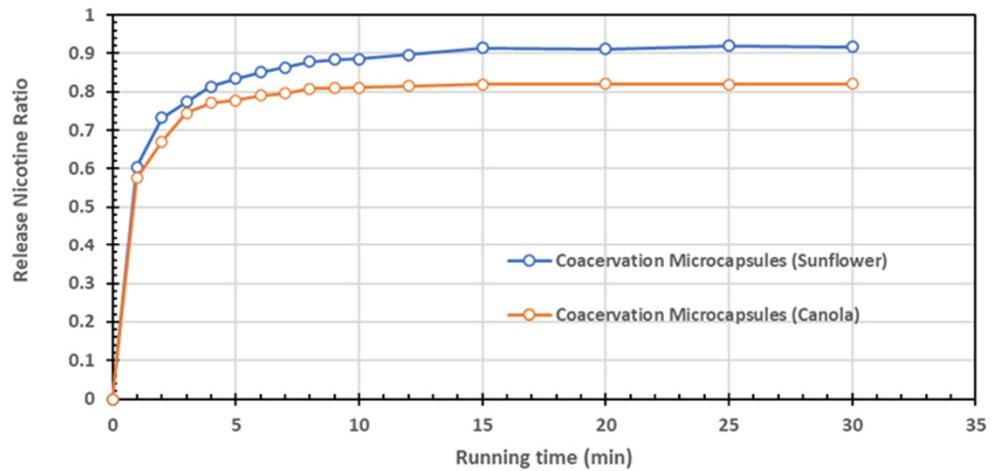
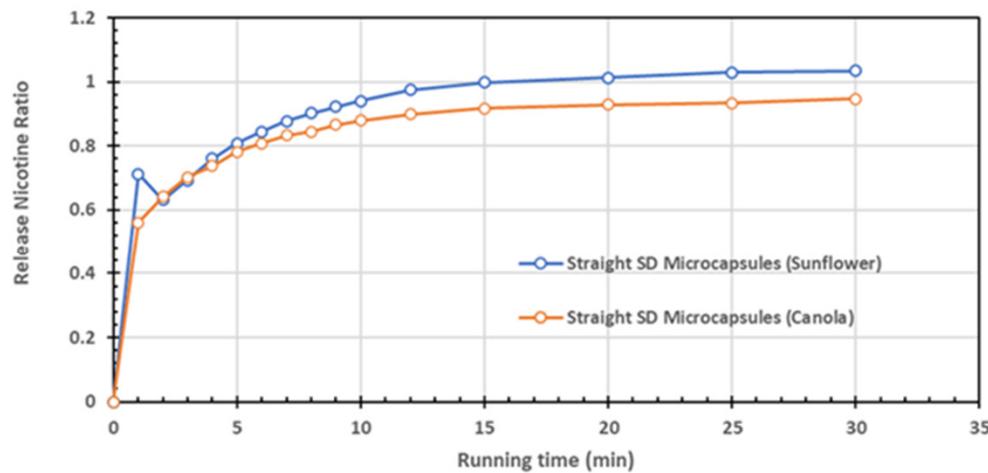
Analyzed by Agilent HPLC 1260 Infinity II

