Food fraud on the example of vanilla flavor – how can we fight best?

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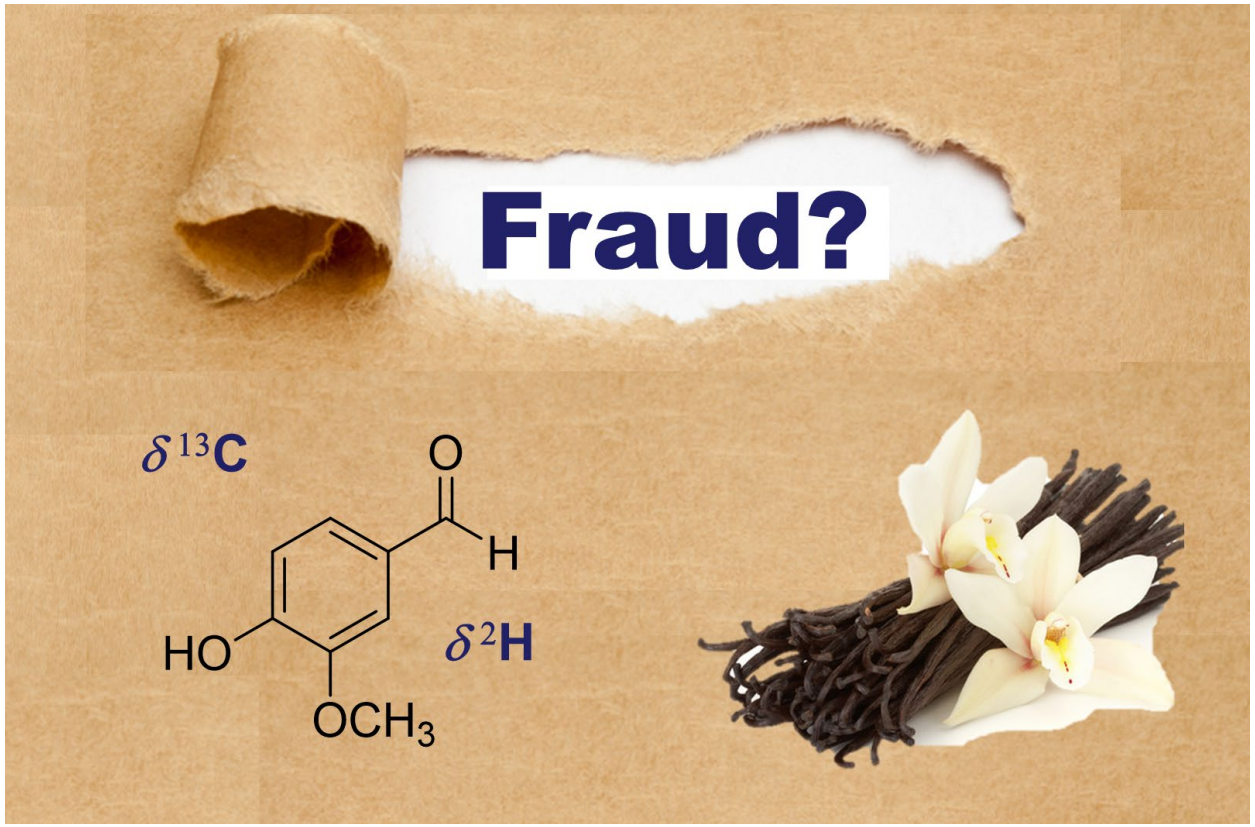


Is it healthy?

Where does my food actually come from?

Is it safe?

Is it authentic?

How was it produced?

Was it produced environmentally friendly?

And under fair conditions?

How do we get informed about our food?

L 304/18 EN Official Journal of the European Union 22.11.2011

REGULATION (EU) No 1169/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 25 October 2011

on the provision of food information to consumers, amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004

(Text with EEA relevance)

