

Uncovering Pathways to Honey Authenticity

An analysis of strategies to ensure authenticity, transparency, and sustainability in the U.S. honey marketplace



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Executive Summary

Honey, like other food, is vulnerable to adulteration, and is one of the most adulterated foods globally. Adulterated honey can take many forms such as diluting with other sweeteners, blending with other grades of honey, or even bee-feeding. Countries of origin can be incorrectly labeled or honey may be heated. Discrepancy between researchers and communities of practice on what adulteration means complicates the issue. Through a review of existing literature, a consumer survey, and interviews with communities of practice, this report seeks to provide a review of adulterated honey in the U.S. and its impact on beekeepers and consumers.

Key findings from our research show that there is commonality and divergence in terminology, what processes lead to adulterated honey, and how to address it. While researchers and the U.S. government use the term “adulteration,” industry professionals sometimes also use other terms such as “fraudulence” and “fake.” This discrepancy may contribute to consumer confusion and barriers to mitigating adulteration within the federal government, especially in light of frequent recommendations from the industry for the FDA to implement a federal standard of identity.

Additionally, identifying what adulteration means varies between industry professionals and researchers. Bee-feeding, for instance, is identified by researchers as a method of indirect adulteration as it alters the natural process and has been shown to result in the same chemical change as diluting honey with sweeteners. However, many industry professionals point to bee-feeding as an essential and common practice. This variance in perspective further complicates mitigation and how the FDA should standardize pure honey.

Our research shows that half of consumers are unaware that adulterated honey exists, and their willingness to pay more for pure honey is hampered by the low prices of honey, which have been devalued by imports that may be adulterated. It is this struggle that may reinforce the decline in U.S. honey production while imports continue to rise. Beekeepers feel burdened by the rising costs of producing honey while competing with foreign imports. Additionally, self-regulation in the industry has led to retaliatory behavior against those who are calling out adulterated honey, according to some industry professionals.

Our team has reviewed feedback from consumers and industry professionals, and has determined that a multi-pronged approach is necessary due to the exacerbation of the issue. Consumer education is needed, but standardization by the U.S. government coupled with enforcement is the key to mitigating adulterated honey. We do not believe

that third-party options, nor self-policing, are supportive, but rather, the FDA needs to develop a federal standard of identity that is created with stakeholder input.

As the U.S. faces declining bee colonies that support not only beekeeper livelihood, but the viability of agricultural crops, it is essential to uplift the work beekeepers do, and preserve their product, which in turn boosts the economic viability of their product and safeguards consumers. Protecting domestically produced pure honey should be part of the work that the USDA does to protect food systems, especially in light of the challenges of climate change.

Introduction

Pure. Natural. Raw. Unfiltered. Organic. What do these words have in common? All of these descriptive terms can be found prominently displayed on containers of honey in grocery stores across the United States and the world. Honey is widely treasured among consumers for its sweet taste and health benefits, and is even seen by some as a “superfood” (Sowell and Lord, 2021; Zanchini et al., 2022). Yet, behind the curtain of these positive associations lies a hidden reality—one marred by fraudulence and adulteration within the honey industry.

This research report, exploring the impact of adulterated products on the U.S. honey market, originated from growing concerns within the honey industry about the prevalence of adulterated honey and false labeling. The specific research question that guided this project is: **How is the U.S. honey market impacted by fraudulent claims and products, and what are the best strategies and policy initiatives to protect it?** By addressing this question in the report, we seek to support the sustainability of authentic honey producers and improve transparency for consumers.

The terms *adulteration* and *fraudulence* are often used interchangeably in the industry. For this report, we chose to primarily use the term adulteration as an identifier of food that has been altered, therefore using the same term as the U.S. Food and Drug Administration (FDA) and U.S. Department of Agriculture (USDA). For the purposes of our study, we are using the FDA’s definition of economically motivated adulteration (EMA): “EMA occurs when someone intentionally leaves out, takes out, or substitutes a valuable ingredient or part of a food. EMA also occurs when someone adds a substance to a food to make it appear better or of greater value” (FDA, 2024a).

In honey production, adulteration can take a variety of forms but is typically conducted through the addition of cheap sweeteners. Regardless of the method, adulteration is a fraudulent practice that threatens both consumer trust and the livelihoods of genuine producers in our food system. The U.S. has proven to be particularly vulnerable with complex supply chains and high value-products that are prime targets for fraudulent practices (Ryan, 2015).

The issue of food fraud and consumer deception is not unique to honey. Similar cases have emerged in other industries, such as the infamous Kona coffee lawsuit in 2023-24, where producers of genuine Kona coffee successfully challenged companies that falsely marketed their products as Kona-grown (Hughes, 2024; Latham, 2024). This lawsuit resulted in multiple settlements totaling \$41 million for Kona coffee farmers, which underscores the seriousness of food fraud and the importance of vigilance across all

sectors of the food industry. Beyond coffee and honey, other commonly targeted foods include olive oil, milk, saffron, orange juice, and apple juice, highlighting the widespread nature of the problem (Choudhary et al., 2020).

Survey findings and interviews conducted for this report reveal a pervasive concern among stakeholders about the integrity of honey products in the U.S. market. From beekeepers to consumers, the impact of adulterated honey is felt across the supply chain, highlighting the need for stronger regulatory measures and more transparent labeling practices.

In conclusion, this report aims to shed light on the hidden but significant issue of honey adulteration in the United States. By understanding the various forms of adulteration and the strategies needed to combat it, we can work towards a future where consumers can trust the labels on their honey jars, and authentic producers are protected from unfair competition.

Literature Review

There has been a great deal written about the topic of food adulteration, and also about challenges faced by the honey industry—but not as much about the combination of the two. Our research team scoured peer-reviewed journals, industry and trade press articles, books, and government publications and websites in an effort to frame the issue as completely as possible and understand what has been learned to date.

American consumers annually eat about 1.9 pounds of honey on average, reflecting a 45% increase since the 1990s (Abadam & Yeh, 2022), and half of this consumption comes from honey-containing products, such as cereal (Matthews et al., 2018). This pressure to meet rising demand, combined with bee colony collapses in the U.S. (Steinhauer, 2023; USDA, NASS, 2016; USDA, AMS, 2024), leaves the honey market especially susceptible to adulteration.

Honey adulteration is a complex issue that affects a wide range of stakeholders from producers and packers to consumers. It undermines market integrity and consumer trust, while also being difficult to detect (Wu et al, 2017, Zhang & Abdulla, 2022). To better understand how the U.S. market is impacted by adulterated honey, a literature review was conducted to examine existing knowledge and identify gaps. Our review found that while there is substantial research around what adulteration means, and methods for detecting adulterated and fraudulent honey, a gap exists around the U.S. regulatory framework for honey production and the levers within that framework that enable economically motivated adulteration.

To strengthen our research, we incorporated a variety of sources including academic articles, news media, industry websites, books, and government agency websites and publications to create a broader framework of understanding. While research on honey adulteration would benefit from a comprehensive approach that includes ecological, social, and economic impacts, our research seeks to focus on providing a basis of understanding for honey adulteration in the U.S. marketplace and challenges to addressing it.

Additionally, this foundational literature review will inform the basis of our data collection, which will support and expand on the existing body of literature surrounding this critical issue. As imports of honey continue to rise while U.S. honeybee colonies decline, understanding the regulatory gaps and market dynamics becomes increasingly important to protect domestic production, maintain market integrity, and protect consumers.

Food Adulteration

Looking at a jar of honey, one may notice gradations in color, from pale yellow to dark amber. Open the jar and one may notice variances in texture, from thin to thick to containing crystals. Taste the honey and one may notice differences in flavor ranging from sweet to bitter. These can all be attributed to being a product of nature with bees pollinating different plants during different times of the year in different regions with different weather conditions. Like wine, honey can and should have varying characteristics, but these differences should be attributed to the “nectar of plants or from secretions of living parts of plants or excretions of plant sucking insects on the living parts of plants, which the bees collect” (FAO, 1981, p.1).

What is often lost on the shelf is the knowledge about what these jars contain or how they have been changed, shifting them from pure to adulterated honey.

Adulteration, or fraudulence in food, has been part of food systems for thousands of years. In the second century BC, agents were assigned to protect consumers through the prevention of producing fraudulent food (Hart, 1952). Around the same time, fines were issued on the Indian subcontinent for adulterated grains, oil, and salts (Hart, 1952).

“It has been decreed and strictly forbidden by our alderman...that henceforth none of our citizens...may buy or sell any honey except that which has been examined and measured by duly appointed honey inspectors.” - Nuremberg law enacted in 14th century (Hart, 1952, p. 10)

Today, adulteration continues to be prevalent in foods, including honey, and continues to be a challenge for regulation and consumer awareness.

Adulteration of Olive Oil: Case Study

Widespread adulteration and deceptive practices within the food industry not only threaten the credibility of the global food supply chain, but also contribute to severe economic consequences (Spink & Moyer, 2011). Recent research estimates that food fraud costs the global economy between \$10 and \$15 billion annually, affecting roughly 10% of all food products (Johnson, 2014). To combat this escalating issue, a comprehensive approach is needed, which includes analytical testing, early warning systems, vulnerability assessments, and intelligence gathering (Amaral, 2021; Pereira et al., 2021). Additionally, fighting food adulteration necessitates a collaborative effort from stakeholders such as policymakers, regulatory bodies, researchers, and the food industry, to maintain the integrity and safety of the food supply chain (Spink, 2019).

The food industry's relatively low profit margins compared to other sectors have driven fraudulent activities, commonly referred to as "food fraud" (Everstine et al., 2013). Food adulteration and food fraud, while related, are distinct concepts that have garnered considerable attention in academic literature. Food adulteration refers to the deliberate addition or substitution of substances in a food product to increase its volume or improve its appearance, flavor, or other properties (Amaral, 2021; Pereira et al., 2021). On the other hand, food fraud is a broader concept that includes not only adulteration, but also practices such as mislabeling, substitution, dilution, concealment, and unauthorized enhancement, all aimed at achieving economic gain (Amaral, 2021; Sprink, 2019). While food adulteration focuses mainly on the physical and/or chemical modification of a food product, food fraud covers a wider array of deceptive practices that may not necessarily involve altering the product itself (Ulberth & Buchgraber, 2000; Pereira et al., 2021).

Olive oil, a staple ingredient in many culinary traditions, has become a prime target for fraudulent activities (Pereira et al., 2021). While this is a widespread problem across many food products, olive oil is particularly concerning due to its high value and high demand. Therefore, developing reliable and rapid techniques to detect adulterated olive oil is crucial (Abbas and Baeten, 2016). There have been several notable cases of olive oil adulteration, including the use of lubricating oil meant for jet engines in Morocco, causing illness in 10,000 people, and the sale of de-naturalized rapeseed oil labeled as olive oil in Spain, leading to over 20,000 cases of poisoning (Yan et al., 2020).

Due to its liquid form, olive oil can easily be blended with cheaper, lower-quality oils, making it one of the most frequently adulterated food products (Yan et al., 2020). Extra virgin olive oil is often mixed with oils like sunflower, soybean, or palm to boost profits (Pereira et al., 2021). As a result, although "extra virgin" is recognized as the highest quality olive oil on the market, many products labeled as such may not actually meet the

strict standards required for this classification, therefore misleading consumers and causing geographical misrepresentation (Pereira et al., 2021). These fraudulent practices pose significant challenges for producers, consumers, and legislators alike, who are working to preserve the integrity of olive oil in the market (Yan et al., 2020).

Olive oil adulteration not only undermines the authenticity and quality of the product, but can also pose potential health risks to consumers (Salah & Nofal, 2020). To address this pressing issue, researchers have been actively developing techniques to detect and prevent olive oil adulteration. These emerging approaches enhance the speed of analysis while offering better statistical insights and lower detection limits, ultimately providing a more thorough understanding of olive oil authenticity (Aparicio et al., 2013). Despite the progress being made in identifying and preventing olive oil adulteration, ongoing research is needed to secure an authentic market for olive oil (Garcia et al., 2013).

Adulteration of Honey

While there are many definitions of adulterated honey, processes that lead to adulteration range from direct (addition) to indirect (fed to honeybees), as well as mislabeling, blending, and altering purity through heat.

Direct

Direct adulteration involves the addition of secondary ingredients not listed on the label (Se et al., 2019). Direct adulteration can contain starchy syrups (e.g., high fructose corn syrup, rice syrup, corn syrup, cane sugar syrup, high fructose syrup from cassava), inverted syrups (e.g., cane sugar syrup, beet syrup), as well as high fructose inulin syrup, date syrup, and jaggery syrup. Types of syrups used vary regionally due to prevalence and cost of sweeteners. While the most often used adulterant syrups are high fructose corn syrup (HFCS), cane sugar syrup (CASS), inverted sugar syrup (ISS), and corn sugar syrup (COSS), wheat and rice-based syrups are used more in Turkey and France while rice syrup is more prevalent in China, and jaggery syrup is predominant in India (Se et al., 2019).

Indirect

Adulteration in honey is also the result of indirect adulterants wherein bees are fed sugar solutions in lieu of using the natural process of pollination (Se et al., 2019). Bee-feeding can be used to increase yield (Fakhlaei et al., 2020), increase the queen's egg-laying production, keep colonies alive during winter months where floral sources are scarce, and treat diseases (Cordella et al., 2005). Syrups fed to bees include HFCS,

sucrose syrup, and other unknown syrups (Se et al., 2019). While the process may seem harmless enough, it does affect bees and their product. Bee-feeding with HFCS has been shown to lead to an increase in bee deaths (Se et al., 2019). Analysis of bee-feeding has also shown that there is a decrease in nutritional quality of honey (i.e., minor sugars, proteins, and amino acids) and that the chemical modifications match those of direct adulteration by diluting honey with sweeteners (Cordella et al., 2005).

Other Methods

Honey can also be blended with different grades of honey, have a mislabeled country of origin or botanical origin, and be heated (Zhang & Abdulla, 2022). Blending different grades of honey such as acacia and rape honeys can occur when producers seek to stretch the product by using inexpensive available syrups (Se et al., 2019).

Mislabeled honey with incorrect country of origin (COO) or botanical origin misleads consumers. While mislabeling COO or pollinating plants may seem minor, knowing where one's honey comes from often drives purchases by those with allergies or dietary preferences. The FDA does not require labeling of floral sources, but it prohibits inaccurate labeling (FDA, 2017). Mānuka Honey, a product that can only be produced in New Zealand, is produced in the amount of 1700 tons annually, but somehow the UK alone imports 1800 tons (Associated Newspapers, 2014). The government of New Zealand charged Evergreen Life Ltd with adulterating mānuka honey by adding in methylglyoxal and dihydroxyacetone, which enables honey producers to use lower quality mānuka honey and alters the flavor to appear to be a high-quality honey (Taylor, 2019).

