

Letter to editor

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A Review and Comparison of Methods for Measuring Sugars in Honey Samples

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Abstract

Accurate measurement of honey's sugar composition plays a key role in quality assessment and adulteration detection, particularly regarding the addition of inexpensive sugar syrups. This letter reviews common methods for honey sugar analysis, including classical titrimetric techniques (Lane-Eynon, Fehling's test) and DNS spectrophotometry, as well as advanced instrumental methods such as HPAEC-PAD, GC-MS, and HPLC-RID, alongside rapid, non-destructive technologies such as refractometry and near-infrared (NIR) spectroscopy, comparing them in terms of accuracy, cost, analysis time, and application. The review suggests that a hybrid approach, combining a rapid method for initial screening with a precise instrumental method for confirming suspicious samples, may offer an economical and reliable strategy for honey quality-control laboratories. It is hoped that raising this topic will encourage further discussion and exchange of views among researchers and specialists in this field within the pages of this journal. It is also suggested that future issues include articles focused on the national standardization of honey sugar measurement methods, in order to improve consistency of results across different laboratories.

Keywords Honey; reducing sugars; honey adulteration; HPAEC-PAD; near-infrared spectroscopy

Dear Editor,

I am writing to share with your readers a topic of growing importance in honey quality control and authenticity assessment: the methods used to measure the sugar composition of honey. Honey is a complex mixture of monosaccharides (mainly fructose and glucose), disaccharides (such as sucrose and maltose), and small amounts of oligosaccharides. The ratio of these sugars not only affects the sensory and physicochemical quality of honey but also serves as one of the most important indicators for detecting adulteration, particularly the addition of inexpensive sugar syrups [1,10]. The choice of an appropriate laboratory method for sugar analysis therefore deserves further scientific discussion in this journal.

Emerging concerns

Existing methods for measuring honey sugars can be broadly classified into two categories: classical wet-chemistry methods and advanced instrumental techniques. In the first category, titrimetric methods such as Lane-Eynon and Fehling's test rely on the reduction of divalent copper ions by reducing sugars. These methods are simple, inexpensive, and suitable for laboratories with limited resources, but they cannot resolve individual sugars and their accuracy decreases in the presence of interfering compounds [1]. The dinitrosalicylic acid (DNS) method also estimates total reducing sugar spectrophotometrically and rapidly, but it likewise lacks discriminating power. Among instrumental methods, high-performance an-



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Method	Measurement Principle	Accuracy/Sensitivity	Cost & Equipment	Analysis Time	Main Application
HPAEC-PAD	Anion-exchange chromatography with pulsed amperometric detection	Very high; resolves simple sugars and oligosaccharides	High; requires specialized instrumentation	Moderate (20-40 min)	Adulteration detection, detailed sugar profiling
GC-MS	Gas chromatography after sugar derivatization	High; simultaneous identification and structural confirmation	High; requires derivatization and costly equipment	Long (time-consuming preparation)	Reference and confirmatory research
HPLC-RID	Liquid chromatography with refractive index detection	Good; lower sensitivity than PAD	Moderate to high	Moderate	Quality control laboratories
Lane-Eynon (Titration)	Reduction of divalent copper by reducing sugars	Low to moderate; non-discriminating	Low; no advanced equipment needed	Short to moderate	Routine testing and traditional standards
DNS Method	Spectrophotometry based on reaction with dinitrosalicylic acid	Moderate; non-discriminating, sensitive to interferences	Low	Short	Rapid screening of total sugar
Refractometry	Measurement of refractive index based on Brix percentage	Low for precise composition; suited to rough estimation	Very low; portable	Very short (instant)	Field control at beekeeping farms
NIR	Near-infrared spectroscopy with chemometric modeling	Moderate; dependent on model calibration	High instrument cost; cheap per-sample analysis	Very short and non-destructive	Production-line QC and high-throughput screening

ion-exchange chromatography with pulsed amperometric detection (HPAEC-PAD) is regarded as one of the most accurate and sensitive techniques, since it can simultaneously identify and quantify a wide range of sugars, from simple monosaccharides to complex oligosaccharides; this capability makes it a key tool for detecting honey adulteration [2,10]. Gas chromatography coupled with mass spectrometry (GC-MS), following sugar derivatization, offers high accuracy and structural confirmation, although sample preparation is time-consuming and costly [10]. High-performance liquid chromatography with refractive index detection (HPLC-RID) is also a common choice in quality-control laboratories, though its sensitivity is lower than that of PAD [2].

Alongside these methods, rapid, non-destructive technologies such as refractometry and near-infrared (NIR) spectroscopy have found a distinct niche. Refractometry, by measuring Brix percentage, provides a fast, field-friendly estimate of total dissolved solids, including sugars, and is useful for preliminary checks at beekeeping farms,

though it cannot resolve individual sugar components. NIR spectroscopy, especially in its portable form, relying on calibrated chemometric models, can estimate sugar composition and even botanical or geographical origin non-destructively and in a very short time [5,7,8], making it highly efficient for screening large sample volumes on industrial lines; however, its accuracy depends on the quality and breadth of the initial calibration dataset [7]. In recent years, complementary technologies such as fluorescence spectroscopy [3], machine-learning-based smart gas sensors [9], and Fourier-transform infrared (FTIR) spectroscopy [4] have also been introduced as fast, inexpensive, and reasonably accurate tools for preliminary adulteration screening.

The table below summarizes a comparison of these methods in terms of measurement principle, accuracy, cost, analysis time, and main application.

Conclusion and discussion

Reviewing this comparison, it appears that no single

method can meet all laboratory needs, and method selection should be based on the purpose of testing (routine screening versus adulteration detection), available resources, and laboratory budget. For routine and field quality control, refractometry and NIR are practical, fast options, whereas for confirming honey authenticity and detecting syrup adulteration, HPAEC-PAD, possibly combined with GC-MS, is recommended [10]. A hybrid approach, namely using a rapid method for initial screening followed by a precise instrumental method to confirm suspicious samples, may offer an economical yet reliable strategy for honey quality-control laboratories [1].

It is hoped that raising this topic will encourage further discussion and exchange of views among researchers and specialists in this field within the pages of this journal. It is also suggested that future issues include articles focused on the national standardization of honey sugar measurement methods, in order to improve consistency of results across different laboratories.

With respect, and thanks to the journal for providing a forum to present scientific perspectives.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: Jun. 2026 Accepted: Sep. 2026

Published online: Sep. 2026

DOI: 10.22034/ASAS.2026.587782.1112

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