Article 7

Fair information practices

1. Food information shall not be misleading

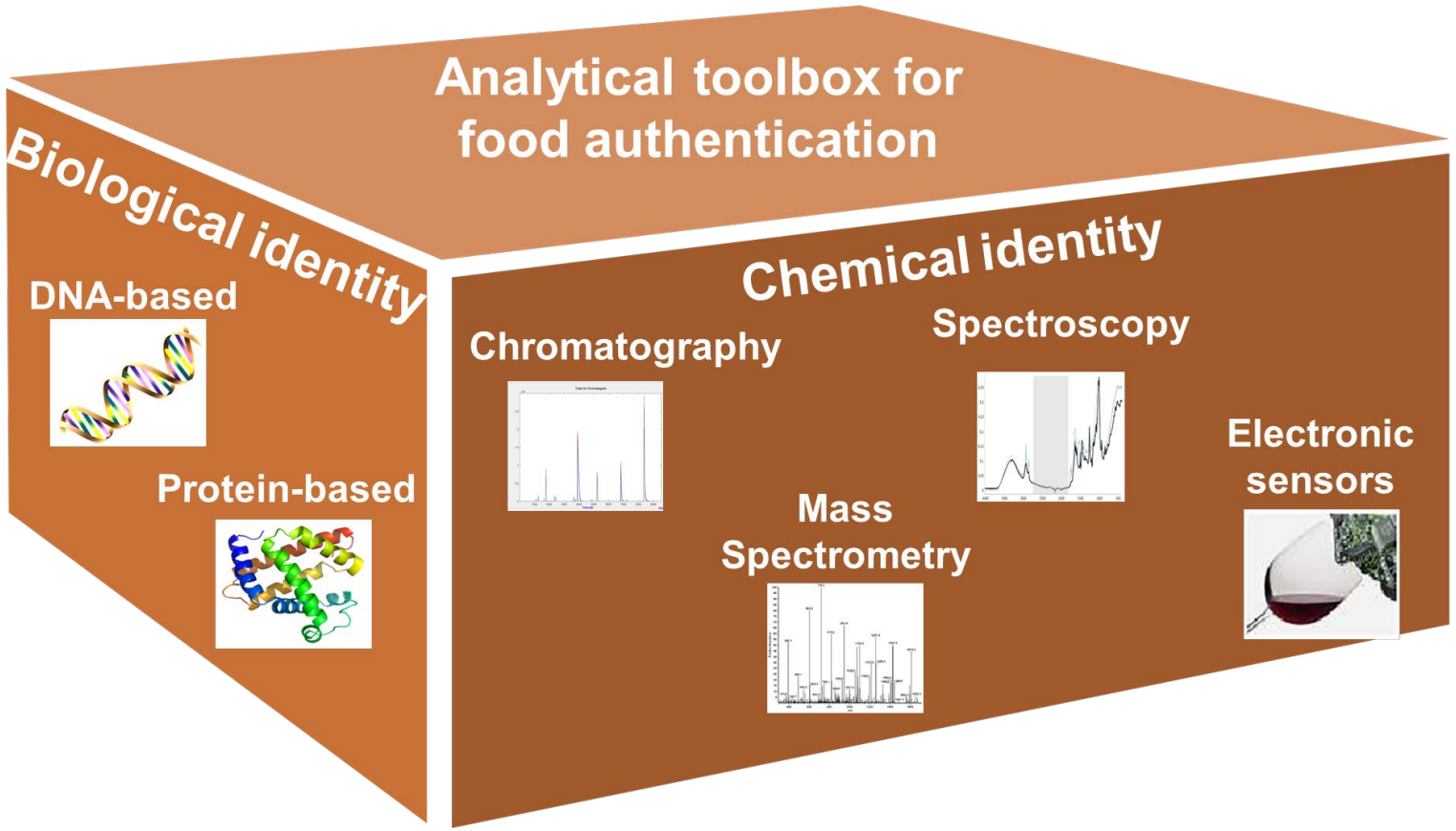
Economical motivated fraud

Food Fraud – A Business to Business problem

- Fraud leads to an unfair competition

- Fraud bears a high risk for brand reputation

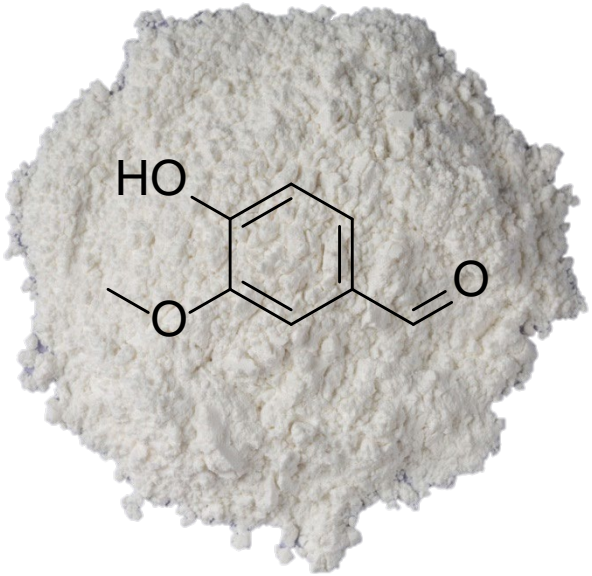
How can analytical chemistry contribute to a system that builds trust?



Can this be so difficult?

Detection of the differences between authentic and adulterated products

Example: Vanilla flavour

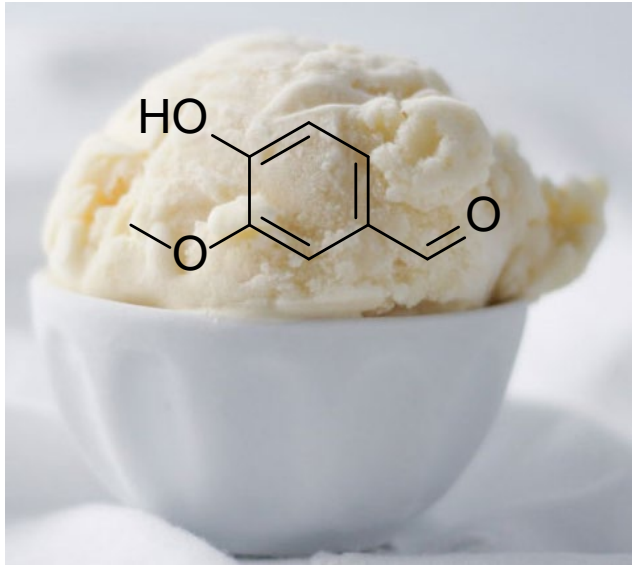


- Vanilla pod: 500 $/kg
- Contains ~2% vanillin

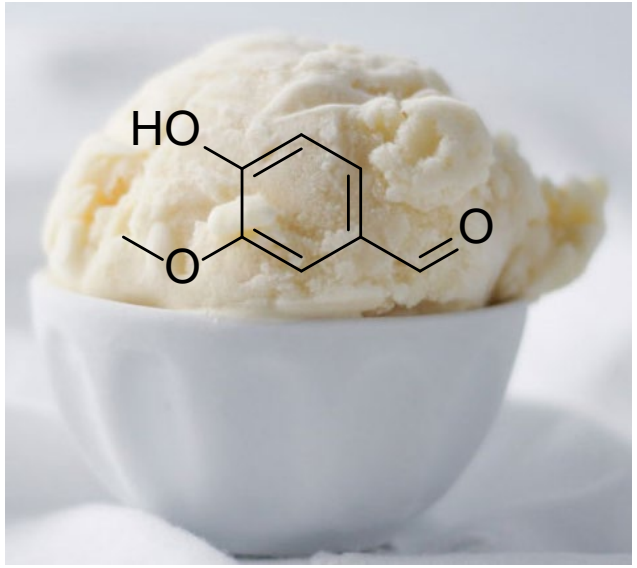
- Synthetic vanillin: 10 $/kg

How to distinguish vanillin from different sources?

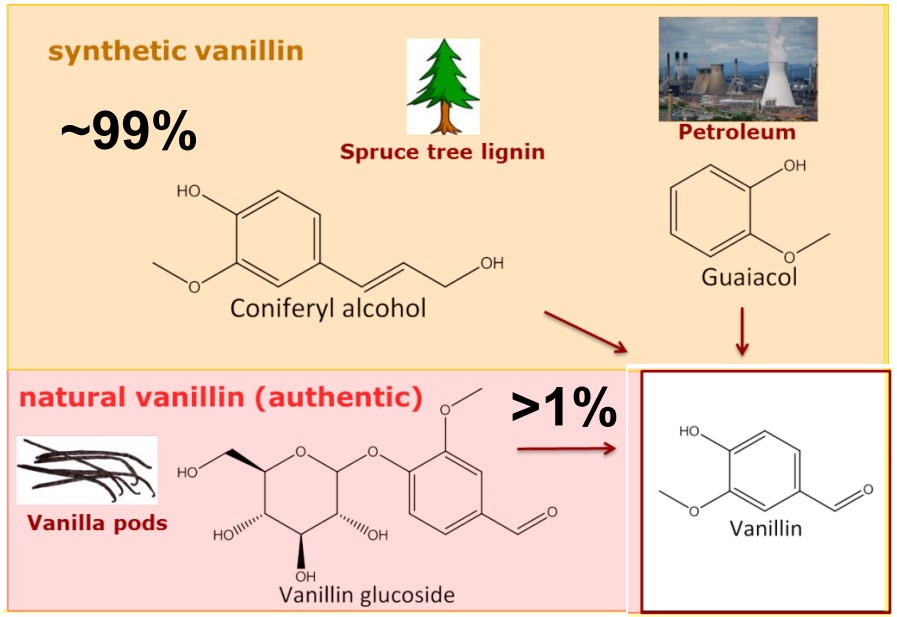
Easy distinction



Difficult distinction



Different vanillin sources

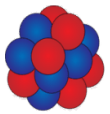


EU regulation 1334/2008

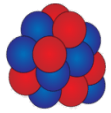
- Natural vanilla flavour
- Flavour, vanillin

How to distinguish vanillin from different sources?