The EU, the second largest importer of honey, has found that almost 50% of their imported honey is adulterated, with 75% of that coming from China (Ždiniaková et al., 2023). A sampling of 320 honey consignments from 20 countries, as well as from unidentified countries of origin, revealed that China had the highest number of suspicious consignments, with 66 out of 89 samples. Turkey, however, had the highest prevalence of "relative proportion of suspicious samples" with 14 out of 15 found to be in this category (p. 5). The U.K. showed a higher rate, with 10 out of 10 samples deemed suspicious, but this is likely due to the importation of foreign honey and its subsequent export, which likely results in an inaccurate perception of the country of origin (Ždiniaková et al., 2023).

Honey has been touted for its therapeutic effects and used to build up tolerance to local pollen, soothe a sore throat, and for immune system support (Morariu et al., 2024). The natural health system, ayurveda, states that once honey is heated, it becomes toxic (Annappoorani et al., 2010). In the world of fraudulence, heated honey would be

considered adulterated since its original composition is altered (Fakhlai et al., 2020). However, there are no requirements by the FDA to address heated honey and no standards in the U.S. or globally around what constitutes raw honey. Heated honey has been found to have decreased protein, nitrogen, and potassium (Fakhlai et al., 2020), yet producers may heat honey to make processing easier or remove potential yeasts and bacteria (Subramanian et al., 2007; Singh & Singh, 2018).

Introduction to Testing

While the technology exists to test every batch of honey, testing each jar of honey for each type of adulteration would be timely and costly. The FDA, the public, and distributors who purchase bulk honey may have access to honey testing in-house or through third parties. However, testing becomes complex no matter who issues the request. Different types of adulteration require different tests to identify each facet of adulteration. Additionally, each test comes with its own set of benefits and drawbacks.

Testing: Origin

Tests are available to identify the accuracy of botanical and geographical origin labels. The traditional method uses microscopy to look for pollen in honey and identify plant sources (Zhang & Abdulla, 2022). However, this process is very specialized and time consuming. Other forms of testing include:

- Mass spectrometry (MS) is an effective method for testing honey, but it is complex and requires expensive equipment to scan for ions and analyze isotopic ratios. Similarly, chromatography, which separates chemical signatures, is a reliable way to identify adulteration. However, like MS, it is a time-consuming process and also relies on costly equipment.
- Spectroscopy does not require the same type of involved handling as MS and chromatography. Raman spectroscopy looks for the “fingerprints” of adulterants in molecules; while this method is cost-effective and quick, it can only test one sample at a time and requires pre-processing.
- Infrared spectroscopy may not be reliable as it typically is unable to detect all origins of honey.
- Nuclear magnetic resonance (NMR) spectroscopy is the most complex type of spectroscopy, requiring a specialist and expensive equipment.
- Hyperspectral imaging has the capacity to test multiple batches at once, but requires significant data processing.
- Laser-induced breakdown spectroscopy (LIBS) is unable to always provide accurate results as it may group sources with similar elemental composition together (Zhang & Abdulla, 2022).

Testing: Direct Adulteration

Direct adulteration tests assess C4 plants which consist of corn and cane plants, as well as C3 plants which produce rice (Rachineni et al., 2022). Tests include:

- Stable carbon isotopic ratio analysis is unable to detect C3 plants. MS can be used to measure the $^{13}\text{C}/^{12}\text{C}$ isotope ratios in honey samples, but results may be inaccurate since blossom plants and sugar-additive plants may both originate from the same classification of plants (Zhang & Abdulla, 2022).
- Chromatography is successful at determining direct adulteration with gas chromatography being efficient, but liquid chromatography is time-consuming and tedious.
- Hyperspectral imaging is an effective test.
- NMR is ineffective as it has difficulty detecting C3 plants, and LIBS does not fully detect adulterants.
- Infrared spectroscopy is an effective and practical test with the ability to test for both C3 and C4 plants. This test is cost-effective, has portable commercial versions for smaller and in-house labs, but is unable to process multiple samples simultaneously.
- Raman spectroscopy is also effective on both C3 and C4 plants, and can test through glass. Like infrared spectroscopy, it is cost-effective, and has portable commercial versions for smaller and in-house labs. However, it is also unable to process multiple samples simultaneously.
- Fluorescence spectroscopy looks at fluorophores in specific amino acids and can measure adulteration to 1% accuracy, but once again is limited to individual samples.
- Testing via thermographic images requires a long process.
- Biosensors can test multiple samples at once, however, the cleaning required to maintain accurate results makes it challenging (Zhang & Abdulla, 2022).

Testing: Feeding Bees

Testing for honey adulteration that occurs through feeding sugar syrups to bees is not commonly available as sugars cannot always be detected and chemical signatures, when found, can be confused with direct adulteration (Zhang & Abdulla, 2022).

Testing: Blending

Blending can be identified through pollen identification and tests such as REIMS, NIR, and NMR (Zhang & Abdulla, 2022).

Conclusion

In 2022-23, the FDA collected samples of imported honey from 25 countries in jars, barrels, and/or drums to check for direct adulteration, repeating a process they conducted the previous year (FDA, 2024b). Of the 107 samples collected, 3% were found to be volatile (i.e. adulterated), which included honey from Yemen, Mexico, and the Dominican Republic (FDA, 2024b). While testing showed a decline over the previous year, the FDA explicitly says their testing is not meant to be analyzed in such a way (FDA, 2024b). Despite samples showing some volatile positive results, the FDA used Stable Carbon Isotope Ratio Analysis (SCIRA) for detecting adulteration (FDA, 2024b). This test has shown to be mostly effective in testing C4 plants, but not as effective with C3 plants (Wu et al, 2017). However, even with C4 plants, SCIRA has incorrectly identified adulteration such as mānuka honey that tested positive for adulteration despite being pure, likely due to the presence of pollen or dust (Wu et al., 2017).

Overall, hyperspectral imaging is recommended for testing origin and direct adulteration since it can process multiple samples simultaneously, has no minimum number of samples required to process, and is fast and economical (Zhang & Abdulla, 2022). However, testing is not yet at capacity to check for every type of adulteration.

Regulation of Honey Production, Labeling, and Certification in the United States

In the United States, multiple federal agencies play a role in regulating the labeling, testing, and certification of honey. The USDA, FDA, U.S. Customs and Border Protection (CBP), and individual state governments each regulate aspects of honey production that are critical to creating clarity and market opportunities for honey producers, and maintaining trust from consumers in the honey supply chain. Identifying the impact of adulterated honey on the market and understanding solutions to reducing honey fraud requires an understanding of the role each agency plays. This literature review includes a brief history of attempts that agencies and industry actors have made to increase the regulatory tools that impact honey production, including creating a federal standard of identity, adjusting labeling requirements, and implementing an organic certification process. White papers from the Resnick Center for Food Law & Policy at UCLA (Roberts, 2019) and the Regenerative Apiculture Working Group (Golbeck, Kastner, Harris, & Tensen, 2021) provide the most thorough and rigorous attempts at describing this regulatory framework and its gaps. This section of the literature review relies heavily on these two sources, as well as U.S. government documents as primary sources.

Food and Drug Administration (FDA)

The 1938 *Federal Food, Drug, and Cosmetic Act* (FD&C Act) defines what a standard of identity for food is, as well as who is responsible for establishing labeling standards for foods (Lam & Patel, 2023). The FD&C Act assigns the FDA statutory authority to regulate those standards of identity and labeling of honey. The agency provides guidance on what can and can't be labeled as honey, and what that labeling should include, as well as holding responsibility for enforcing compliance with its labeling standards (FDA, 2019). The FDA's authority to enforce compliance with labeling expectations includes ensuring that products labeled with honey as a sole ingredient don't contain any other ingredients. This makes the FDA the primary agency responsible for preventing and responding to suspected cases of honey adulteration (FDA, 2022).

It's important to note that when it comes to labeling, the FDA offers regulations for some products, but not all. For honey, the FDA only offers a Guidance Document. In March 2018, the FDA released a document titled *Guidance for Industry: Proper Labeling of Honey and Honey Products*. This document clarifies that "FDA's guidance documents...do not establish legally enforceable responsibilities. Instead, guidance describes [FDA's] current thinking on a topic and should be viewed only as recommendations, unless specific regulatory or statutory requirements are cited. The use of the word 'should' in guidance from the FDA means that something is suggested or recommended, but not required" (FDA, 2019, para. 5).

One way the FDA can create standards that enable legal action against adulteration in packaged food products is by creating a standard of identity. "Standards of identity are regulations that establish the composition of a food, its name, and the ingredients that must be used, or may be used, in the food. Once a standard of identity is established, any food that purports to be the standardized food must comply with the standard of identity, and a food may not bear the standardized name if it does not comply with the standard" (Steele et al., 2016). In his 2019 white paper, Michael T. Roberts of UCLA detailed the honey industry's long-standing advocacy efforts for an FDA standard of identity for honey (Roberts, 2019). In 2006, the FDA was called upon via a citizen petition to adopt the standard set by the Codex Alimentarius Commission (CAC). The CAC is an international body created by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations which sets international food guidelines and standards. By 2009, the FDA was directed by both the House and Senate Agriculture Appropriations Committees to review said petition (Roberts, 2019). Ultimately, the FDA denied the petition (Roberts, 2019), but in 2018 issued guidance on labeling that was not enforceable (FDA, 2018). Despite soliciting public comment in 2014 (Roberts, 2019), as of July 2024 the FDA has still not created a federal standard

of identity for honey. In the absence of agency action, the latest attempt to move a standard forward has been by Representative Kelly Armstrong (R-ND), who introduced legislation in 2023 that would require the FDA to create a standard of identity (HIVE Act, 2023).

The FDA has several mechanisms it can use to address label noncompliance. Actions may take the form of a warning letter, recalls, import restrictions, product seizures, and court-ordered injunctions to legally force companies to take a desired action (FDA, 2024a). However, without a standard of identity, enforcement becomes challenging.

USDA Agricultural Marketing Service (AMS) & USDA Organic Certification

In addition to regulating elements of labeling for honey like country of origin and grade, USDA AMS also oversees all agricultural products sold, labeled, or represented as organic in the United States. Organic certification has four categories that include crops, wild crops, livestock, and handling (defined as selling, processing, or packaging) (USDA AMS, 2015). Domestic honey producers seeking USDA Organic certification from certifying organizations must currently adhere to the livestock standards (Golbeck et al., 2023). There have been multiple attempts to develop a USDA Organic standard for honey over the past 24 years, but none have resulted in finalized federal standards. The two most significant attempts have been in 2001 and 2010. The *2010 Formal Recommendation by the National Organic Standards Board (NOSB) to the National Organic Program (NOP)* (2010) laid out this history, and the goals of the 2010 recommendation process:

In the Fall of 2001 the NOSB issued a recommendation on Apiculture Standards. The proposed standards were sent back to the NOSB Livestock Committee for further work and refining. In the interim, many new pressing issues resulted in apiculture languishing on the Livestock Committee's work plan. In late 2008 an apiculture working group formed independently of the NOP and the NOSB, with two goals: 1) help the Livestock Committee rework the 2001 Apiculture Recommendation, and 2) bring apiculture back to the forefront.

In the latest rules laid out in National Organic Program (NOP); Organic Livestock and Poultry Standards (2023), honeybees are still categorized alongside mammals as "non-avian livestock." Since these 2023 rules, there have not been any new standards set specifically for apiculture (USDA AMS, n.d.).

Honey is an unusual category for organic certification because of the wide foraging range of bees. In their 2021 *Regenerative Apiculture White Paper*, Golbeck et al. note that "most beekeepers in the US are unable to produce organic honey due to a lack of

access to organic certified land for their bees to live on and forage” (p.16). They identify the primary challenge as the NOP’s “forage zone,” which specifies that colonies must be surrounded by a 1.8-mile radius circle of wild or managed cropland that meets organic standards. An additional 2.2-mile radius is designated a “surveillance zone,” where beekeepers must provide a description of all crops and potential contaminants in the zone. This amounts to a 50.27 square mile area that requires active management and/or record-keeping for beekeepers interested in certifying their honey as organic. There simply are not many tracts of land manageable to this standard in the continental United States. Hence, it was not surprising to us to find that guidelines for organic honey created by the USDA have never been widely implemented, if at all.

Given the lack of academic literature on organic apiculture, we supplemented with observational research in retail stores, where we found a limited amount of honey for sale with the USDA Organic certification. Most of this came from other countries, such as Brazil and New Zealand which – we gathered from several of our interviews and from the USDA AMS *International Trade Partners* web page – have organic “equivalency arrangements” with the U.S. (n.d.). Interviews noted that a handful of beekeepers in Hawaii are the only producers in the United States that can sell honey with a USDA Organic seal, as it is generally acknowledged that Hawaii’s geographic isolation can facilitate the production of organic honey under the current livestock certification rules. Golbeck et al. frame the lack of clear and achievable standards for domestic organic honey certification as an important market access issue for beekeepers. Without accessible standards, they argue that beekeepers lose one tool they could use to mitigate the economic impact of artificially low prices caused by honey adulteration. While there are many articles and web resources that outline the challenges with organic apiculture, beyond Golbeck et al.’s work the authors were not able to find any other published academic papers outlining this regulatory issue and possible solutions.

Customs and Border Protection (CBP)

U.S. Customs and Border Protection is the primary agency charged with monitoring, regulating, and facilitating the flow of goods through U.S. ports of entry. This includes enforcing trade and customs laws, like antidumping duties (AD), that are designed to protect U.S. consumers and businesses (Jones & Seghetti, 2015). Technically, adulteration is a food safety issue and outside the scope of CBP’s regulatory authority. CBP’s testing regimen focuses on Country of Origin identification, preventing transshipment and identifying the purity of honey to ensure the application of the correct tariff schedule. While not focused directly on adulteration, the agency also recognizes that adulteration and import fraud “...also pose a serious threat to the U.S. health and to food safety” (Johnson, 2022, p. 2). In light of the overlap between its authority and the FDA’s food safety responsibilities, CBP works both independently and collaboratively

with the FDA, on actions like seizing honey imports that are suspected to be fraudulent, and the testing of honey imports (CBP, 2020).