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

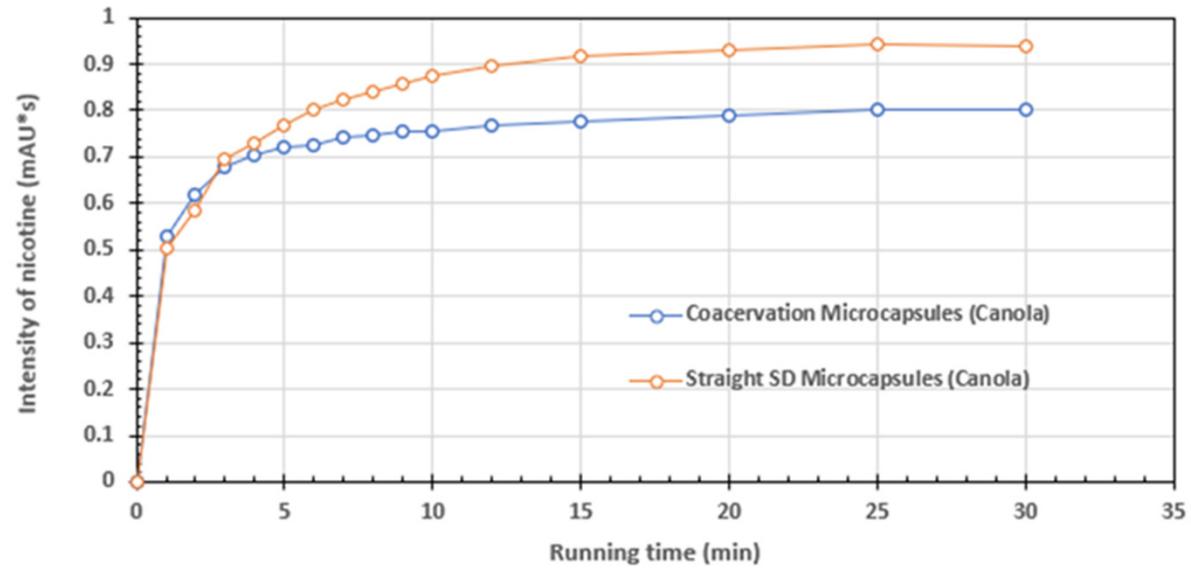


Nicotine Release Profile by Carrier Oil



✓ 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

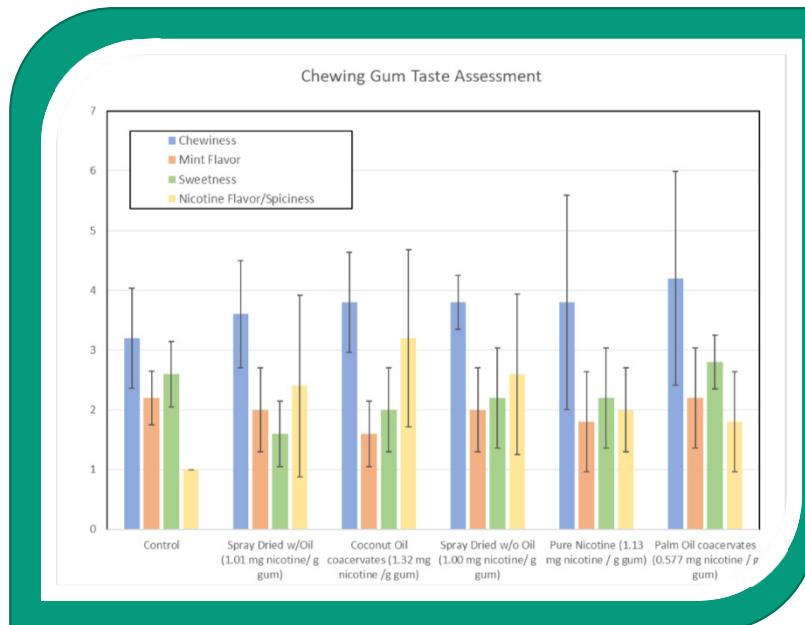


4 mg/235 mg serving
Very Spicy

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

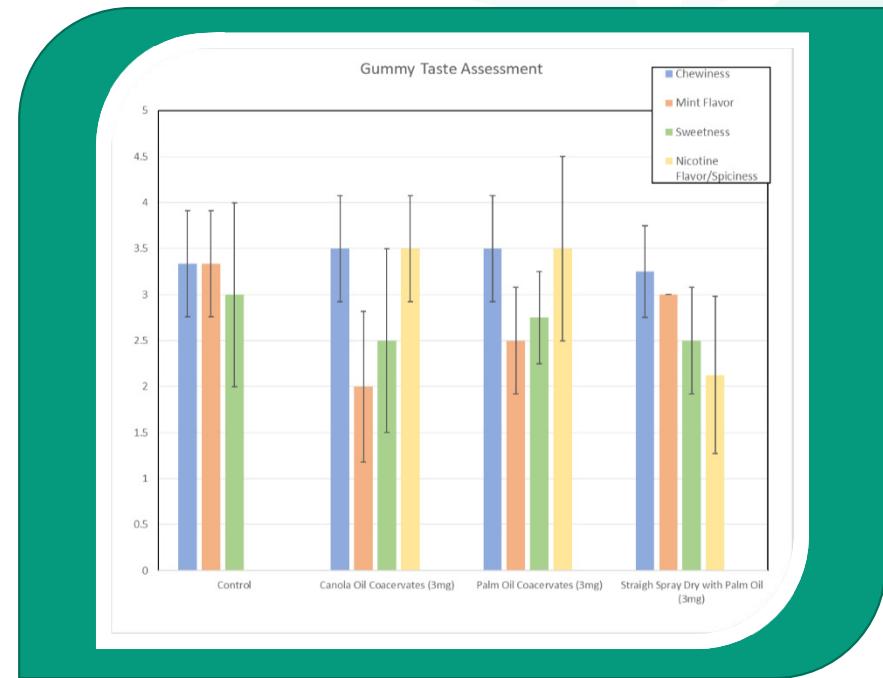
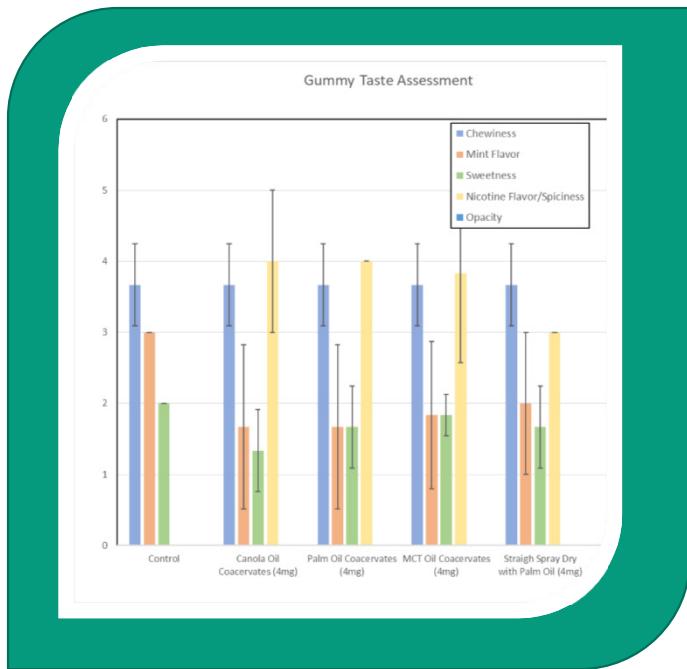
Application: Nicotine Chewing Gum



Acesulfame potassium, calcium carbonate, carnauba wax, yellow #10, gelatin, gum base, **mannitol**, menthol, mint flavor, sodium bicarbonate, sodium carbonate, **sorbitol**, **sucralose**, **TiO₂**, **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



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