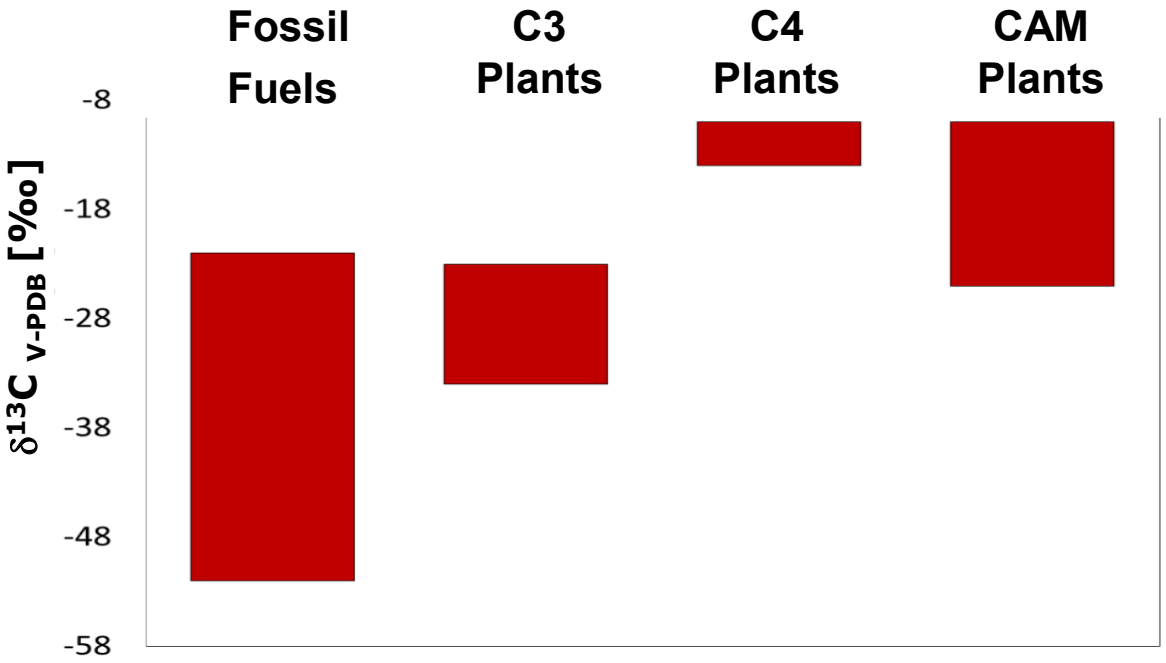
Stable carbon isotope analysis



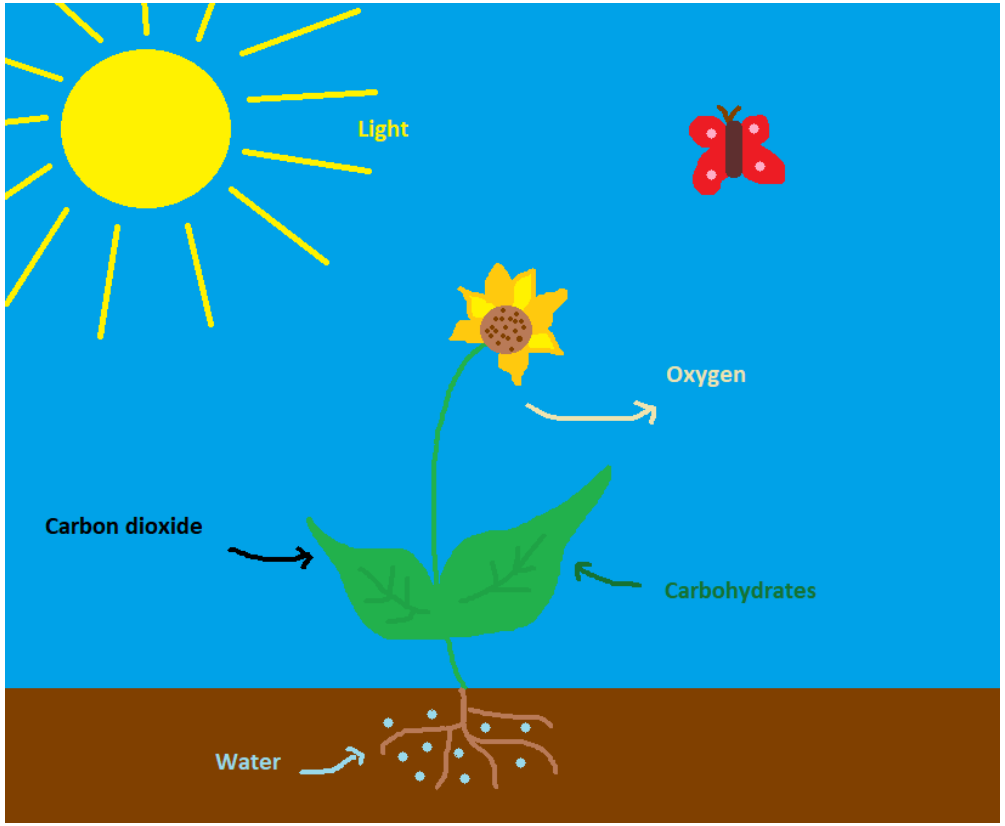
Carbon 12



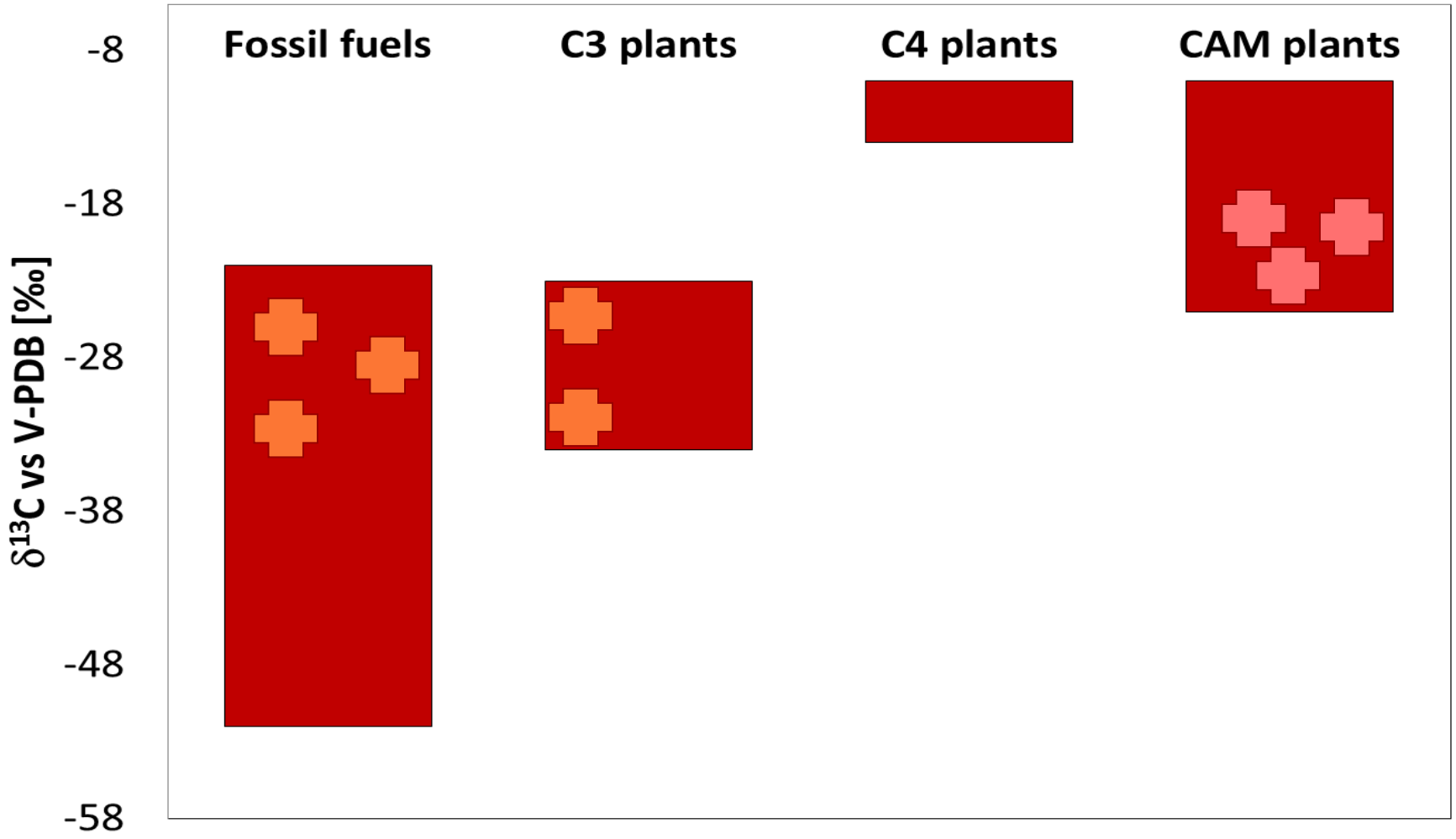
Carbon 13



Plants take up CO_2 from the air via photosynthesis



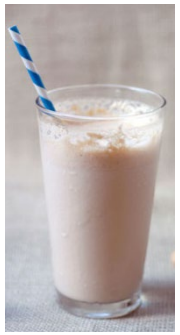
How to distinguish vanillin from different sources?



Research project with small market survey

Vanilla ice cream

Vanilla yoghurt



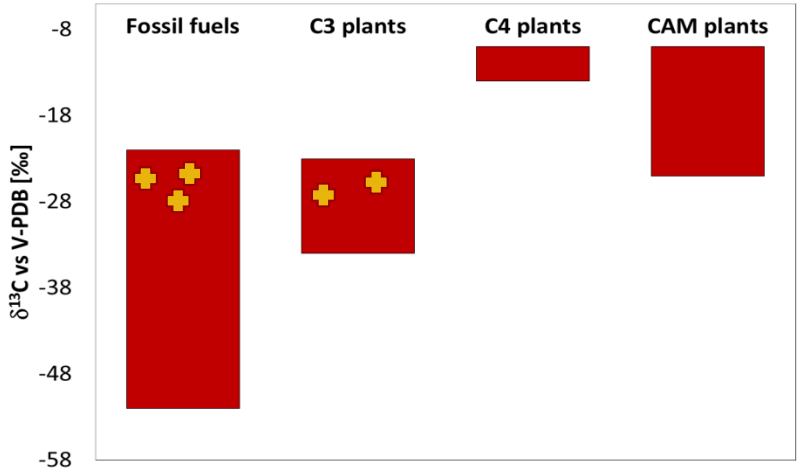
Vanilla protein shake

Vanilla sauce

Vanilla sugar

Vanilla chai tea

- Analysis of 23 market samples
- 22% have a wrong declaration
- 35% that claim to have real vanilla flavour have not



For further information…

Received: 1 July 2019 | Revised: 26 February 2020 | Accepted: 12 March 2020

DOI: 10.1002/ffj.3573

Check for updates

RESEARCH ARTICLE

WILEY

Determination of $\delta^{13}C$ of vanillin in complex food matrices by HS-SPME-GC-C-IRMS