State Laws

Many states have laws that regulate different elements of beekeeping and honey production. Examples of state-level honey regulations include additional labeling requirements (Scher, 2018); state-specific standards of identity (FDACS, 2009); and regulations about honey marketing claims using the term “local” (Young, n.d.).

While state laws can play a role in protecting honey from adulteration by complementing existing federal regulations, they also operate to make up for perceived gaps in federal law that impact local producers and honey markets, like not having a federal standard of identity for honey. In a 2022 Congressional Research Service report, it’s noted that USDA has been aware of the difficulties that a patchwork of state laws can create for honey producers since at least a 2014 report it made to the FDA:

...some states have “enacted differing honey standards raising concerns about inconsistencies, the flow of commerce within the honey industry, confusion in the marketplace and unanticipated legal challenges,” highlighting the need “to develop a consensus federal standard of identity” by FDA. (Johnson, p. 2)

This USDA report demonstrates that there are opportunities for the federal government to look at existing state laws, and identify places where federal regulation might provide for a clearer regulatory framework for the honey industry.

Industry Certifications for Honey

In an attempt to combat the ongoing issue of honey adulteration in the supply chain, multiple certification programs have been created by the food industry to authenticate pure, unadulterated honey and increase transparency to consumers. Two of the most common programs are True Source Honey and GenuHoney®.

True Source Honey

True Source Honey, a non-profit created in 2010, was collaboratively formed by honey companies and importers to specifically target “illegal sourced honey from China” (True Source Honey, n.d.). Over time it has evolved into the leading certification program for honey, with over 40% of honey currently sold in the U.S. and Canada displaying its seal. The organization claims that any honey with the



True Source Certified® seal is “fully traceable, from hive to table, tested to confirm authenticity and audited by a third party” (True Source Honey, n.d.).

GenuHoney

Despite True Source Honey’s seemingly comprehensive certification process, GenuHoney® was created to establish an even more rigorous certification program for authentic honey. Their website states that they are the “*only* certification that allows consumers to trace honey back to the beekeeper who produced it” (GenuHoney, n.d.). They tout a simple 3-step authentication process including an audit, authenticity test, and segregation (GenuHoney, n.d.). An article published by VICE that is linked on the website of GenuHoney® claims that “True Source hasn’t been as thorough as they claim to be, and has instead become a shield behind which nefarious players can import adulterated honey without reprimand” (Love, 2020). It is clear that GenuHoney® distinguishes itself as a superior and more reliable honey certification program compared to True Source Honey. However, there is a lack of peer-reviewed sources to substantiate this notion.



Impacts of Food Certifications

Food certification programs and labels have become increasingly prevalent, aiming to enhance transparency for consumers. These certifications are managed by various entities, including government bodies, private companies, and nonprofit organizations, with goals ranging from sustainability and equity to health and purity. Despite their positive intentions, the actual impacts of these programs can be unexpected and complex. Reviewing these effects is crucial to understand how a certification program aimed at protecting honey from adulteration might impact the market. A pertinent example is the Non-GMO Project certification.

The Non-GMO Project Certification Case Study

The Non-GMO Project is a certification initiative created by a nonprofit organization that establishes stringent standards for testing, traceability, and segregation of genetically modified organisms (GMOs). Food products verified by this program can display a label on their packaging indicating they are free from GMOs, thereby offering consumers increased transparency about the product’s origin and impact.



In a study on the politics and history of non-GMO certification, author Robin Roff (2008) highlighted the uniqueness of the non-GMO label, noting that it “does not fill a

previously occupied space, but a void in which regulation never existed” (p. 354). This is comparable to the honey industry, where regulation on adulteration is lacking. In her conclusion, Roff explained that despite initial intentions of the Non-GMO Project to push manufacturers to eliminate genetically engineered ingredients, the certification was co-opted by industry interests, shifting focus from feasibility to economic profitability. This transformation increased industry participation but weakened the certification's potential to prevent the spread of genetic modification, as it re-legitimized dominant agrifood actors and reduced public debate. The paper suggests that activists for causes similar to the Non-GMO Project should consider alternative strategies, such as targeting retailers directly, organizing boycotts, leveraging socially responsible investment, and broadening consumer activism to include institutional purchasing programs. According to Roff, these alternatives could be more effective in addressing agro-ecological issues without reinforcing elite power structures (Roff, 2008).

Other scholars have warned that third-party certifications can end up supporting the same free-market attitudes and relationships that go against the environmental and social goals they aim to achieve (Guthman, 2007; Brown & Getz, 2008). A book on biotechnology from the University of California Press further expressed concern that food certification programs such as the Non-GMO Project create niche markets that depend on the existence of conventional, non-certified products to show their value (Guthman, 2004).

In the same vein, researchers found that certification labels like organic and fair trade can create gaps between consumer expectations and on-the-ground realities (Getz & Shreck, 2006). Case studies in Mexico and the Dominican Republic revealed that small farmers often do not fully benefit from these certifications, with fair trade sometimes failing to deliver true fairness and organic certification imposing rigid and exclusive trade terms that can harm social relations. This article urges consumers to critically examine the real social and environmental factors behind certified food and questions the effectiveness of market-driven certification models in promoting truly sustainable and equitable food production (Getz & Shreck, 2006).

It is also worth noting that in 2022, the United States government implemented the National Bioengineered Food Disclosure Standard, which requires that “food makers, importers, and certain retailers label foods that are bioengineered or have bioengineered ingredients” (FDA, 2024c). Since then, all food sold in the U.S. that meets the definition of bioengineered food must provide a disclosure on their packaging that states “bioengineered food,” displays the bioengineered food symbol, or gives directions for using a phone to find the disclosure. Although one may assume that this new standard would impact consumer behavior, a case study on GMO and non-GMO

labeling effects found that adding mandatory labeling to a market with existing voluntary non-GMO labels did not change demand (Adalja et al., 2023). Instead, the legislative process raised awareness about GMOs and boosted non-GMO product sales even before the law took effect. This increased demand for non-GMO products also spread to other states considering similar laws. Their results suggest that voluntary non-GMO labels might already provide an effective way to inform consumers without needing mandatory GMO labels (Adalja et al., 2023).

Beekeeping in the U.S.

While *The Washington Post* highlighted an increase in bee colonies (Van Dam, 2024), based on the USDA's 2022 census showing 3.8 million colonies in the U.S. as of December 2022 (USDA, 2024a), the National Agricultural Statistics Service also reported a 1% decline in colonies for operations with five or more colonies (USDA, 2024c). Pesticides accounted for 9.9% of colony health stressors in these larger operations, while varroa mites were responsible for nearly 40% of colony losses (USDA, 2024c). Though mites and pesticides may seem like separate issues, with pesticides often linked to colony collapses (EPA, 2023), they, along with poor nutrition, can all be tied to broader environmental stressors. Rising temperatures, especially in autumn, may further aggravate varroa mite infestations (Smoliński et al., 2021).

Penn State University's Center for Pollinator Research, in partnership with other universities across the country and the USDA Agricultural Research Service, is working to support beekeepers through Beescape. This Geographic Information System allows users to zoom in on specific geographic areas to identify pollinators, flowers, and land-use data from USDA satellites. Beescape predicts habitat quality based on nesting availability, crop and floral resources, and insecticide usage. It also relies on species identification from the public via iNaturalist (Penn State College of Agricultural Sciences, n.d.). Additionally, the tool measures climate trends and the economic value of crops in the selected area.

For example, in a three-mile radius near Glorybee Honey in Eugene, Oregon, Beescape shows that 92% of the land is developed, resulting in low crop value due to limited agricultural use in the area. Despite this, Glorybee Honey maximizes available greenspace to support bee colonies and provide consumers with high-quality honey, while also aiding the pollination of food crops and flowers that benefit other species. In contrast, a three-mile radius around Penn State University, where only 54% of the land is developed, reveals that bees contribute to a crop value of \$71,000 annually.

Honey in the Marketplace

The U.S. market for honey has experienced significant fluctuations in recent years. According to the USDA Economic Research Service (ERS), honey prices declined by 16% from 2022 to 2023, with the average price paid to producers dropping to \$2.50 per pound (USDA, ERS, 2024). Major honey-producing states like North Dakota, South Dakota, and California tend to have the lowest prices (USDA, ERS, 2024).

Although honey production increased in 2023 after three consecutive years of decline, imports remain crucial to meet the relatively high demand from U.S. consumers (USDA, ERS, 2024). This is evidenced by the fact that imports accounted for 73% of the total U.S. honey supply in 2023. A substantial 79% of these imports came from just four countries: India, Argentina, Brazil, and Vietnam. However, this list of top exporters has shifted over time due to various trade-related issues (USDA, ERS, 2024).

Honey-producing colonies in the U.S. decreased 8.43% between 2014 and 2023 (Table 1). While honey could still be harvested from colonies that did not survive a full calendar year, the average price per pound has increased by \$0.35 (Table 1).

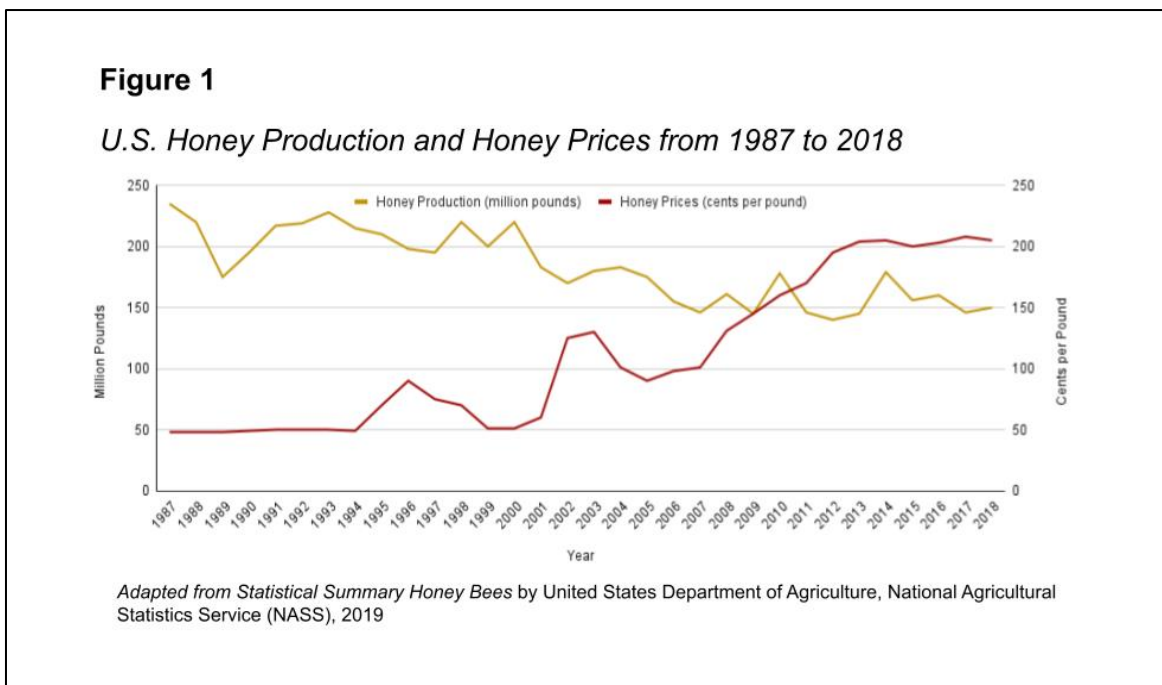
Table 1

A Comparison of U.S. Honey Production Trends in 2014 and 2023: Fewer Colonies, Higher Prices

	Honey producing colonies (1,000)	Yield per colony (lbs)	Production (1,000 lbs)	Stocks December 15 (1,000 lbs)	Average price per pound (dollars)	Value of production (1,000 dollars)
2014	2,740	65.1	178,270	41,192	2.17	387,381
2023	2,509	55.2	138,571	44,016	2.52	349,199

Sources: USDA, NASS (2016); USDA, AMS (2024)

Looking at data over a 31-year period shows the decline of honey production (in million pounds) since 1993 while documenting an increase in honey prices (cents per pound) during the same time frame (see Figure 1).

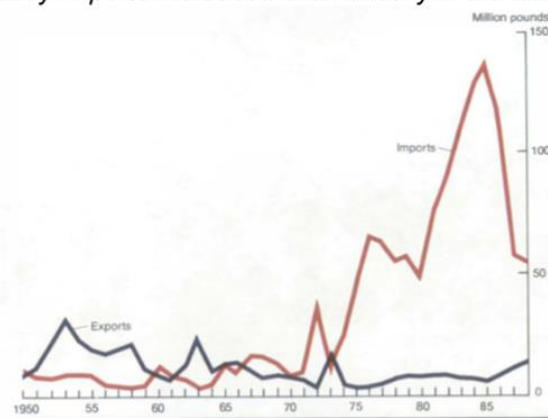


Bee Informed Partnership Inc., a non-profit organization in the U.S. that researches bee declines, reports a loss in bee colonies based on responses from over 3,000 beekeepers across the United States who manage approximately 12% of the estimated 2.7 million honey-producing colonies (Steinhauer, 2023). Seasonal loss rates occurred among all beekeepers, regardless of operation size. Winter consistently had the highest colony losses, due to viruses and adverse weather conditions (Steinhauer, 2023).

“Although the mysterious colony collapse disorder has recently had an impact on American honey bees, the half-century decline in their numbers may partly reflect decisions by honey producers to leave the industry in the face of competition from cheaper imported honey, given that the USA became increasingly reliant on imported honey beginning in the late 1960s.” - Aizen and Harder (Golbeck, Kastner, Harris, & Tensen, 2021)

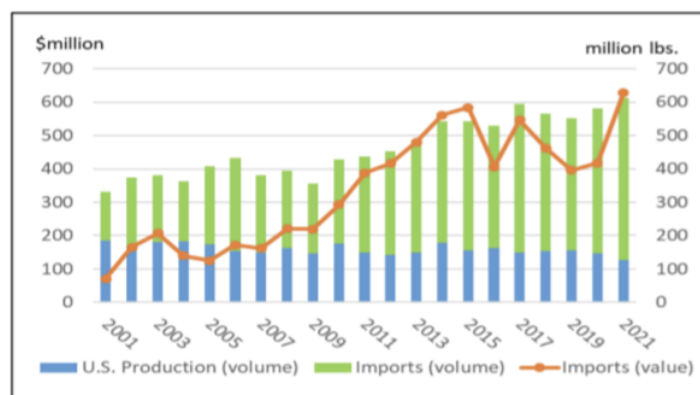
In 1987, honey prices were less than 50 cents per pound, but by 2018, they had risen to 216.6 cents per pound—an increase of nearly five times—highlighting the significant impact of market forces and supply constraints on the value of honey over this period (USDA, NASS, 2019).

