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Identification of Coffee Species, Varieties, Origins, and Processing and Preparation Methods—A Status Report †

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Abstract: Coffee is one of the most popular beverages in the world. It is made from roasted and ground beans of the coffee plant. There are over 100 species of coffee plants, but only 2 are widely available: *Coffea arabica* and *Coffea canephora*. There are many different ways to prepare coffee. The most common method is to brew the coffee with hot water. However, there are also many other methods, such as those employed to produce cold brew, espresso, and Turkish coffee. The brewing method can affect the flavor of the coffee. The identification of coffee species, varieties, origins and processing and preparation methods is important for a number of reasons. First, it can help to ensure that coffee is of the highest quality. Second, it can help to track the origin of coffee, which can be important for marketing and sustainability purposes. Third, it can help to develop new coffee products and to improve the quality of coffee. There are a number of different methods that can be used to identify coffee species, varieties, origins, and processing and preparation methods. One method requires the use of molecular biology techniques. Molecular biology techniques can be used to identify the genetic markers that are unique to each species of coffee plant. Another method is chemical analysis. Chemical analyses, such as NMR or GC/MS, can be used to identify the hundreds of compounds that are present in coffee, which can be used to determine the origin and processing and preparation methods of the coffee. This introductory lecture will summarize the current state of the art in coffee identification techniques and introduce the audience to the following specialized talks.

Keywords: coffee; species; variety; origin; processing; preparation; molecular biology; chemistry

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1. Introduction

Coffee is a globally recognized beverage with a rich history that spans cultures and continents [1]. Its preparation and consumption have evolved over centuries, resulting in many methods that cater to diverse tastes [2]. However, this diversity has created a need for accurate identification of various aspects of coffee, such as species, varieties, origins and processing and preparation methods [3]. The identification of these elements serves essential purposes, including quality assurance, supply chain transparency, consumer protection, sustainability, and innovation.

2. Influences on Coffee Quality and Authenticity

2.1. Coffee Species and Varieties

The coffee plant genus, *Coffea*, encompasses over 100 species, but for widespread consumption, two species hold prominence: *Coffea arabica* (commonly known as Arabica coffee) and *Coffea canephora* (often inaccurately referred to as Robusta coffee) [4]. Arabica coffee, known for its nuanced flavors and higher acidity, is generally considered superior in quality. Robusta coffee, on the other hand, has a stronger and more bitter taste, making it suitable for certain blends and espresso. The accurate identification of coffee species and

varieties ensures that consumers receive the quality they expect and helps maintain the integrity of coffee blends.

2.2. Coffee Origins and Processing

Understanding the origin of coffee beans has become crucial for both marketing and sustainability efforts. Coffee's terroir, including factors like climate, altitude, and soil composition, significantly influences its flavor profile. By identifying the origin of coffee, producers can highlight unique characteristics, creating distinctive regional branding. Additionally, knowing the origin aids in sustainable sourcing, ensuring that beans are ethically produced and purchased at fair prices, benefiting both growers and consumers.

The processing methods employed after coffee cherries are harvested play a pivotal role in shaping the final flavor. Processes such as washed, natural, or honey processing can dramatically alter the taste and aroma of the coffee. Identifying the processing method helps in ensuring consistency and allows for experimenting with new processing techniques, such as controlled fermentation, to develop innovative flavors [5].

2.3. Coffee Preparation Techniques

The preparation of coffee is a delicate art that varies across cultures and personal preferences. While traditional methods like hot water brewing remain popular, newer techniques, such as those used to produce cold brew [6], espresso, and Turkish coffee, have gained significant traction. Each method offers a unique sensory experience, highlighting different flavor notes and intensities [7]. Understanding the preparation method is essential for achieving the desired coffee experience.

3. Methods for Identification

Several scientific methods facilitate the identification of coffee attributes. Molecular biology techniques have become increasingly powerful in distinguishing coffee species and varieties [8]. By analyzing genetic markers specific to each species, researchers can accurately identify the type of coffee used in a particular blend or product [9].

Chemical analysis techniques, including GC/MS [10,11] and NMR [12–14], enable the comprehensive examination of the compounds present in coffee. These compounds provide valuable information about the coffee's origin, processing methods, and preparation techniques. The precise composition of volatile compounds and flavor precursors can reveal subtle differences between various coffee samples [15–17].

Accurate identification of coffee species, varieties, origins, and processing and preparation methods benefits all stakeholders in the coffee industry. It ensures that consumers receive the quality and flavor they expect, fostering trust and loyalty. For producers, this identification allows them to showcase the uniqueness of their beans, opening up opportunities for market differentiation.

Additionally, identification contributes to sustainability efforts by promoting transparent supply chains, organic farming, ethical supply chains, and fair-trade practices. By tracking the origin of coffee beans, companies can verify that they source beans from regions where sustainable practices are employed, promoting ethical and environmentally friendly coffee production.

Nevertheless, there is a lack of international reference methods that would accomplish any of these goals. Many of the methods available in the literature are only case studies lacking proof of applicability for real-world samples as well as the validation required for official control purposes. The only exception may be the NMR method for Arabica and Canephora differentiation, which was recently validated by an international interlaboratory ring trial and is currently in the last stage of publication as a European Norm (EN) and German Norm (DIN) method DIN EN 17992 [18].

4. Conclusions

The identification of coffee species, varieties, origins, and processing and preparation methods is essential for maintaining quality, promoting sustainability and driving innovation in the coffee industry. Advances in molecular biology and chemical analysis techniques have significantly improved our ability to precisely identify the various aspects of coffee.

As coffee enthusiasts, professionals, and researchers, it is our responsibility to stay up to date with the latest identification methods and use this knowledge to enhance the overall coffee experience. By understanding the intricacies of coffee identification, we can ensure that every cup of coffee brings delight to consumers while supporting the livelihoods of coffee growers and preserving the beauty of coffee origins.

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