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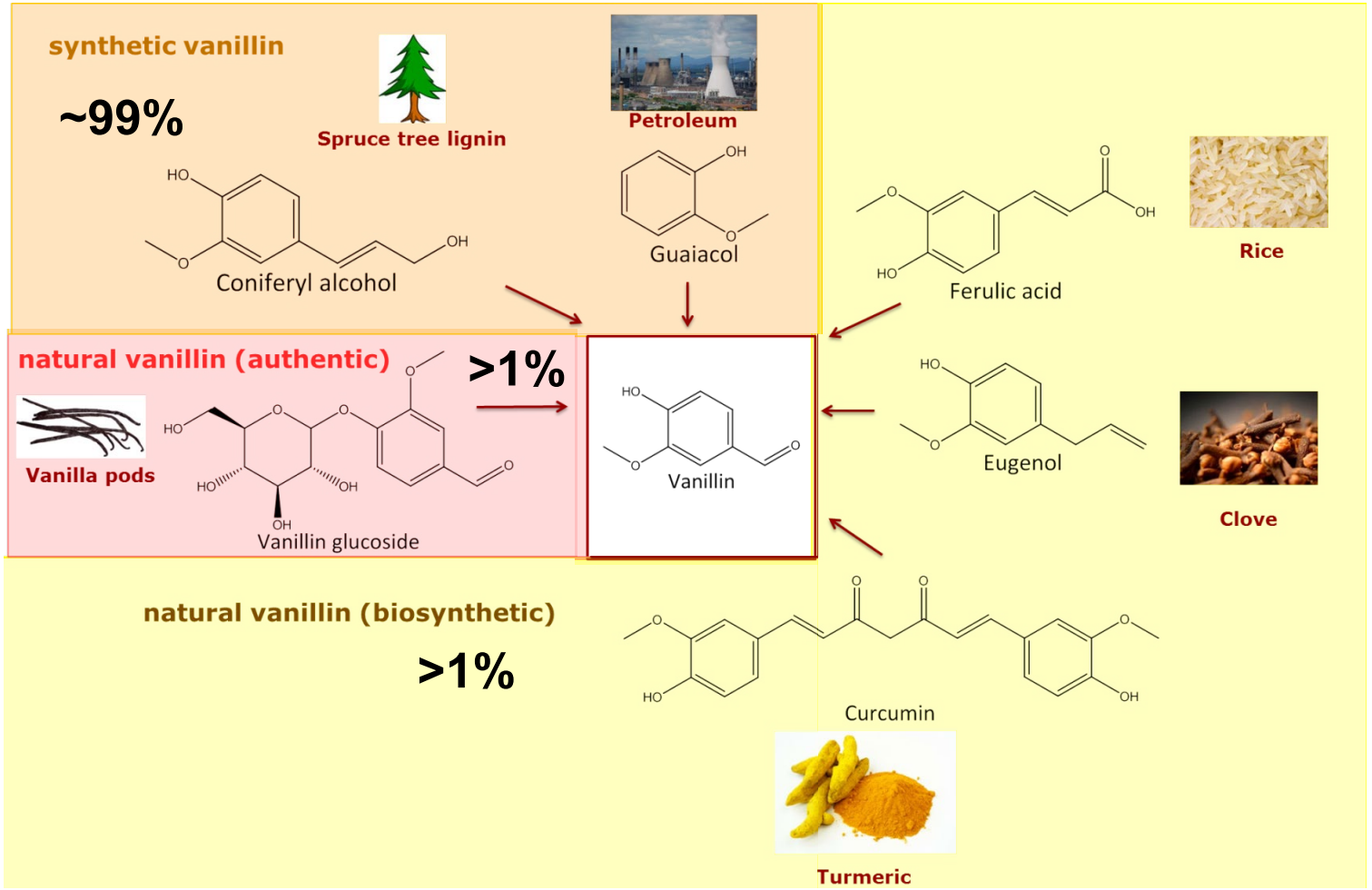
Abstract

Vanilla is one of the most popular spices in the world and is therefore often added to food products to enhance the taste with its desirable flavour. Vanilla flavour is highly susceptible to economically motivated food fraud since the main component 'vanillin' can easily be produced by much cheaper synthetic processes. The determination of the vanillin source is not always an easy task, especially when very low concentrations are incorporated in complex food matrices. Here, we present an easy sample preparation procedure that includes a solid-phase extraction clean-up to determine the isotopic carbon ratio of vanillin in food products by headspace solid-phase microextraction and gas chromatography coupled to isotope ratio mass spectrometry. Isotopic fractionation during the sample preparation procedure was carefully evaluated. The method was applied to 23 commercial food samples including vanilla sugar, dairy and soy products. The study illustrates the potential and limitations of the authentication of vanilla flavour by the isotopic carbon ratio of vanillin. Further, the complexity of the authenticity assessment of vanilla flavours in composite food is demonstrated.

KEYWORDS

$^{13}C/^{12}C$ ratio, biovanillin, food authenticity, isotope ratio mass spectrometry, SPME