While U.S. production has slowed, imports have increased (see Figure 2).

Figure 2*U.S. Honey Imports Increased Dramatically in the Early 1980's*

Adapted from *Beekeeping and the Honey Program* by Hoff, F. L., 1990, *Food Review/National Food Review*
<https://ageconsearch.umn.edu/record/279825?ln=en&v=pdf>

By comparing this data, we can better understand the dynamics of the honey marketplace, particularly the interplay between domestic production and global trade. The first significant increase in honey imports starting in the early 1980's can mostly be linked to the policy changes formally introduced by the Food Security Act of 1985, which eliminated the parity formula and progressively lowered support prices for honey from 1986 to 1990 (Hoff & Phillips, 1990, p. 62-63). These changes made domestic production less profitable, leading to a greater dependence on imports to meet U.S. demand.

Figure 3*U.S. Honey Production and Imports*

Adapted from *Ongoing Efforts to Address Fraud and Adulteration of Honey* by Johnson, R. 2022, Congressional Research Service Report.
<https://sgp.fas.org/crs/misc/IF12185.pdf>

However, the most current and reliable data on U.S. honey production and imports between 2001 to 2021 was conducted by the Congressional Research Service (CRS) (Johnson, 2022) (see Figure 3). This data conveys critical trends in domestic production and import volumes, showing that U.S. honey production has remained relatively stable, with minimal fluctuations. In contrast, imports have grown substantially since the policy changes were introduced by the Food Security Act of 1985 (Hoff & Phillips, 1990).

Notably, the steady increase in the volume of imported honey began to accelerate around 2010 (Johnson, 2022). This led to a peak in 2015 when imports reached one of their highest levels in the two decades observed (Johnson, 2022). After a brief decline in 2016, imports surged again, reaching another peak in 2021 (Johnson, 2022). In 2021, U.S. honey imports totaled approximately 500 million pounds in volume, with their value approaching \$600 million, reflecting the significant increase in both volume and value of imported honey over the observed period (Johnson, 2022).

The data from the Congressional Research Service (CRS) clearly illustrates a significant shift in market dynamics, with U.S. reliance on imported honey growing substantially. The sharp rise in honey imports, especially from countries like India (124.7 million pounds), Vietnam (123.5 million), Argentina (95.3 million), and Brazil (76 million), has far outpaced domestic production (Johnson, 2022). In 2021, domestic production in the U.S. totaled only 126.5 million pounds, with North Dakota contributing 28.3 million, South Dakota 12.3 million, California 9.6 million, Florida 8.5 million, Texas 7.7 million, and all other states combined contributing 60.2 million pounds (USDA-AMS, 2024).

Honey prices between 2014 and 2023 increased across all categories (Table 2).

Table 2
Honey Prices by Market Type - United States: 2014 and 2023

		Price (dollars per pound)		
		Co-op and private	Retail	All
2014	All Honey	2.07	4.05	2.17
2023	All Honey	2.23	6.55	2.52

Sources: USDA, NASS (2016); USDA, AMS (2024)

The significantly higher retail price of honey may be due to additional costs associated with packaging, branding, distribution, quality control, and consumer convenience compared to co-op and private sales (Hoff & Phillips, 1990). Furthermore, rising honey prices are directly linked to increasing losses of pollinators, which have been exacerbated by factors such as viruses and adverse weather (Steinhauer, 2023). Recent data demonstrates how these colony losses negatively impact honey production and market dynamics (Steinhauer, 2023).

In response to honey shortages, increased imports are often necessary to meet consumer demand (Hoff & Phillips, 1990). However, reliance on imports can raise concerns about honey quality and authenticity, as imported honey is sometimes perceived to be of lower quality (Hoff & Phillips, 1990) and as indicated earlier, may have a relatively high incidence of adulteration.

Understanding and addressing bee colony losses is essential for stabilizing the U.S. honey market. Efforts to improve bee health, particularly during high-risk seasons like winter, can help maintain affordable honey prices, ensure the availability of high-quality honey, and reduce dependency on imports (Steinhauer, 2023). This is especially crucial for U.S. commercial operations, which manage the largest number of colonies and experience the most substantial losses (Steinhauer, 2023). It is crucial that government policies support domestic beekeepers, enabling them to compete effectively against imported honey (Hoff & Phillips, 1990). By fostering a healthier bee population and ensuring a robust domestic honey market, policymakers can help secure the future of U.S. honey production, benefiting both beekeepers and consumers (Steinhauer, 2023).

Marketplace Impact

The law of supply and demand is fundamental to economics and heavily impacts price along with market outcomes. Quantity of bees, technical advancement, quantity of producers and costs of production are all factors that affect the ratio of supply and in turn demand for honey. According to the U.S. Fish and Wildlife Service, pollinators are already facing extinction despite supporting the survival of 90% of wild flowering plants and 75% of food crops in the United States, contributing an estimated \$18 billion annually to agricultural production (Aizen et al., 2016, p. 2). Adulteration of honey is economically motivated and poses great risk to producers and consumers alike. Economically motivated adulteration (EMA) (FDA, 2024a) of honey undermines the economic viability of legitimate beekeepers and honey producers who adhere to and maintain quality standards in the global market. Paying special attention to law enforcement accounts, a Homeland Security Investigation based in Chicago reported “a seizure of nearly 60 tons of illegally imported Chinese honey” (U.S. Immigration and

Customs Enforcement, 2016). It is important to consider what is gained by fraudulent goods and to what degree we are aware of the problem.

Success in the marketplace is critical to sustainable development, which includes global food security that can only be achieved through protecting the environment. Pollination plays a vital role in the ecosystem. Without animal pollination, shifts in global crop supplies could lead to higher prices for consumers and lower profits for producers. This situation could result in an annual net economic loss ranging from \$160 billion to \$191 billion globally for crop consumers and producers, with an additional \$207 billion to \$497 billion in losses affecting producers and consumers in other markets (Lautenbach et al., 2012). Food fraud is a risk to global food security (Gepp & Tiwari, 2024). While updated economic analysis is needed to inform stakeholders and promote sustainable consumption practices it is clear fraudulence does not positively benefit America's national interest in food security.

“Food fraud is a growing epidemic across all types of products. From seafood to vintage wines to honey, food products with any economic value are being intentionally adulterated, smuggled, or simply misrepresented by knowing participants to maximize profits. Protecting the American consumer from smuggled and potentially unsafe imported food is one of HSI's enforcement priorities.” - James M. Gibbons, special agent Homeland Security Investigations, Chicago. (U.S. Immigration and Customs Enforcement, 2016)

The economic impact of fraudulence in the United States is wide-ranging, greatly affecting market dynamics, consumer trust, regulatory creation, agricultural sustainability, and international trade relations. OrganicEye, an organization monitoring the organic industry, released a white paper highlighting concerns about uninspected organic imports negatively impacting U.S. farmers. They allege that these imports, certified by foreign agribusinesses rather than independent USDA-accredited agents as required by law, undercut domestic prices and push American farmers out of lucrative markets (Kastel, 2024).

Economic Gain Associated with Origin

Terroir, a term generally linked with wine, encompasses a combination of natural elements that shape the taste, texture, and quality of agricultural products. Just like maple syrup, olive oil and wine, honey has terroir. Impacted by climate, human practices, and soil, terroir is a source of national as well as producer pride (Matthews, p. 162. 2003). Honey embodies the essence of its surroundings, reflecting the diverse floral sources, climate conditions, and geographical landscapes where it is harvested.

An analytical survey of Composition of American Honeys was published by the U.S. Department of Agriculture in 1962. The primary determinant of honey's terroir is the

diversity of floral sources available to bees (White et al., 1962). Different plants produce nectar with varying ranges of sugars and amino acids (Wiley, 1907). Honey derived from wildflowers, citrus groves, clover fields, lavender fields, or eucalyptus forests will exhibit unique flavor profiles characteristic of these plants (VanEngelsdorp et al., 2009). Secondly, weather conditions such as temperature, humidity, and rainfall significantly impact honey production and quality. Bees are sensitive to weather fluctuations, which affect their foraging behavior and the availability of nectar. A region's microclimate, influenced by factors like elevation and proximity to bodies of water, further shapes the honey's terroir (Kolpan et al., 2010). Knowledge of bee behavior and their natural habitat can safeguard against threats affecting their survival which in turn can help prevent colony collapse (World Organisation for Animal Health, n.d.).

Adulterated honey artificially inflates supply, which is in turn responsible for driving down prices and negatively impacting value added by terroir. This creates unfair competition for genuine honey producers by undermining legitimate producers who adhere to strict quality standards (FDA, 2024b). Fraudulent honey also impacts international trade relations (European Parliament, 2014). Honey is a global commodity (FAO, 2021), and the reputation of U.S. honey as a premium product is jeopardized by fraudulent practices that undermine trust and compliance with international quality standards. Concerns over authenticity and regulatory compliance can lead to trade disputes, import restrictions, and reduced export opportunities for legitimate U.S. honey producers (Jones, et al., 2003).

The economic implications of adulteration encompass potential losses in export revenue, disruptions to trade relations with key markets, and diplomatic challenges associated with addressing fraudulent honey practices on a global scale (FAO, 1981). The integrity of international trade involving honey production hinges on collaborative efforts to enforce standards, promote transparency and ensure marketplace competition (Chirsanova et al, 2021).

Methodology

Our study aims to assess the impact of adulterated honey awareness on consumer behavior, evaluate perceived market impacts, and determine the role of certification on mitigating adulterated honey. This study uses mixed quantitative and qualitative research methods including a survey and interviews to analyze consumer behavior and assessment of the marketplace by communities of practice.

Materials and Methods

Survey

The consumer survey to gauge consumer behavior and awareness around adulterated honey was administered online through the QuestionPro platform to groups who were recruited both online and in person. A QR code or website link was provided both in-person and through social media. In-person locations included farmer's markets in California, New Mexico, Pennsylvania and New York, as well as select independent food stores in Oregon, where the public were requested to participate. Additionally, Instagram, Facebook, and LinkedIn were used to promote the survey. Participants were required to be ages 18 or older and residing in the U.S. As our methods for soliciting responses depended on social media outreach by our team and Arizona State University's Swette Center for Sustainable Food Systems, we are unable to calculate the total number of persons solicited for participation.

Interview

Interviews were conducted with a wide swath of professionals including honey producers and beekeepers, business associations, wholesale purchasers, legal experts, exporters, researchers and academics, technical assistance providers, and supply chain professionals. Our initial pool of contacts was developed by researching industry association leadership, followed by referrals by communities of practice (personal contacts of the researchers, and suggestions from our client partner, Pass the Honey). Our team contacted 33 individuals for interviews, with 14 final interviews conducted and consent forms received. All interviews were conducted over Zoom. Participants were in Arizona, California, Maryland, Michigan, New York, Oregon, and Pennsylvania, as well as Mexico and Canada.

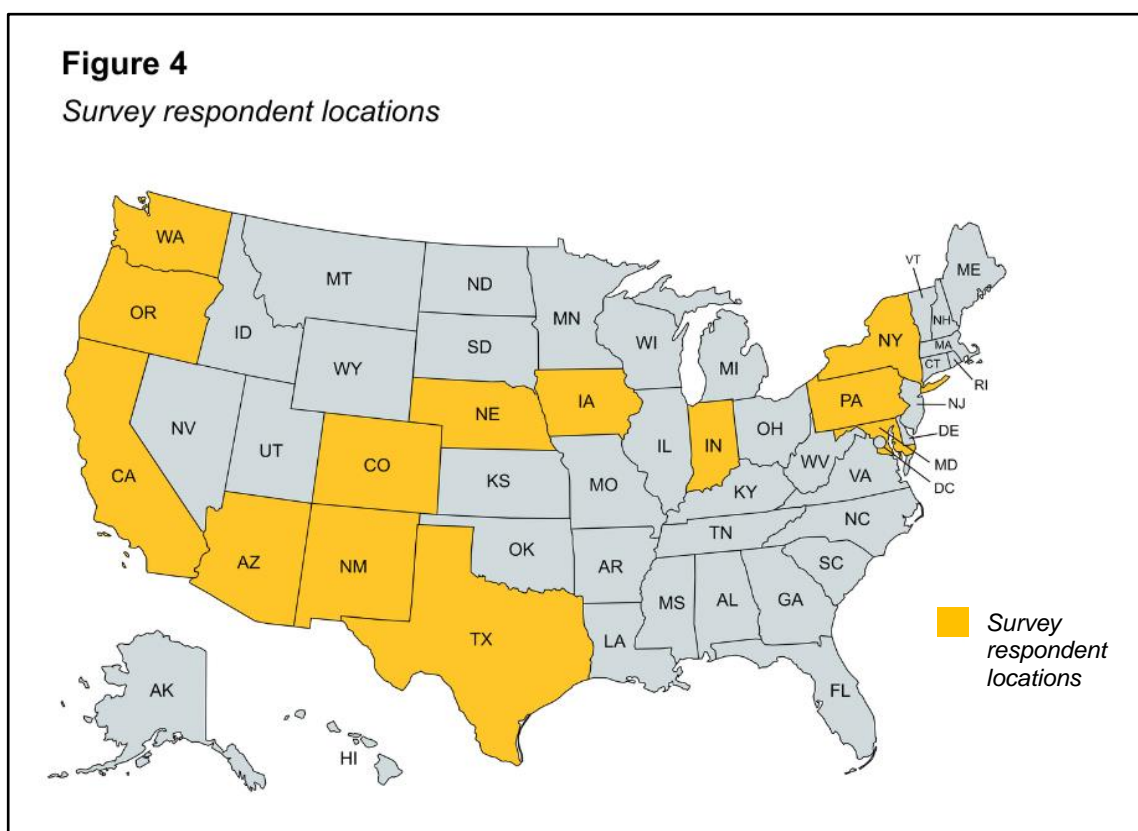
Results

Survey Findings

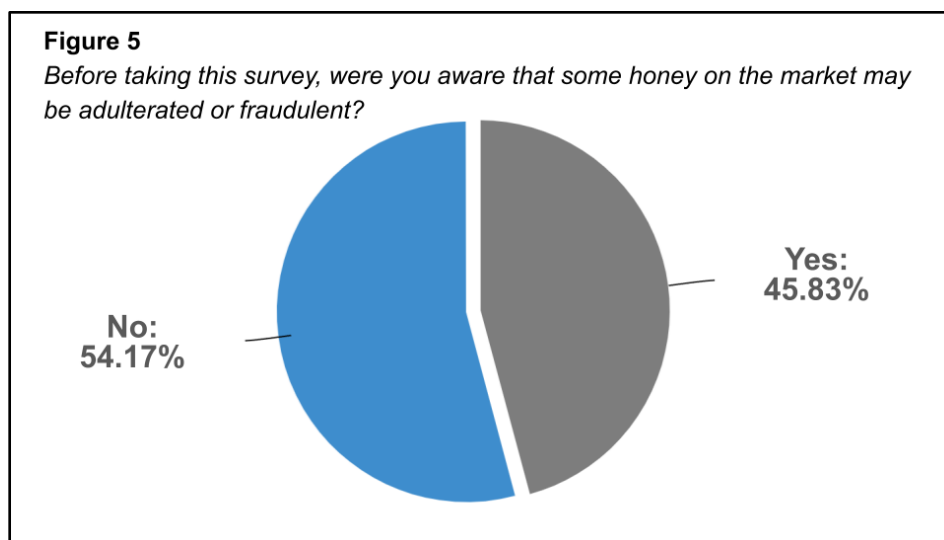
The consumer survey consisted of 13 questions (see Appendix C). A total of 75 participants completed the pre-survey consent form, but two did not proceed with the survey, and three did not finish the survey. This left a total of 70 participants who completed the survey from start to finish. However, since not all questions were mandatory, some participants skipped certain questions. Additionally, some questions

permitted multiple responses from the same participant. As a result, the number of respondents varies for each question.

