Rhovanil® US NAT:
A new natural vanillin to meet the demand for natural and clean label

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Agenda

- Food Market Trends
- Introducing Rhovanil® US NAT as a solution for clean label
- Authentication Methodology
- Sensory and Applications Results
- Conclusion
3 main consumer trends...

...are driving the food and beverage market

1. **Switch to Natural**
   - 63%
   - 32% experience cost pressure, reinforced by vanilla bean price volatility

2. **Consumer Awareness**
   - 61%
   - Food safety and traceability are key

3. **Health & Wellness**
   - 59%
   - 45% of the market is adapting towards a healthier portfolio
Vanillin is a key ingredient that is responsible for the typical taste of vanilla.

- Vanillin is by far quantitatively the main component amongst the 250 components in vanilla beans.

- Content of vanillin depends on 2 main factors:
  - Harvesting maturity
  - Crop origin (the dry matter of cured vanilla beans)

  - Planifolia Madagascar: 1.6 to 2%
  - Planifolia Mexico: 0.9%
  - Planifolia Indonesia: 0.3%

  Ref: flavor creation handbook, John Wright

With an annual crop of 2000t of vanilla beans, less than 1% of the global vanillin market demand are covered.

Nature not being sufficient, alternative routes are used to make an exact copy of the vanillin present in nature and address the market need.
Overview of industrial pathways to obtain vanillin

- **SYNTHETIC VANILLINS**
- **GLOBAL NATURAL VANILLINS**
- **US NATURAL VANILLINS**

**Vanillin**

- **Guaiacol**
  - Catechol
- **Lignin**
  - Paper pulp
- **Curcumin**
  - Turmeric or curcuma
- **Eugenol**
  - Clove
- **Guaiacol**
  - Conifers
- **Ferulic Acid**
  - Rice bran
- **Vanilla Bean**
  - Vanilla
Introducing Rhovanil® US NAT: a natural vanillin identical to the one extracted from vanilla beans

To satisfy increasing global demand, Solvay has developed ways to produce vanillin identical to the one present in vanilla beans.

**NEW Rhovanil® US NAT route**

- Raw materials natural origin
- Natural GUAIACOL
- US natural
- Produced all year round
- Consistent quality
- Sustainable sourcing
- Natural origin proven

**Ferulic route**

- Rice bran oil
- Ferulic acid
- Global natural
- Produced all year round
- Consistent quality
- Sustainable sourcing

**Catechol route**

- Nature identical ingredient
- Rhovanil®: highest purity in the market
- Stable production & pricing
- Food safety
Rhovanil® US NAT: THE natural vanillin solution

| **Key features** | Natural Vanillin  
Typical vanillin profile  
compliant with US Natural status  
Easy switch for synthetic vanillin |
| **Physical properties** | **Mp**=81-83°C  
In ethanol (90% at 20°C) Easily soluble: 620 g/l  
In ethanol (70% at 20°C) Easily soluble: 430 g/l |
| **Aspect** | White crystal |
| **Purity** | 99.5% min purity |
| **Quality assurance** | Halal, Kosher certified, non-GMO produced in FSC 22000 certified unit |
| **Solvay Product Labelling** | “Natural Vanillin” (US*)  
complies to FDA 21 CFR 101.22 |
| **Customer Finished Product Labelling** | “**Natural Flavor” (qualifies for in finished products; F&B and F&F in the US) |
Authentication of Rhovanil® US NAT by C14 activity

Advantages of 14C activity analysis:
- Allows to discriminate fossil carbon (from oil) from modern carbon (plant) → biosourced
- Reasonable price
- No database required

Drawback of 14C activity analysis:
- Does not allow to discriminate all vanillins from the market
Second level: $^{13}$C IRMS - $^{13}$C ($\delta^{13}$C) isotopic deviation measured by IRMS: Principle