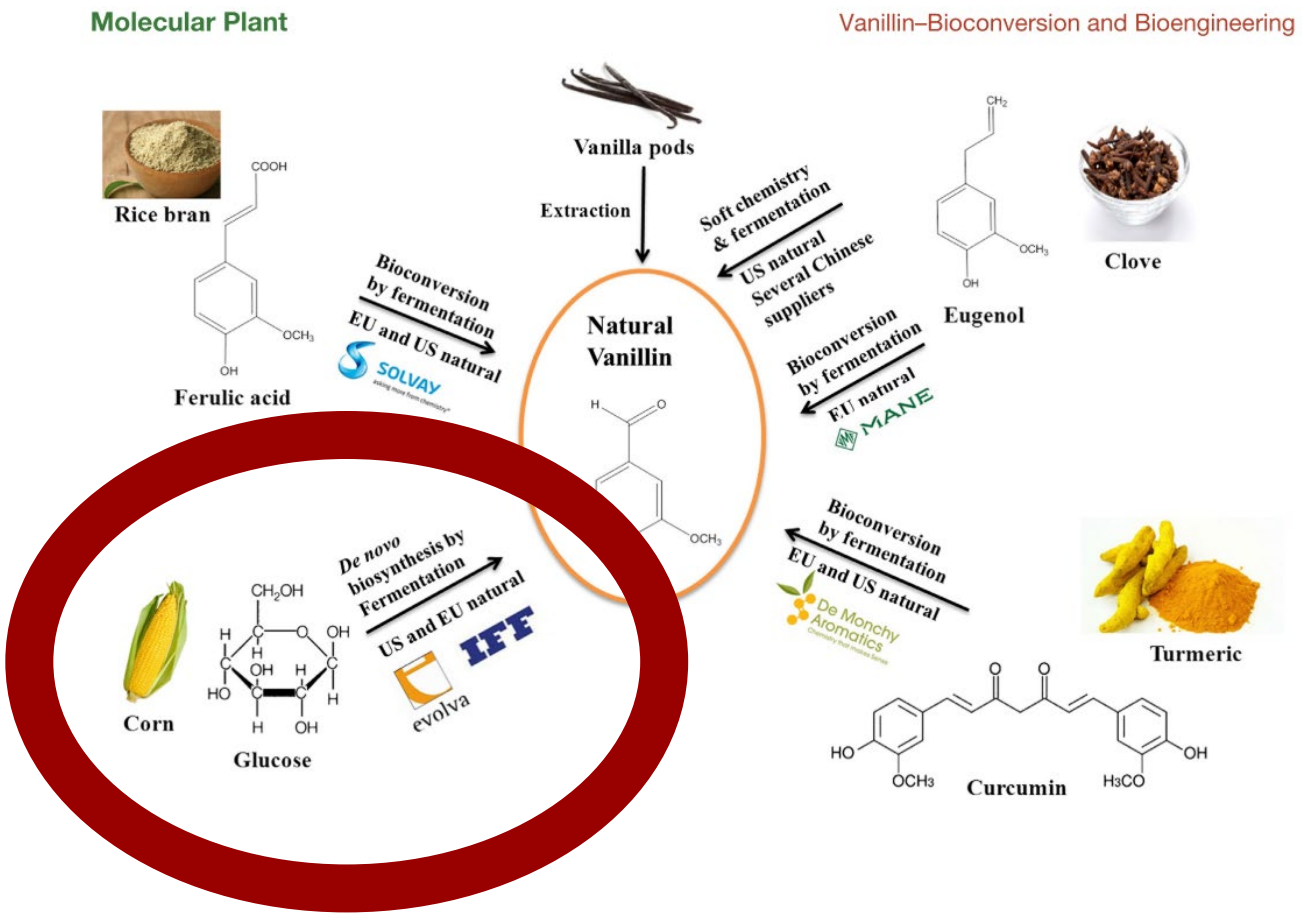
Different vanillin sources

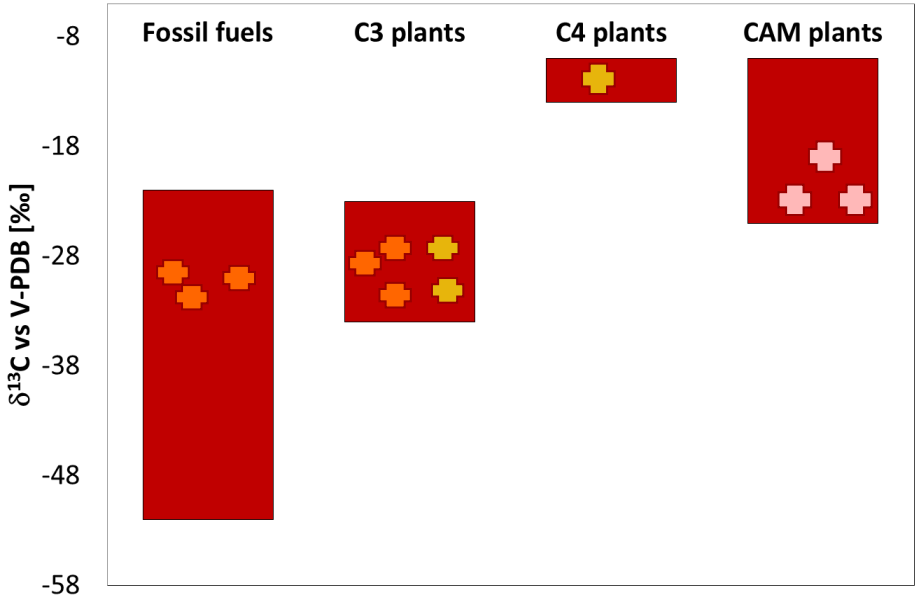


EU regulation 1334/2008

- **Natural vanilla flavour**
- **Flavour, vanillin**
- **Natural flavouring, natural vanillin**

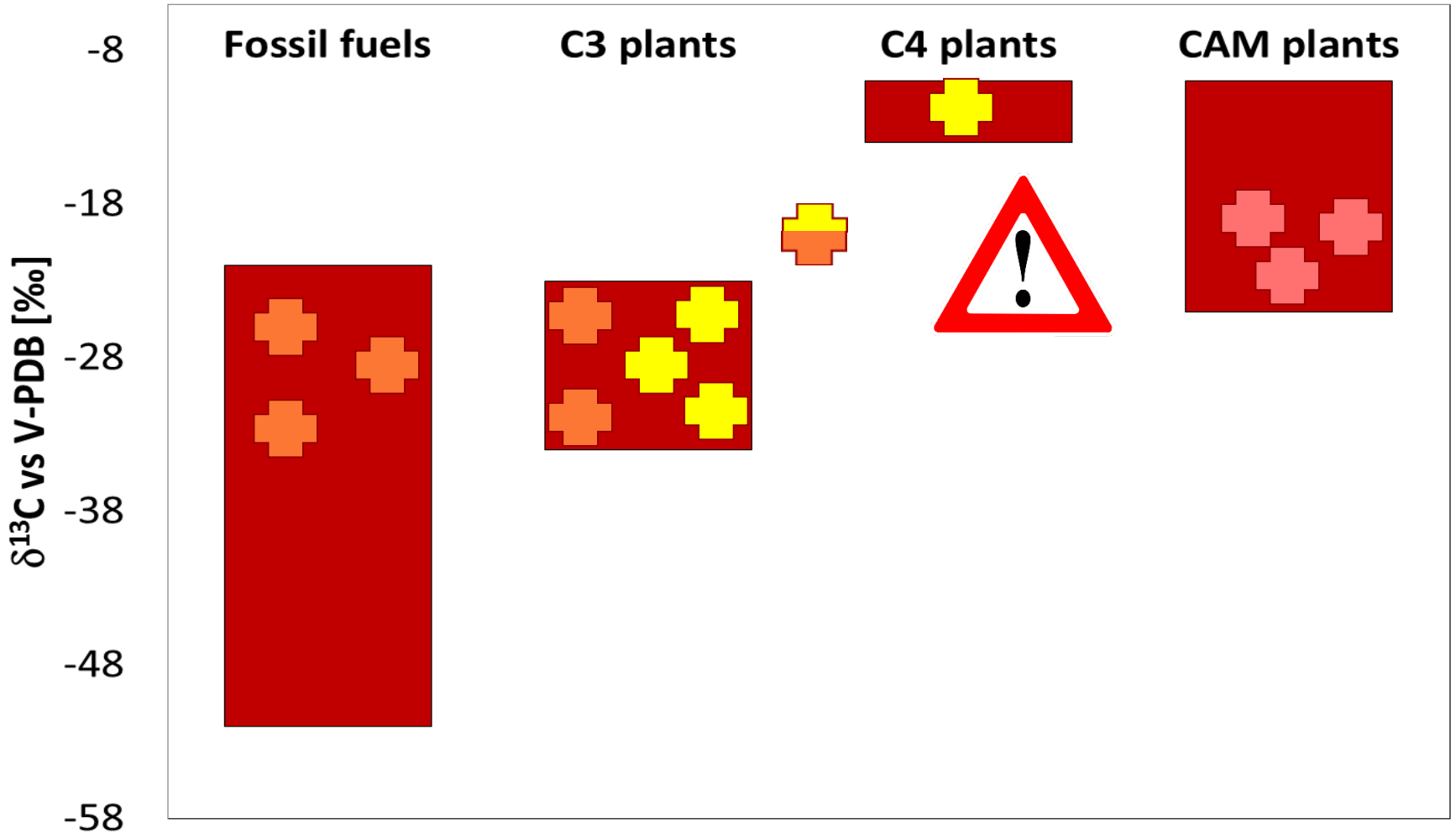
New challenge for natural vanilla authentication?