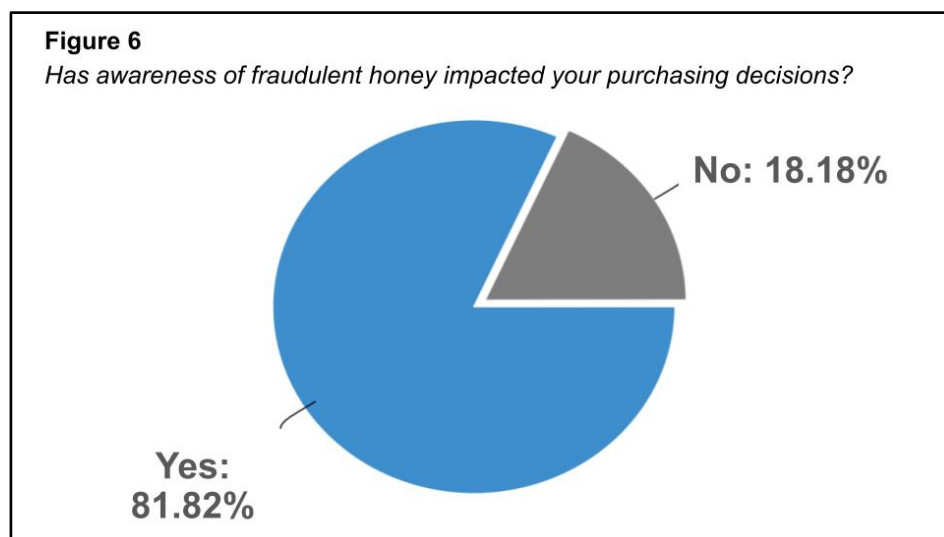
Respondents were a mix of ages between 18 and 65 and older, with the most responses coming from those 25-34 years old (39.73%). The majority of respondents were women (50.68%), followed by men (42.47%), and non-binary/third gender (2.74%). Some respondents preferred not to share their age (4.11%). Respondents came from thirteen states as indicated by their zip codes: Arizona, California, Colorado, Indiana, Iowa, Maryland, Nebraska, New Mexico, New York, Oregon, Pennsylvania, Texas, and Washington (see Figure 4).



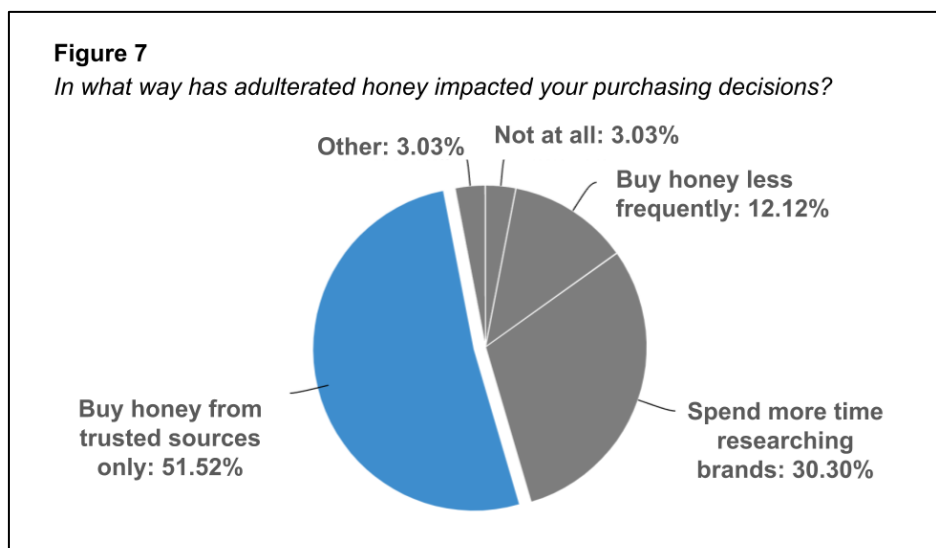
Participants were asked about their knowledge and awareness of adulterated honey. Respondents ($n=72$) were almost evenly split with 54.17% ($n=39$) unaware and 45.83% ($n=33$) aware (see Figure 5). While ($n=33$) respondents indicated awareness of honey adulteration, ($n=49$) respondents answered the multiple-choice question about their source of knowledge. Among these responses, 24.49% ($n=12$) learned about adulterated honey from friends and family, 20.41% ($n=10$) from news articles, 16.33% ($n=8$) from social media, 14.28% ($n=7$) from school and education, 12.24% ($n=6$) from documentaries, 8.16% ($n=4$) from other sources (including farmers, beekeepers, product appearance, or mistrust of supermarkets), and 4.08% ($n=2$) from product labels.



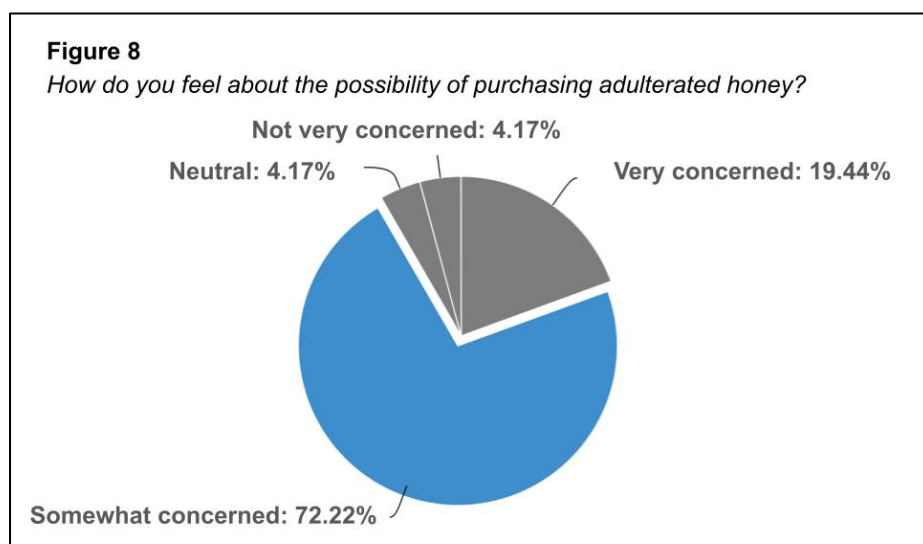
Of the respondents who were already aware of honey adulteration (n=33), 81.82% (n=27) indicated that this awareness impacted their purchasing decisions, while 18.18% (n=6) reported no change in their buying habits (see Figure 6).



Respondents who answered “yes” (n=27) selected all applicable changes to their purchasing habits. A total of (n=33) responded to this question (see Figure 7). 51.52% (n=17) respondents buy honey only from trusted sources, 30.30% (n=10) spend more time researching brands before purchasing, 12.12% (n=4) buy honey less frequently, 3.03% (n=1) buy only local honey, and 3.03% (n=1) reported no change in their purchasing habits. A total of (n=33) responded to this question. Notably, the one respondent who reported no change in their purchasing habits in this question previously indicated that their purchasing habits had been influenced by honey adulteration awareness. This suggests a contradiction in their responses.

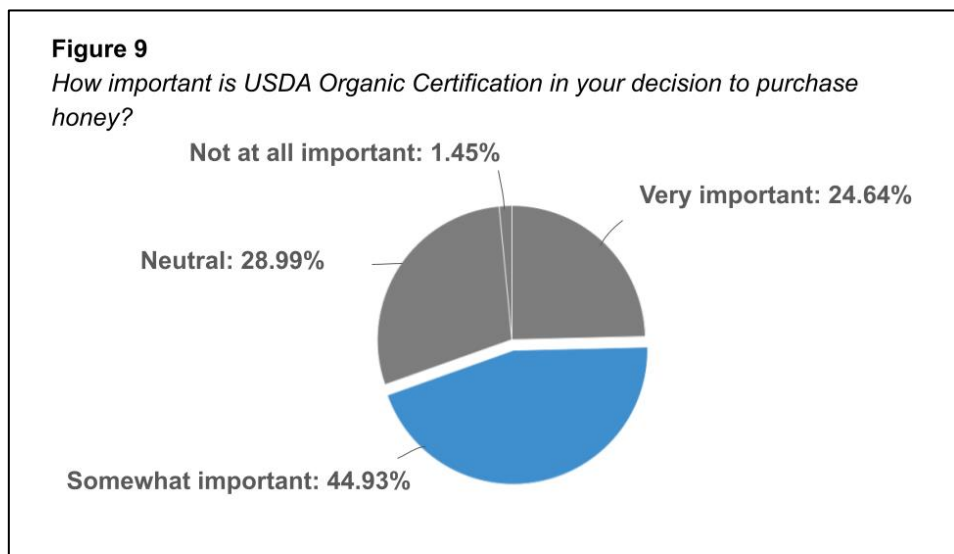


Total number of (n=72) respondents had varying levels of concern around adulterated honey. Most respondents at 72.22% (n=52) indicated they were "somewhat concerned" while 19.44% (n=14) were "very concerned," 4.17% (n=3) were neutral, and 4.17% (n=3) were "not very concerned" (see Figure 8).

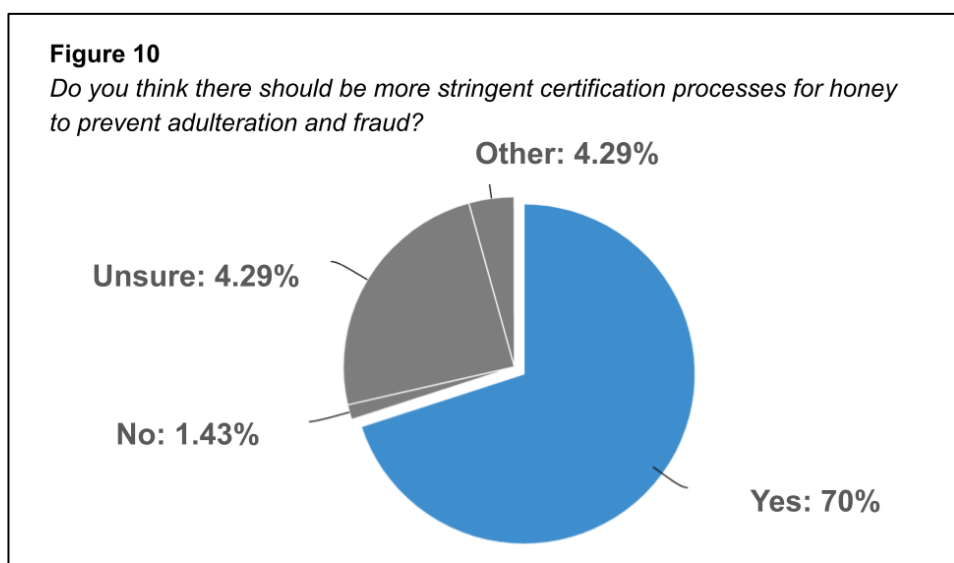


Our survey explored opinions on honey certification and marketplace practices. The results revealed a total response of (n=69) of strong consumer interest in USDA Organic Certification for honey products (see Figure 9). Notably, 24.64% of respondents (n=17) rated organic certification as "very important" in their purchasing decisions—a significant finding as this proportion is nearly four times higher than the general organic food purchase rate in the United States. Even more telling, the largest segment of respondents (44.93%, n=31) considered organic certification to be "somewhat important." When combining these responses, more than two-thirds of respondents

(69.57%) indicated that organic certification held importance in their honey purchasing decisions. Meanwhile, 28.99% (n=20) remained neutral, and only a small minority (1.45%, n=1) viewed organic certification as “not at all important.” These findings suggest substantially higher consumer interest in organic certification for honey compared to typical organic product purchase patterns.