Advantages of $^{13}$C IRMS:
- Allows to discriminate main botanic origins
- Clearly discriminates between synthetic and natural vanillins
- Widely used by F&F companies (in EU)

Drawback of $^{13}$C IRMS:
- Not perfectly discriminant for all vanillins as monovariate value
- Does not allow to detect or authenticate blends
- A representative database is required

Source: Solvay / Eurofins
3rd Level: SNIF-NMR Principle

- Site Specific Natural Isotope Fractionation measured by nuclear magnetic resonance
- Built on: “The Natural Isotopic Fractionation”. The resulting isotopic fingerprint can provide information on the origin of the molecule or product.
- Routine for food authenticity, two nuclei are used:
  - The Hydrogen nuclei: $^2H$-SNIF-NMR method was the initial application of SNIF-NMR.
  - The Carbon nuclei: $^{13}C$-SNIF-NMR method has opened new possibilities of analysis by SNIF-NMR.
  - This technique was initially developed in 90’s and used on wines and fruit juices and is now applicable to pure molecules
- In 2007, SNIF-NMR® method was authorized by AOAC for vanillin.

Stable isotopes (D/H, $^{13}C$/12, distribution is non statistical)
3rd Method Level: SNIF-NMR $^2\text{H}$ and $^{13}\text{C}$

SNIF-NMR $^{13}\text{C}$ measures the $^{13}\text{C}/^{12}\text{C}$ isotopic ratio for each carbon of the molecule thus providing an isotopic fingerprint.

Advantage of SNIF-NMR: Multivariate analysis, fingerprint, allowing the highest level of discrimination, to detect mixtures, difficult to falsify.

$^2\text{H}$-SNIF-NMR is a powerful tool however **in our case study** we found that $^{13}\text{C}$ SNIF-NMR is **THE method** to discriminate all vanillins from the market.

Additional advantages of $^{13}\text{C}$-SNIF-NMR vs $^2\text{H}$-SNIF-NMR:
- 3 times fastest
- less source material required.
Sensory evaluation shows Rhovanil® US NAT has a clean, typical vanillin flavor profile.

Organoleptic profile of Rhovanil® US Nat

Method of testing:

- Aromatic profile of 10% vanillin dilution in ethanol
- Taste profile of vanillin flavored, sweetened dairy beverage.

*Sensory evaluation performed by a trained panel in our Vanil'Expert Center, Lyon, France

Rhovanil® US Nat is comparable to Rhovanil. Both show the typical vanillin profile unlike vanillin produced from eugonol.
Applications

1) Can be used directly in food products as a 1:1 replacement of Rhovanil (synthetic)

- Chocolate: plain (dark) & milk chocolate, coatings, cocoa dry mixes, dessert sauces
- Confectionery: jellies, hard candy, caramel, nougat, chewing gums, all other sweets
- Bakery goods: cakes, cookies, pastries, waffles, muffins, breakfast cereals, baking mixes

2) As a key ingredient in liquid and spray dried natural flavor formulations:

- Vanilla WONF, natural flavor types
- Sweet brown flavors:
- Masking Flavors
- Fruit flavors (strawberry)
Conclusions: Value attributes of Rhovanil US NAT

New naturally sourced vanillin
- New vanillin invented by Solvay (patent filed)
- High purity
- Authenticated as natural by 3 methods & the Solvay traceability systems.

Labelled as:
- “Natural vanillin” (US market) - FDA 21 CFR 101.22
- Customer product labeling “Natural flavor”

For easy use in:
- Food & Beverage
- Flavors

✓ In application tests, it shows a clean, typical, vanillin profile
✓ 1:1 replacer of synthetic vanillin with no spicy note: easy to formulate as steady based note.

Methodology to authenticate vanillin’s naturality
- $^{14}$C Activity: differentiate between fossil and bio-sourced origin
- $^{13}$C IRMS: are complementary test to prove naturality
- SNIF-NMR: multivariable analysis to identify mixtures (difficult to falsify)

Solve it with Solvay