- Glucose from C4 plant (e.g. corn)
- Glucose from C3 plants (e.g. wheat)

New challenge for natural vanilla authentication?



Real vanillin

Synthetic vanillin

Biovanillin

→ Imitation of authentic vanilla flavour

For further information…

Food Control 106 (2019) 106735

Contents lists available at ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

Isotopic characterization of vanillin ex glucose by GC-IRMS - New challenge for natural vanilla flavour authentication?

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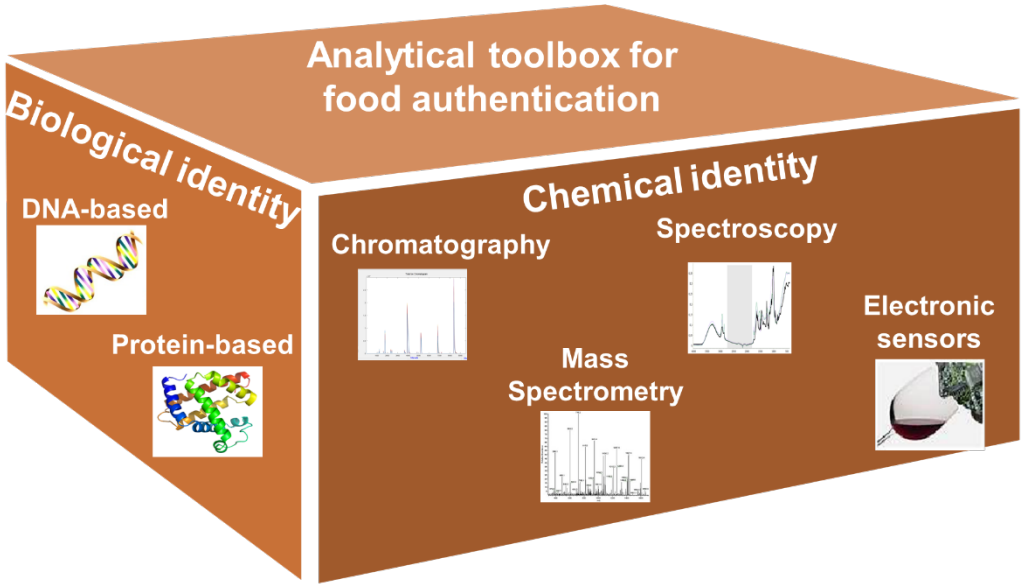
ARTICLE INFO

Keywords:
Authenticity
Natural vanilla flavor
Biovanillin
$^{13}C/^{12}C$ ratio
$^{2}H/^{1}H$ ratio
Isotope ratio mass spectrometry

ABSTRACT

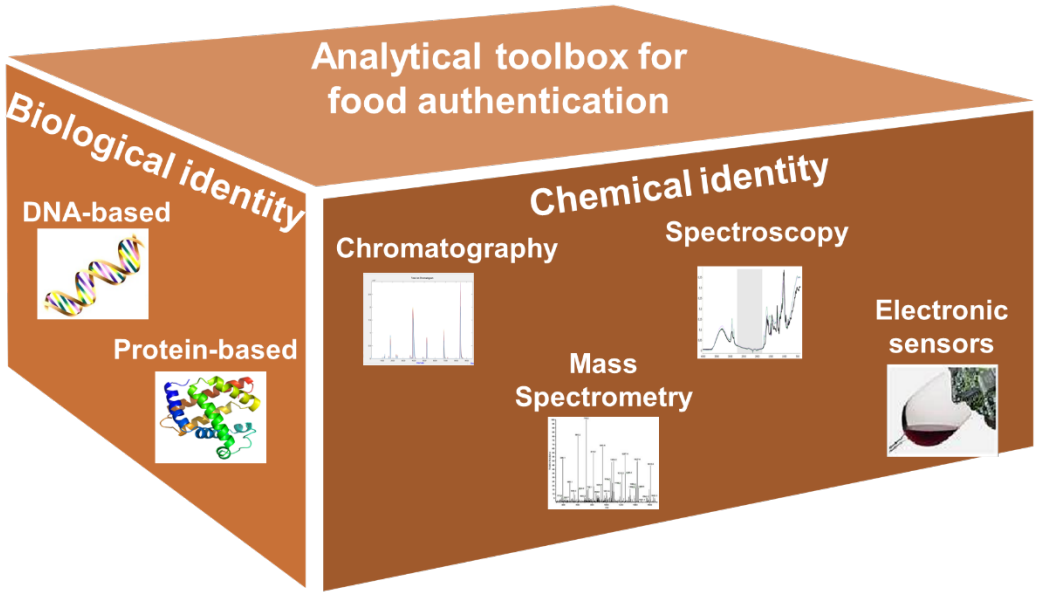
Vanilla flavour is highly vulnerable to economically motivated adulteration as the main component vanillin can be derived by much cheaper production methods than by the extraction from vanilla pods. The $\delta^{13}C$ ranges for synthetic vanillin from petroleum and C3 plants are depleted in comparison to the reported $\delta^{13}C$ range for vanillin from vanilla orchids. However, with the invention of new biosynthetic pathways, vanillin overlapping with the characteristic $\delta^{13}C$ range reported for vanillin from vanilla pods can be produced. Here, we present bulk and site-specific analysis by GC-IRMS of stable carbon and hydrogen isotope ratios of vanillin derived from glucose. This is the first time a $\delta^{13}C$ value for biovanillin that is higher compared to vanillin from vanilla pods is reported. The possibility to simulate the $\delta^{13}C$ range of vanillin from vanilla pods by combining vanillin derived from inexpensive sources constitutes an increased risk for fraud being perpetrated while remaining unnoticed.

Can analytical chemistry solve the problem alone?