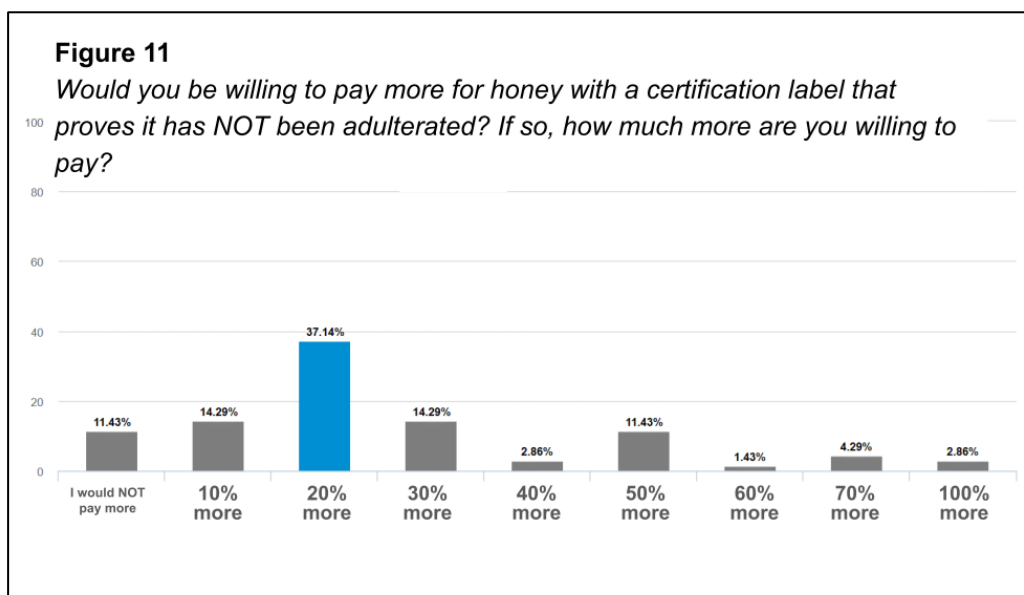
Respondents (n=70) largely showed support for stricter measures to prevent honey adulteration, with 70% (n=49) expressing that certification processes should be more stringent to reduce adulteration and fraud (see Figure 10). However, it should be noted that these respondents, primarily recruited through honey-related channels, may not represent the general consumer population, and their responses could be influenced by their pre-existing interest in honey products.



Regarding trust in certification types, respondents (n=69) were almost split between trusting government certifications at 37.68% (n=26) and certifications from honey producers' associations at 33.33% (n=23). Third-party independent certifications were next at 17.39% (n=12), while 11.59% (n=8) had no specific preference.

In a multiple-choice question, respondents (n=69) were asked to select additional measures to enhance trust in honey authenticity. Traceability was the most favored measure, chosen by 37.58% (n=62), followed by transparent labeling at 29.09% (n=48), regular testing and publication of results at 16.97% (n=28), and consumer education campaigns at 14.55% (n=24).

The survey also examined the willingness of respondents (n=70) to pay more for certified honey. While 11.43% (n=8) of respondents indicated they would not pay more for honey with a certification label proving it has not been adulterated, 89% (n=62) of respondents claimed they would pay 10% or more. Among those willing to pay more, 37.14% (n=26) expressed that a 20% increase is the maximum they would consider. The other respondents provided varied responses regarding how much more they would be willing to pay, with their willingness falling anywhere between 10% and 100% more (see Figure 11).



Survey Discussion

While not designed to produce statistically significant results, the consumer survey revealed important insights into public awareness and attitudes toward honey adulteration. Awareness of honey adulteration was notably split among respondents, with 54.17% reporting they were unaware of the issue. This suggests a significant gap in consumer knowledge. Among those who were aware, the primary sources of

information included friends and family, news articles, and social media, indicating that interpersonal and media channels play crucial roles in shaping consumer understanding of food authenticity issues.

The survey results show a strong correlation between awareness of adulteration and purchasing behavior. A remarkable 81.82% of those aware reported that their awareness influenced their buying decisions, with many opting to purchase honey only from trusted sources or conducting more research before making a purchase. This shift in consumer behavior emphasizes the potential for increased transparency and education to positively impact market dynamics.

Concern regarding adulterated honey was prevalent among respondents, with 72.22% indicating they were "somewhat concerned." Notably, this level of concern exceeds the percentage of respondents who reported prior awareness of adulteration (54.17%), suggesting that the survey itself may have influenced respondent attitudes by introducing or heightening awareness of the adulteration issue. The overwhelming support for stricter measures to combat honey adulteration, with 70% of respondents advocating for more stringent certification processes, underscores the public's desire for accountability and transparency in the marketplace. This sentiment is further supported by the preference for traceability as a measure to enhance trust in honey authenticity.

Interestingly, while there was a divided trust in certification types, with government certifications receiving slightly more support than those from honey producers' associations, the willingness to pay more for certified honey was striking. An impressive 88.57% of respondents expressed readiness to pay 10% or more for certified honey, with many willing to pay up to a 20% increase. This willingness indicates a robust market potential for certified authentic honey, highlighting an opportunity for producers to capitalize on consumer demand for purity.

As a final note, our research group felt it necessary to express that we value accessibility in academia and therefore aimed to make the language in our survey accessible to the general public. This is reflected in our decision to make all questions optional to answer, except for the question about age, as we needed to verify that all respondents were at least 18 years old. We hope that this survey reflects a culturally responsive research methodology and that our results capture the sentiments of our network around this subject.

Interview Findings

Requests for interviews were made with 33 contacts. Interviews were conducted via Zoom and phone calls with 16 contacts. However, we did not receive signed consent

forms for two interviewees, so their data was not included in this study. Names, organizations, and titles for all consenting interviewees can be found in Appendix A.

Interviewee interpretations of honey adulteration and fraud

All 14 interviewees specifically named EMA as a major issue for the industry, and expressed concern about resin technologies or sugary substances being added to honey. However, many interviewees also used the term “adulteration” in ways that did not match the FDA definition. One legal expert noted that the term “adulteration” is used in court documents, but the terms “fraud” and “fake honey” are most common since they are connected to the legal concept of consumers being “defrauded.” When asked about adulteration, three interviewees also discussed concerns about labeling and certification fraud. The reliability of private industry-led certifications like True Source, and the veracity of USDA organic certifications for imported honey, were particularly called into question. Interviewees also shared concerns about Country of Origin Labeling (COOL) and the lack of verifiability of varietal claims on honey labels.

There were a number of ideas about what constitutes adulteration in honey that go beyond the FDA’s definition. While adding sweeteners to harvested honey was consistently viewed as adulteration, one honey producer saw heat extraction, also known as “superheating” honey, as a form of adulteration. Most industry professionals who discussed feeding corn syrup or sugar water to bees during low-nectar months shared the view that it is a common and necessary practice in beekeeping, but one interviewee shared that supplemental feeding was a practice that some in the industry think of as a form of adulteration.

Adulteration isn’t limited to one place in the supply chain

Interviewees made it clear that the U.S. honey market faces significant challenges due to widespread adulteration occurring at multiple levels across the supply chain. Interviewees described EMA taking place at almost every stage post-harvest, including during processing, by exporters, and mid-supply chain by packers and brokers. The possibility of adulteration in so many places requires robust detection, testing, and enforcement efforts. Interviewees lifted up the role of international exporters, packers, and domestic importers in the United States as holding responsibility for the creation and import of most adulterated products.

Adulteration has significant negative impacts on producers

"[Adulteration is] harming American beekeepers. And by harming American beekeepers, it's jeopardizing global food security." - Ronald Phipps, honey importer

Interviewees agreed that adulteration puts considerable downward pressure on honey's price, and that adulterated honey creates a price anchor that makes consumers unwilling to pay for genuine honey. These low prices are a major concern for the beekeepers we interviewed, especially as their costs for production inputs continue to increase. Phipps shared that in spite of anti-dumping petitions, the sheer volume of adulterated honey entering the country makes it especially hard for domestic producers of honey to compete.

Fraud and adulteration's negative impact on the economic viability of honey production for beekeepers poses significant risks to our food system, particularly because of bees' role in pollination and crop production. Mitchell Weinberg, President of GenuHoney (a honey authenticity certification organization), asserts that EMA's impact goes well beyond difficult pricing decisions: "A lot of beekeepers around the world have gone out of business. If a beekeeper closes up shop, our entire agricultural system is at risk if you don't have bees going out and pollinating." Federico Berrón, Co-CEO of the Mexican Association of Honey Bee Exporters, agreed that adulteration is "... killing beekeepers," and one industry professional emphasized the extent to which adulteration's economic impact has changed the ability of the sector to not only retain existing beekeepers, but also to attract new producers:

"People aren't getting into the honey business anymore and that's not sustainable. We need the bees. We need people to manage bees to pollinate our crops... If it weren't for pollination contracts, I don't think it would be worth it to be a beekeeper."

Interviewees who keep their own bees shared that they feel forced to choose between two marketing approaches, both of which have limitations: 1) attempt to match the low prices consumers expect due to wide availability of cheap adulterated product, likely losing money, or 2) sell direct to consumers or via self-distribution at a significant premium, with significant associated time and cost given over to marketing.

Sarah Red-Laird, beekeeper and Executive Director of Bee Regenerative (a non-profit with the mission to educate and inspire communities to conserve bees) suggests that adulteration has affected the market to a point where it is impacting the mental health of beekeepers. In addition to the emotional distress caused by navigating the challenging economics of beekeeping that cheap adulterated products have caused, there's a pride issue: "Producing a quality product they worked hard to produce, and then seeing it mixed with adulterated honey... creates burnout and mental health issues."

Adulteration also hurts consumers

“There’s also a food justice issue here - why should consumers who can’t afford to pay end up with adulterated honey? You’re in this long enough and crazy seems normal. It’s a crime; it’s adulterated. We shouldn’t think of [genuine honey] as something we have to pay more for.” - Michael T. Roberts, Professor at the Resnick Center for Food Law and Policy at UCLA School of Law

Interviewees were also clear that while lower prices might seem like a boon for consumers, the impacts of adulteration were overwhelmingly negative for them. Interviewees were adamant that when consumers buy adulterated honey, they are “being cheated” and are receiving a substandard product. Jeff Pettis, President of Apimondia (the International Federation of Beekeepers' Associations), and former Director of the USDA Bee Research Lab, sees the conundrum that honey sellers face: “[Given the current market] we have to tell consumers to be careful and do their research,” implying that the availability of adulterated honey has reduced consumer confidence in the honey category.

Risk of adulteration in imported honey

Interviewees generally agreed that the majority of adulterated honey in the U.S. market is imported, and in their view, few domestic beekeepers are directly engaging in adulteration of their own product. Given that U.S. production is significantly lower than consumption, the country’s continued reliance on imports increases the risk of adulterated honey entering the domestic supply. While there is variability in the adulteration of imported honey, respondents said that adulteration is especially high when honey is imported as an ingredient in processed foods. Overall, respondents consistently agreed that honey imports were the key driver undermining the viability of the U.S. honey industry.

Government intervention in addressing adulteration

“The best role of the government in this issue is to define what is not acceptable with clear definitions, and seek criminal penalties that are severe.” - Anonymous researcher

The need for rapid government intervention to combat honey adulteration was a clear message across almost every interview. This includes a need for clearly defining product standards and the regulatory framework for honey, appropriately resourcing the enforcement of existing laws meant to protect domestic producers and the honey supply chain, funding stronger testing regimens, and supporting domestic beekeepers to ensure they can compete fairly. Industry members also cited a need for cross-

collaboration between agencies to increase their ability to detect, deter, prevent, and enforce penalties against adulteration.

Respondents agreed that the U.S. has weaker regulations than other countries to protect producers and consumers of honey. They suggested that the federal government can better protect domestic honey producers from the impacts of adulteration by:

- Creating a federal standard of identity for honey - a critical and achievable first step in strengthening the ability of beekeepers to combat adulteration through the legal system
- Increasing tariffs on imported honey
- More investigation of dumping claims, and consideration of quotas for honey imports
- Congress implementing a price floor for honey to even the playing field for domestic producers
- Providing additional federal funding for R&D on testing methods to combat adulteration
- Providing funding for updating and adopting modern methodologies and technologies for testing for adulteration
- Following adulterated imports back through the supply chain, and collaborating internationally on shutting down facilities that are producing fraudulent products
- Increasing federal prosecutions of fraudulent actors in the industry

There are, however, concerns about whether key agencies are willing, or have the resources, to prioritize economically motivated adulteration. In particular, two respondents who have attempted to work with the FDA on food marketing issues pointed to the FDA's hesitancy to wade into complex waters when there wasn't a direct public health or safety threat. Examples cited were their hesitation to create new food standards of identity in recent years, and their unwillingness to tackle defining the word "natural" in product labeling. Anne Marie Fauvel, Program Director at American Honey Producers Association (AHPA), is adamant that domestic beekeepers will eventually go out of business, or feel pressured to cut corners, without government intervention. She also says that AHPA has been told by the FDA that unless the FDA is told legislatively to adopt a standard of identity to do so, they won't prioritize it.

Multiple respondents noted underfunding at both the FDA and CBP as part of their hesitancy to address EMA that isn't directly associated with an immediate public health issue. Chris Hiatt, President of AHPA, acerbically summed up the lack of government intervention in his interview: "Kind of like the nightly news, 'If it bleeds it leads.'"

[Adulteration] isn't very sexy, no one is dying from honey fraud, but there are a lot of business owners hurt by it and the consumer is being cheated.”

The need for better testing and regulatory oversight of imports

The necessity for enhanced testing and stronger regulatory oversight of honey imports is critical to combating adulteration in the U.S. honey market. Researcher and beekeeper Robyn Underwood points out, "there's no individual that has the funding or ability to do this testing. So [the government] have to be the ones." While some honey packers conduct tests on their imports, there was widespread acknowledgment that current testing methods are inadequate, particularly in detecting C3 sugars—an increasingly common adulterant. Interviewees felt strongly that to protect the integrity of the U.S. honey market, the FDA must both update its testing procedures and work more closely with Customs and Border Protection to enforce more frequent testing regimens.

"The FDA needs to update their testing procedures. The only thing they test for is C4 sugars (e.g. cane sugar and corn syrup), but Asian countries are using C3 sugars and they aren't testing for that. They [FDA & CBP] aren't using the latest technology. The FDA also needs to work closer with Customs and Border Patrol. If, all of a sudden, you see an onslaught of honey coming in from a country that never exported honey before, you should be testing that product and really questioning it."
- Anonymous quality assurance professional

Phipps and honey producer Robert Podolski both argued that testing should be conducted by government or university laboratories, rather than relying on industry and private laboratories, to minimize corruption and ensure scientific objectivity.

Industry-led certifications

A number of interviewees agreed that industry-led certifications have proven to be inadequate in addressing EMA and fraud in the honey market. One respondent noted that the problem with private certifications is that “anyone can say that something is certified.” True Source, a widely recognized honey origin certification, has tightened its testing requirements over time, but it still faces significant issues according to many interviewees. One quality assurance professional said, "Asian countries that are exporting fraudulent honey are hiding behind the True Source shield," undermining the certification’s credibility. They further note that while GenuHoney offers stronger certification by employing newer technology like NMR tests, these tests are not foolproof either.

Beyond a lack of rigor, multiple interviewees described True Source as an example of monopolized self-policing that does more harm than good. Podolski is particularly

critical of True Source, and says that "when they [Customs] see the certification, they assume it must be authentic," but in reality it allows fraudulent products to pass as legitimate. He also asserted that in his experience getting certified there was little actual verification of his practices in the application process, and believes that "there is too much damage done by True Source for any other [industry] certification to be trusted."

Interviewees were firm that industry-led certifications like True Source are insufficient at preventing, and are sometimes even complicit in, perpetuating fraud. Some respondents did suggest that stronger, government-backed certifications, including Organic certification, might be part of helping protect market integrity, but consensus was that certifications are not a replacement for rigorous testing and enforcement of imports.

Organic certification

Interviewees differed in their thoughts on the USDA Organic program for honey and whether it's a meaningful tool for addressing adulteration. Phipps says that organic certification in honey is ripe for fraud itself, and a researcher interviewed agreed, asserting that the price premium for organic, combined with "organic" being a credence attribute (something that the consumer can't see) makes it a major fraud opportunity, despite "strong organic enforcement."

Despite concerns about organic certification's ability to address adulteration, respondents spoke at length about organic honey and the opportunities to improve USDA's current approach. Most respondents agreed that current organic standards in the U.S. are insufficient to allow for any meaningful U.S. production of organic honey, and recommended that these standards need to be revised and strengthened to 1) create opportunities for domestic production and 2) protect the integrity of organic honey. Multiple respondents noted that according to the Organic Integrity Database, the only domestic organic honey production in the United States takes place at a few locations in Hawaii, where the unique geographic conditions allow producers to follow the National Organic Program standards as written. One honey buyer shared that there is consistently strong interest whenever he is able to get a load of organic domestic honey from Hawaii, and sees the potential for market development.

Interviewees noted that as a starting place USDA should adopt organic standards specific to honey, since they are currently managed under the organic livestock program rules which often don't apply to the idiosyncrasies of honey production. An additional consideration cited by interviewees was the difference between process-based and testing-based organic standards. Currently, organic certification is based on a checklist of production standards that producers follow. For example, requirements about what

pesticides can be used are included, but not requirements that finished produce or honey tests negative or below a certain threshold for pesticide residue. One organic honey researcher shared that considering a shift to testing-based certification is especially relevant for honey, where testing of the finished product for a variety of organic production techniques is increasingly feasible.

Underwood agrees with the majority of organic rules except for forage distance, and says that current organic guidance is not actually matching our up-to-date understanding of bee biology. Current organic forage guidelines say that producers need to know what's happening in both the primary forage zone and surveillance zone, which together extend to an approximately 4 mile radius around the hive and is the square acreage of a small city. That's tens of thousands of acres, and according to Underwood, simply not possible. She is working on a bee dance study that, alongside other recent research, makes a strong case for USDA to reduce forage radius requirements in the next organic rule review.

Other respondents agreed that there should be less of a focus on large forage radius, but differed on the adjustments to standards they'd like to see. One controversial approach is the use of public conservation land for organic production. One beekeeper we interviewed argues that just because those lands might not meet a certain forage radius where certified organic produce is available around the bee yard doesn't mean they shouldn't be able to be certified organic - the focus should be on being far away from pesticide applications. He suggests creating a permitting process for using these conservation lands. Another beekeeper was conversely adamant that public lands should not be viewed as "certified organic land" for honey production, to prevent damage to native bee populations.

Barron thinks it's also important to note the challenges of the organic program's reciprocity rules, which allow producers from certain other countries with organic standards to put a USDA Organic label on their product if they meet their own country's standards. He shares that the largest producer of organic honey is Brazil, but much of the imported organic honey from Brazil may not meet consumer expectations for how it is produced: "They call it organic if it's harvested where there are no nearby plantations that use pesticides or are surrounded by forests. However, this is not the same as organic guidelines in the U.S. that require a lot of documentation."

While almost all interviewees stressed a need for changes to the USDA Organic standards for honey, one respondent did argue that organic rules are written as they should be, and this means that domestic organic honey production in the U.S. just isn't very realistic.

Labeling should be more specific and transparent

Although it is not always an adulteration issue, label fraud is a related concept and our researchers felt that it came up in enough interviews to merit including findings.

We heard from two producers that current labeling practices often list the U.S. as the first country of origin in blended honeys. They say this is misleading, since it is usually not where the majority of a blended honey comes from. They recommended that labeling requirements be changed so that label order reflects the actual predominance of ingredients by weight, similar to how they are listed on Nutrition Facts labels. Another producer pointed out that while labels may indicate multiple countries of origin, the reality is that 99.99% of the product often comes from just one country, which is deceptive to consumers. Interviewees also named gaps in origin labeling requirements that allow slight processing changes in one country to obscure production provenance. Kevin Kearsley, honey buyer and beekeeper, says that origin labeling has a transparency problem: “Here in the U.S., you can take a group of honey from different origins, transform them by manufacturing it into a food product as an ingredient, and the finished goods will become a product of the USA.”

One honey seller recommended that beekeepers be encouraged, if not required, to label their products with specific information about where the honey was produced at a regional level, including where the hives are kept, in addition to where the honey is processed or packaged. Another producer noted that varietal labeling in the honey market is frequently false and misleading, creating significant confusion for consumers. One way to solve this would be to require that varietal claims should reflect the percentage of specific pollens present in the honey, ensuring accuracy. Interviewees acknowledged that these additional requirements may impose significant expense for additional testing or tracking on honey producers, and recommendations for additional labeling made to the FDA should ensure that they are not overly burdensome.

The role of packers and brokers

Packers and brokers were identified by respondents as key contributors to the landscape of honey fraud and adulteration. One interviewer noted that there are only a few large honey importers and packers domestically, and that they hold significant power in the amount of fraudulent product that comes into the United States. Pettis underscores the importance of their cooperation:

We would need buy-in from the honey packers. Several really big ones. They would need to be willing to be thoroughly tested. If we had more traceability like blockchain technology, it would help clean up the supply chain. Getting the large honey packers on board would be a challenge but essential.

While some interviewees simply noted their ability to influence the impact of adulteration in the marketplace, Weinberg laid out the role of honey brokers bluntly: “Collectively, the exporters... the importers in the US, and the packers, are engaged in a global scheme to traffic in adulterated honey.” Another producer agreed, referring to domestic importers and packers as a “honey cartel.”

The challenge is not just about compliance but also about confronting the deep-rooted practices within the industry that allow adulteration to thrive. Weinberg contends that beekeepers are striving to produce authentic honey, but their efforts are undermined by packers who blend their pure products with adulterated ones. One honey producer even asserted that packers will blacklist producers who speak out against their blending practices.

One beekeeper shared a radically different long-term vision for the industry: producers would pull their product out as much as possible from large national or multinational packers, creating local co-ops that control the honey supply chain. This would build opportunities for localized marketing resources for small producers, and local co-ops where beekeepers can pack their own honey, or collaborate on regional brands, with transparent marketing and high consumer trust.

As long as middlemen continue to be gatekeepers to access to retail for most producers, interviewees made it clear that addressing honey adulteration requires confronting the central role that these gatekeepers play. Without their cooperation and commitment to full transparency, and additional regulation and enforcement of their activities, respondents believe it will be very difficult to reduce the amount of adulterated honey available to consumers.

The role of supermarkets and retailers

Supermarkets could play a crucial role in preventing honey fraud by enforcing stricter sourcing and labeling standards. One interviewee suggested that if grocers insist that they are supplied with authentic honey we might “actually see a change in the industry.” Roberts is adamant that identifying exactly who knows what about the provenance and purity of honey along the supply chain, however, is difficult:

Everyone at the top (food safety managers) are completely committed to doing the right thing. The problem occurs at the middle of the company - the person who has to make a business decision that depends on economic performance. They are the ones that buy honey that’s not authentic. It’s not corruption at the top - it’s in the middle. They have every reason to buy the cheaper honey. Often the company isn’t even aware of it.

Ultimately, respondents suggested that wholesalers and sellers want to keep the price of honey low for consumers, and therefore have little desire to directly address adulteration. Certification is one example of a place where retailers could exert their influence by being picky about the certifications they choose to sell. One interviewee with retail experience stated that generally it's the opposite: most grocers just take a "what we don't know can't hurt us legally" approach, and want to see a certification only to make sure they can demonstrate responsibility to consumers, regardless of the rigor of the certification.

One interviewee disagreed, arguing that some of the bigger retailers, like Costco, are likely aware that there is no way to produce pure honey at the price point they are selling it at. Whether retailers are actively or passively complicit, respondents named pressure from retailers on brokers and importers as unlikely to happen without outside intervention like lawsuits or public pressure.

The role of the consumer

As one interviewee says: "The consumer is everything." If consumers aren't willing to buy adulterated product, adulteration would no longer be a problem. Other interviewees agreed, naming consumer education as one tool for reducing the negative impacts of adulteration. Underwood believes that with a proper understanding of adulteration, "...consumers do and would pay more for pure honey and would not go back." The types of consumer education that respondents suggested would reduce adulteration varied, and included campaigns focused on natural properties of honey, such as crystallization being an expected property of pure honey; consumer tastings, and building fluency in the flavors of different varieties; and directly discussing the amount of fraud in the market, and the importance of finding a trusted honey source.

Roberts, however, cautions against holding consumer education up as a panacea: Industry loves to shift the burden to consumers. We expect so much out of consumers. They don't know where the fraud is, what it is, or how it might affect them. You can't put that on a label or certification.

Interviewees generally agreed that consumer education can play a role in reducing adulteration, but not at the expense of government intervention focused on actively detecting, reducing, and deterring adulteration along the supply chain.

The role of adjudication

Adjudication and lawsuits have emerged as important tools in the fight against honey adulteration, largely due to regulatory inaction. According to Red-Laird, the burden of legal action has fallen disproportionately on beekeepers, who are forced to invest millions of dollars into lawsuits just to compel the FDA to enforce existing regulations. The frustration stems from the fact that, as Red-Laird emphasizes, “there’s plenty in place with the FDA to protect American producers and keep adulterated products from coming in, but they just aren’t doing their job.”

In addition to pushing for enforcement, lawsuits have also played a critical role in addressing structural issues in the honey industry. One respondent noted that a recent antitrust lawsuit was pivotal in stabilizing tariffs on imported honey, an action that the industry had been advocating for years without success. The lawsuit provided the necessary pressure to create more equitable conditions for domestic honey producers who have long struggled to compete with cheap and often adulterated imports.

Litigation serves not only as a means to enforce regulatory compliance, but also as a strategic tool to halt fraudulent practices through injunctive relief. Litigation, however, is not always a successful or accessible strategy. One legal expert explains that while adding syrups to honey is actionable, proving other forms of adulteration in court can be complex. The difficulty lies in establishing clear evidence and identifying who is responsible, which makes legal cases both expensive and time-consuming. They also underscored the high costs and challenges involved in pursuing litigation against honey fraud. With complex food fraud cases, reverse-engineering products and conducting comprehensive testing are necessary, but costly. Plaintiffs' lawyers often want to minimize effort, leading to settlements instead of full litigation. Even when a judgment is secured, collecting damages can be difficult if the fraudulent party is based in another country or changes names. Respondents also shared that the legal strategy for honey producers has recently turned to organizing RICO (Racketeer Influenced and Corrupt Organizations) claims, which increase potential damages and create stronger legal repercussions.

Interviewees were clear that the challenges of proving fraud, the financial burdens on plaintiffs, and the possibility of retaliation all complicate the feasibility of the legal action as a tool for combatting adulteration. Lawsuits fill a necessary gap when self-regulation and government regulation both fail, but respondents would like to see that gap closed as much as possible.

Discussion

When comparing the literature review with the survey and interview findings, there are both overlaps and conflicting perspectives on adulterated honey.

First, researchers use the term “adulterated” broadly to include direct adulteration (e.g., adding alternative sweeteners), indirect adulteration (e.g., bee-feeding), and blending, while the industry uses varied terms such as “fraudulent,” “adulteration,” and “fake.” Although the government officially uses the term “adulteration,” the inconsistency in industry terminology could further confuse consumers and lawmakers who are being petitioned to address the issue. Additionally, while the literature review classifies bee-feeding as a form of adulteration due to the chemical changes that mimic direct adulteration, most interviewees did not view bee-feeding as adulteration, and many believed it was a necessary practice.

Nearly half of consumers are unaware of adulterated honey, as indicated by the survey. Although a small number of survey respondents suggested that consumer education could help build trust in honey authenticity, some interviewees acknowledged the need for education while also emphasizing that the burden of ignorance should not fall on consumers. This underscores the importance of government regulation in addressing adulteration.

Survey respondents were divided on whether the government or the honey industry should establish a certification system. However, interviews with industry representatives revealed that the industry feels it cannot—and should not—self-regulate, citing the current failure of the True Source program and retaliatory behavior within the industry. Both the literature and interviewees indicated that industry testing is costly and often ineffective, particularly in detecting direct adulteration by C3 plants. While some interviewees suggested enhancing organic certification as part of a strategy to combat adulteration, most survey respondents indicated that organic certification is only somewhat important for honey or felt neutral about its significance. The majority of interviewees also agreed that organic certification is not a feasible solution due to regulatory challenges and geographic limitations.

When shopping for pure honey, survey respondents were more likely to trust beekeepers and farmers' markets as reliable sources, yet few identified “local” honey as trustworthy. This suggests a disconnect in recognizing beekeepers as local honey producers. Additionally, most survey respondents said they are “somewhat concerned” about adulterated honey, with few expressing deep concern, highlighting a gap between

consumer awareness and the severity of the issue as identified by industry experts and research.

While most survey respondents expressed a willingness to pay a modest premium (approximately 20%) for pure honey, their willingness declined as the price increased. Interviewees noted that the prevalence of adulterated honey has driven down prices, devaluing pure honey in the eyes of consumers and reducing the perceived worth of authentic honey. At the same time, beekeepers are struggling with rising costs, making it difficult for them to compete with imported honey, which, according to research and interviewees, is more likely to be adulterated. This devaluation of honey, coupled with increasing production costs, threatens the sustainability of domestic honey production.

Given the decline in U.S. bee colonies, it is crucial to recognize the value of beekeepers' essential work—not only in honey production but in supporting broader food systems through pollination. Encouraging consumers to accept higher honey prices is another key challenge, as doing so would help sustain beekeepers' efforts in promoting sustainable practices that are vital for mitigating climate change.

Recommendations

Grounded in a study of scholarly sources, consumer data, and interviews of industry professionals, the following recommendations aim to balance the needs of consumers, producers, and the environment while fostering a transparent and high-quality honey market where domestic interests flourish. Implementation requires collaboration across private and public sectors. For clarity, we delineated which entity should lead each recommendation.