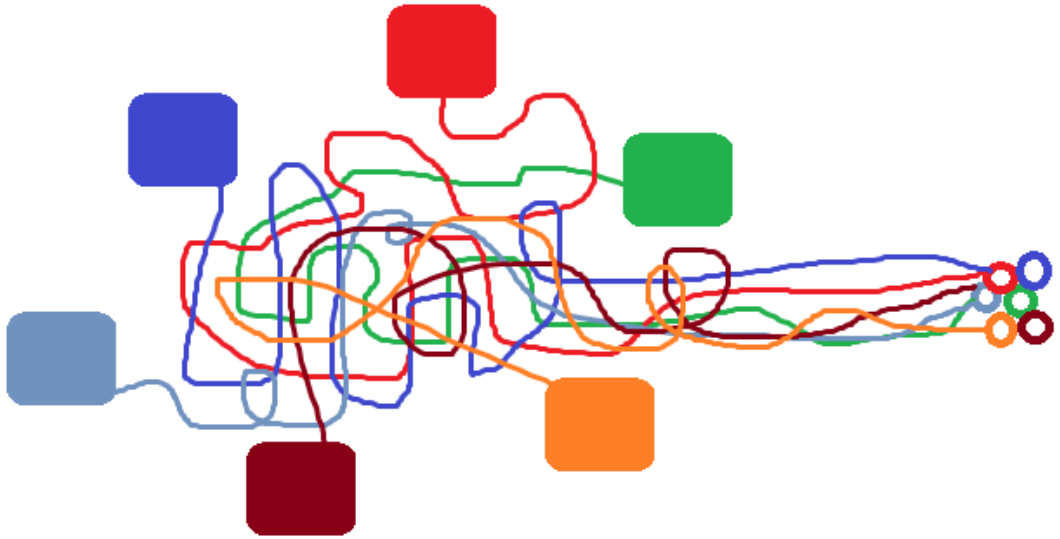


- **Analytical methods are powerful**
- **But not without limitations**

We need a comprehensive approach



Analytical methods



Traceability

REGULATION (EC) No 178/2002 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

Art 18: Traceability

→ Traceability is needed on all stages

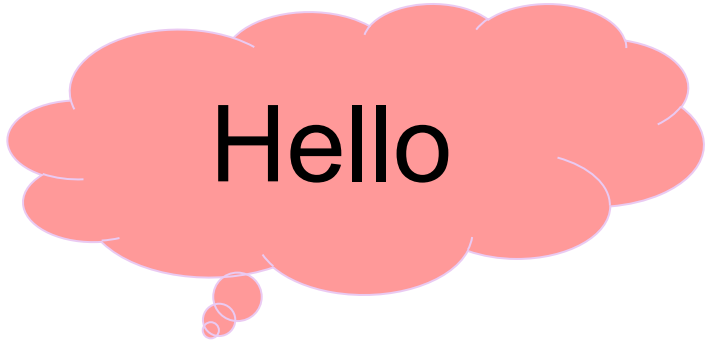
→ A company must know where their products come from

→ A company must know to whom they sell their products

→ One step forward, one step backwards

Rules for implementation?

- Handwritten?
- Digital?
- Not specified in EU regulation 178/2002



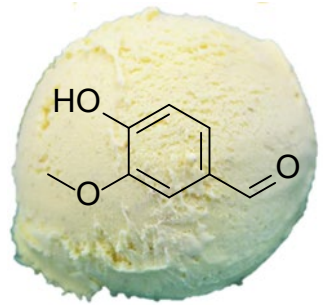
Can blockchain technology improve the management of food supply chains?

- Blockchain is (merely) a database
- Important properties: immutable and distributed
- GIGO – problem?

- **G**arbage **i**n
- **G**arbage **o**ut

Future vision: How could a blockchain look like for the vanilla case

- Vanilla farm
- Intermediates
- Ice cream company
- Intermediates
- Consumer



Certificates,
Mass balance

Something went wrong? Contamination?

For further information*…

*The report was written on behalf of the project ‘Bottom-up blockchain-værdikæder i fødevaresektoren’ (‘Bottom-up blockchain value chains in the food sector’) supported by a grant from Industriens Fond.

Perspective

Received: 16 July 2020 Revised: 12 October 2020 Accepted article published: 15 October 2020 Published online in Wiley Online Library:

(wileyonlinelibrary.com) DOI 10.1002/jsfa.10883

On the benefits and challenges of blockchains for managing food supply chains

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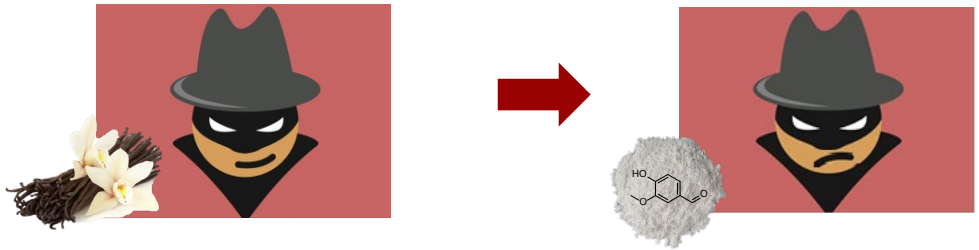
Abstract

The expansion of the food industry, within and beyond national borders, has resulted in complex collaborative networks and supply chains. The management culture adopted for food supply chains has an impact on the quality of the end product and the vitality of the businesses involved. In this report, we focus on the use of blockchain technology, and distributed ledgers in general, for managing supply chains in the food and agricultural sectors. We explore the challenges with which typical management systems are faced, such as food safety, food fraud, and inefficient processes, as well as ethical aspects like fair trade, animal welfare, and the environmental impact of food production. The use of blockchain-based systems for managing a supply chain offers significant benefits, such as faster and more reliable traceability. Our analysis, involving small and medium enterprises (SMEs) from Denmark, highlights that SMEs could benefit from blockchain-based systems that encourage fair trade and authenticity documentation, expose good practices, and decrease management costs. However, due to a lack of important policies and standards, and due to the limited understanding of the technology itself, its large-scale adoption is at the moment immature.

Keywords: supply chains; case studies; blockchain technology; food industry

Conclusion

- **Knowledge from a versatile range of fields like natural, social, ethical, economic, political science, and jurisprudence, needs to be gathered**
- **The design of the solutions is independent of the availability of a decentralized immutable database**
- **A significant step needs to be taken towards the digitization of SMEs and their supply chains**
- **With all the above in place, the integration of decentralized immutable databases in food supply chains can significantly support and advance the food supply chain management.**



Thank you for your attention

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Interest in collaborations?

- **Food Authenticity**
- **Process contaminants**