Consumer Education

Educating consumers is an important part of addressing honey adulteration. Educated consumers are empowered consumers, and can help drive changes through their purchasing power and by advocating for change with their legislators. We believe consumer education can be achieved through awareness campaigns that inform people about the different types of honey, the benefits of supporting local beekeepers, and how to identify high-quality products while avoiding adulterated ones. The industry can also provide resources on the potential health benefits of honey and how to use it in cooking and wellness. Additionally, nonprofit organizations and non-governmental organizations are most equipped to address consumer education as they already have strong community ties and vast networks. Furthermore, they have the flexibility to try innovative consumer education programs in ways the federal government simply cannot.

Standardize Honey Classification

To truly mitigate the challenges of adulterated honey, the FDA should establish a standard of identity for honey. If the FDA is unwilling to act, Congress should consider passing legislation mandating the FDA to do so. The HIVE ACT, introduced by Representative Kelly Armstrong (R-ND), is an example of current legislation that would instruct the FDA. They should focus on developing clear and consistent definitions for different types of honey (e.g., raw, organic, blended) to ensure consumers understand what they are purchasing, as well as establish standards for honey purity, including specific criteria for identifying adulteration (e.g., with high-fructose corn syrup or other sweeteners).

Promote and Enforce Anti-Adulteration Measures

Stricter government enforcement is needed to deter honey adulteration and ensure a fair market. The FDA should introduce stringent pre-import testing requirements to detect and prevent adulteration of imported honey, support research and development of new techniques to identify adulterated honey more effectively, and solicit direct feedback from stakeholders, including producers, consumers, and scientists, to make informed adjustments to policies.

Enhance Labeling Requirements

The FDA should explore enhancements to honey labeling guidelines to provide clear information for consumers, and provide more transparency on the origins and production methods for honey. Additional labeling guidelines could include requiring the order of country of origin to reflect the predominance of ingredients by weight, similar to the format used on Nutrition Facts labels. This would ensure that country of origin labeling is not misleading and it would clearly show consumers where the honey is predominantly sourced. Additional guidelines could also review the level of heat extraction/heat processing the honey has been exposed to and consider changes to the way varietal claims can be made. The FDA might consider requiring that varietal claims reflect the percentage of specific pollen present in the honey, similar to how yogurt labels disclose active cultures. It's important that labeling changes are based on what is realistic and are not overly cost prohibitive for small beekeepers. To keep labeling manageable, the FDA should perform outreach to the honey industry, with a particular focus on small producers, to identify which label changes are most realistic. Industry associations, or researchers, could provide the FDA with consumer data showing which labeling changes would help them make the most informed decisions about their honey.

Conclusion

In conclusion, the research highlights the multifaceted challenges of honey adulteration, underscoring its widespread impact on consumers, beekeepers, and the broader honey industry. Survey results reveal a significant gap in consumer awareness, with many respondents initially unaware of adulteration but expressing a strong preference for traceability and transparency once informed. There is clear demand for more stringent certification standards, enhanced labeling practices, and consumer education efforts to ensure informed purchasing decisions. However, relying solely on consumer vigilance is unrealistic—government intervention and regulatory oversight are critical.

Interviewees consistently pointed to EMA as a primary concern, with its effects permeating the supply chain and threatening the viability of domestic honey producers. The financial burdens faced by U.S. beekeepers, exacerbated by the influx of adulterated imports, are particularly troubling. The study also revealed varying levels of trust in the certification processes and labeling, with government-backed certifications holding the most credibility. However, despite their credibility, even these certifications were seen as inadequate by the interviewees unless stronger enforcement measures were in place.

Legal action, while important, was noted as a costly and time-consuming strategy to address adulteration. Litigation serves as a necessary tool when regulatory bodies fail to act, but interviewees emphasized the need for a more proactive approach from the FDA and other agencies to safeguard the integrity of the honey market. Additionally, the limitations of current testing methods, particularly for C3 sugars, highlight the urgency of expanding to a fuller gamut of detection testing when verifying the authenticity of the honey.

Addressing honey adulteration requires a collaborative effort between consumers, producers, regulators, and the industry. Strengthened regulations, more rigorous testing, and transparent certification processes are essential to restoring consumer trust and protecting the livelihoods of beekeepers. Without these measures, the market for authentic honey will remain vulnerable to adulteration, undermining both consumer trust and the future of domestic honey production.

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Appendices

Appendix A: Honey Industry Interviewees

Name	Organization, Title
Federico Berrón	Co-CEO, Mexican Association of Honey Bee Exporters
Anne Marie Fauvel	American Honey Producers Association, Program Director
Chris Hiatt	American Honey Producers Association, President
Kevin Kearsley	Hummingbird Wholesale, Purchaser; Alpine Valley Apiary LLC, Owner
Jeff Pettis	Apimondia, President
Ronald Phipps	CPNA International, Ltd., President and Founder; Apimondia Scientific Commission on Beekeeping Economy, former Vice President
Robert Podolski	Podolski Honey Farms, Owner
Sarah Red-Laird	Bee Regenerative / Bee Girl Honey, Founder and Executive Director
Michael T. Roberts	Resnick Center for Food Law and Policy at UCLA School of Law, Professor
Robyn Underwood	Penn State Extension, Extension Educator, Apiculture
Mitchell Weinberg	GenuHoney, President and CEO
Anonymous #1	
Anonymous #2	
Anonymous #3	

Appendix B: Honey Industry Interview Questions

1	Can you tell me a bit about your organization?
2	What are your primary markets for selling honey?
3	What are your main distribution channels?
4	Do you believe the U.S. liquid honey market is impacted by adulterated products? In what ways?
5	What do you believe is the impact on domestic honey producers in the U.S. due to adulterated honey?
6	What role do you see the USDA and/or FDA playing in this process?
7	Do you believe organic honey, following USDA Organic regulations, is possible?
8	Should organic honey have different regulations than other organic products and if so, what standards should it have? If so, why should honey be treated differently than other products?
9	How can the USDA and/or the FDA protect domestic honey producers?
10	What challenges have you seen in implementing a certification system for honey?
11	Have you collaborated with other producers or industry bodies to address the issue of honey fraud?
12	What role do you think industry associations should play in combating honey fraud and promoting certification?
13	What additional measures do you think could help improve consumer trust in the authenticity of honey?
14	Any additional comments or questions?

Appendix C: Consumer Survey Questions

Questions marked with * are required.

* 1. Age (must be at least 18)

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65 or older

2. Gender

- Male
- Female
- Non-binary / Third gender
- Prefer not to say

3. Location (zip code)

4. Approximately when was the last time your household purchased honey? (sliding scale)



Less than a week ago

More than 6 months ago

5. Where do you typically purchase honey? (select all that apply)

- Supermarket
- Farmer's market
- Online store
- Specialty health store
- Directly from beekeepers
- Other

6. Of the following, which three factors are the most influential in your choice of honey? (select 3)

- Price
- Brand
- Taste
- Organic / Non-organic
- Origin (local vs. imported)
- Certification
- Packaging
- Recommendations
- Other

7. Much of the honey in the United States is labeled as pure honey with no additional ingredients. To what extent do you trust that label? (sliding scale)

●

Fully trust the label DO NOT trust the label

8. Before taking this survey, were you aware that some honey on the market may be adulterated or fraudulent? (Findings indicate that some honey in the United States is not pure; it is adulterated in one way or another. This is sometimes referred to as fraudulent honey.)

- Yes
- No

9. Please indicate where you learned about adulterated or fraudulent honey.

- News articles
- Social media
- Friends or family
- Documentaries
- Product labels
- School / education
- Other

10. Has awareness of fraudulent honey impacted your purchasing decisions?

- Yes
- No

11. In what way has adulterated honey impacted your purchasing decisions? (select all that apply)

- Not at all
- I buy honey less frequently
- I spend more time researching brands
- I buy honey from trusted sources only
- Other

12. How do you feel about the possibility of purchasing adulterated honey?

- Very concerned
- Somewhat concerned
- Neutral
- Not very concerned
- Not concerned at all

13. Explain what concerns you have, if any, about the possibility of purchasing adulterated honey.

Perceptions on Certifications for Honey

In this section, you will be asked a series of questions about your ideas around certain certification measures like USDA Organic.

14. How important is USDA Organic Certification in your decision to purchase honey?

- Very important
- Somewhat important
- Neutral
- Somewhat important
- Not at all important

15. Do you think there should be more stringent certification processes for honey to prevent adulteration and fraud?

- Yes
- No
- Unsure
- Other

16. Would you be willing to pay more for honey with a certification label that proves it has NOT been adulterated? If so, how much more are you willing to pay?

I would NOT pay more

- 10% more
- 20% more
- 30% more
- 40% more
- 50% more
- 60% more
- 70% more
- 80% more
- 90% more
- 100% more

17. Which type of certification would you trust the most?

- Government certification (e.g., USDA Organic)
- Third-party independent certification
- Certification by honey producer's associations
- No preference

18. What additional measures would increase your trust in honey authenticity? (select all that apply)

- Transparent labeling
- Traceability (knowing where the honey comes from)
- Regular testing and publication of results
- Consumer education campaigns
- Other

19. Any additional comments or suggestions regarding the honey marketplace and certification?

About the Authors

Jane Coghlan

Driven by her passion for building a food system that sustains ecosystems and communities alike, Jane earned her Bachelor of Science in Sustainable Food Systems with a minor in Nutrition and Healthy Living from ASU in 2022. She proudly belongs to the first graduating class to receive this degree from ASU. With a USDA NextGen scholarship, Jane is continuing her education by pursuing a Master of Science in Sustainable Food Systems. In her current job at the Swette Center for Sustainable Food Systems, Jane leads the Center's communication strategies and assists in research projects related to organic agriculture and true cost accounting of food. Additionally, her dedication to organic farming and soil health has been recognized through her selection as a board member for the Grain Place Foundation.

Carolyn Hosannah

Carolyn is a driven community advocate committed to working towards a more equitable food system. An avid believer in the power of holistic education, Carolyn works in partnership with entities across the NYC food justice space to deliver people-centered policy reform, community advocacy and environmental harm reduction. She served as an AmeriCorp Food Education service member, and she taught children in grades K - 5 about food and nutrition in the classroom. In this role, she also secured grant funding for maintaining new and existing school and community gardens. Carolyn holds a BPS in Food Studies from the Culinary Institute of America, and she is currently attending ASU Online to earn a Master of Science in Sustainable Food Systems. Additionally, her passion for change extends beyond the food system in her current position as a paralegal with the Hosannah Law Group where they are dedicated to "*Law in the Service of Human Need.*"

Susan Kiskis

Susan has over a decade of experience leading for-profit and nonprofit organizations through program development, fostering internal and external relationships, partnership development, education, and business management. She holds an M.S. Global Health and is currently a graduate student in the M.S. Sustainable Food Systems program at ASU. She is passionate about leading organizations toward the successful integration of programs around food, health, and climate change, and has worked in the natural foods sector for over a decade. In 2023, she was selected as a changemaker by the Clinton Global Initiative University for her climate action project. To date, her project has planted three hundred trees and helped install an agroforestry track.

Susan is a Children's Programmer at Cleve J. Fredricksen Library, where she facilitates STEM programs and manages their One Seed Grows children's educational garden. She is a Graduate Service Assistant working with Dr. Rissing on a USDA AMS analysis of organizations managing farmer's markets. In the summer of 2023, Susan lived in Indonesia, where she was a Research Assistant Intern at Alam Sehat Lestari, an NGO in Sukadana, where she analyzed data on the health perceptions of organic farming by organic farmers, as well as research on the mental health impacts from climate change. Susan also volunteered at the Borneo Orangutan Survival Foundation in Central Kalimantan during her time in Indonesia, and continues to volunteer for Borneo Orangutan Survival USA. She serves on the planning committee for Market on Market, a farmer's market in Pennsylvania where she resides.

Aaron Poplack

Aaron is a passionate advocate for building resilient regional food systems that hold equity and community as core values, and he's spent over a decade engaging the next generation of growers, cooks, and eaters to do just that. As the Oregon & Washington Impact and Partnership Lead for FoodCorps, Aaron collaborates with innovative school leaders to resource their goals for increasing access to food education and nourishing, culturally affirming school meals. Aaron also serves as a member of the Oregon Farm to School and School Garden Network's Steering Committee, which he chaired from 2019-2022, and as part of two Policy Working groups that advocate for Oregon's farm-to-school grant program and School Meals for All. He formerly served on the board of Zenger Farm, a working urban farm in Portland that models sustainable agricultural practices. Aaron's passion for food sprouted at the University of Oregon, where he received his BA in Environmental Studies, and published research on pollinator conservation practices and native pollinator efficiency on Oregon farms. He is currently pursuing his MS in Sustainable Food Systems at Arizona State University.

Imelda Rodriguez Benavides

Imelda is an advocate for food justice and sustainable food systems. Raised in East Palo Alto, with roots in Watsonville, CA, her passion for creating positive change in the food landscape began early. She earned a BS in Food Studies from Syracuse University, where she co-founded the first nationally recognized Food Policy Club, launched a CSA drop-off program, and helped establish the university's first slow food cafe. After returning to the Bay Area, Imelda continued her mission to empower communities through food justice initiatives, working in San Jose, Oakland, and serving as a Dean of Students and Families in San Francisco. She also led California alumni policy efforts at FoodCorps, influencing state legislative priorities. Imelda currently serves as the Program Coordinator at Nuestra Casa in East Palo Alto and a Community Ambassador for Fresh Approach, all while pursuing her MS in Sustainable Food

Systems through ASU Online. At Fresh Approach, she helps implement small-scale solutions to mitigate climate impacts, like flooding and drought, while educating communities on sustainable gardening and climate resilience. At Nuestra Casa, her focus is supporting philanthropy work and community-focused programs.

Tatyana Trujillo

After graduating from the University of New Mexico with an MA in Chicano Chicana Studies, Tatyana dedicated herself to working with middle school students as the community schools coordinator in the South Valley of Albuquerque, NM. Born and raised in New Mexico, her Nuevo Mexicana roots run deep and have encouraged her to seek a deeper connection to place through agriculture. Studying native food systems and how to grow in a changing climate is at the forefront of Tatyana's passion. Currently, she is pursuing a Graduate Certificate in Food Policy and Sustainability Leadership at ASU. Tatyana is invested in dedicating her time and education to food justice and ensuring young students are at the table for discussion regarding equal access to healthy, nourishing foods.



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