



Fenugreek

The evolution of a traditional spice from flavor compound development to the frontier of functional flavors

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Modern extraction technologies have brought fenugreek (*Trigonella foenum-graecum* L.; **pictured**) from traditional spice to the forefront of flavor compound development and functional flavors. And while application in maple syrups historically consumes the largest volume of basic fenugreek extracts in North America, fenugreek extracts are now formulated into tobacco flavors, seasonings, bakery and dairy applications, tea, pizza sauces, soups, and even livestock feed. But even as fenugreek markets consistently point to growing demand, which supply can only meet with sustainable price levels, few specialists will tag their name on a short-term doom-and-gloom scenario for this commodity.

Recent industry activity in fenugreek makes it the ideal case study for management of a natural. In an era where complacency leads rapidly to business failure, the lack of any major crisis may just be the perfect time to reconsider all aspects of an ingredient administration. Wrestling with currency fluctuations, rising energy and extraction solvent costs, some key fenugreek players are proactively questioning their business practices in sourcing, processing, research and marketing by taking a vigorous look at enhancing efficiencies all along the supply chain and extraction process. This story provides a glimpse behind the scenes of advanced ingredient management: improving the sourcing of seeds in India, fine-tuning fenugreek grade selection to enhance extraction yields, researching new products and applications, and catering to new markets—all in effort to take fenugreek to the next level.

Flavor and Scent

Fenugreek, a tiny golden seed (**pictured**) and age-old spice, is a key ingredient of Indian curry powder spice blends. The flavor of fenugreek is potent, reminiscent of vegetable cubes, with its unmistakable lovage and

celery notes. Today, more than 50,000 tonnes of fenugreek are harvested every year, the vast majority of which is consumed by the spice trade. The flavor industry's need for fenugreek extract generates a miniscule demand for seeds versus the appetite of the spice world.

Fenugreek is mainly marketed to the flavor industry in three forms: the classic oleoresin, the concrete, which is the precursor to the extract, and the high performance premium-priced absolute. Seeds are either raw or roasted before extraction. GC analysis of the material has uncovered more than 50 volatile components, including n-alkanes, sesquiterpenes and oxygenated components.¹ Its signature odor, however, derives mainly from its content of 3-hydroxy-4,5-dimethyl-2(5H)-furanone, also known as fenugreek lactone, sotolone, sugar lactone or 2-hydroxy-3-methyl-2-penten-4-olide.

Fenugreek oleoresin is the classic fenugreek flavor ingredient. The oleoresin process involves extraction of crushed seeds with solvents such as neat and/or aqueous methanol, ethanol, acetone or hexane with successive washes, filtration and concentration. The end product is a relatively affordable and high impact golden to dark brown liquid, with a classic fenugreek note. Fenugreek absolute, on the other hand, ranks at the top of high performance fenugreek extracts for the flavor



Fenugreek, *Trigonella foenum-graecum* L.



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Snapshots from Fenugreek Country

In March, at the peak of the fenugreek harvest, the flat landscape of Gujarat is bone-dry. Fields go as far as the eye can see—small parcels of wheat, fenugreek, cotton, ricin, mustard, fennel and more. Farmers proudly display plots of fenugreek that were planted over the winter; the green herb has now dried to a bright gold (**pictured**). The plant stands ankle high and is so dry it almost shatters at the touch. The stems are garnished with three-inch pods filled with a dozen golden seeds.

One farmer explains that fenugreek is used not only for its obvious farming income, but also for its soil regeneration and rejuvenation properties when rotated with other crops. His preferred method is to alternate wheat and fenugreek, reminiscent of Provence farmers who rotate wheat, lavender and clary sage. The farmer describes all the prep work that leads to harvest day: seed selection to boost germination rates; ancestral sowing, plowing and harrowing practices to place the seeds at just the right depths in the correct soil; and careful watering from the local electric well pump throughout the season. In the end, a single hectare will require an average of 25 kg of planting seeds spread in the winter, half of them growing into a mature plant within four months. Left at the mercy of Mother Nature and the farmer's expert care, that single hectare will then produce an average of 1,200 kg of seeds.

With no shortage of labor in India, local farmers still rely on manual labor to harvest the crop. Bent over the short stalks, men and women expertly cut the bottom of the plant with a small sickle (**pictured**). The crop is then collected in large piles, where it is kept to dry for a few days. Eventually, just like rice or wheat, the whole plant is beaten to break open the pods to access the valuable seeds.



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industry. The absolute is manufactured following a two-step process:

1. A primary extraction into concrete (**pictured**): seeds are crushed and processed with hexane to yield a very waxy, pasty substance, or concrete, that is alcohol insoluble and of little use for flavor and fragrance applications.
2. A secondary extraction into absolute: the concrete is mixed with alcohol and chilled, then decanted to remove waxes and fixed oil. Residual alcohol is

then removed by vacuum distillation to yield the absolute.

Charabot's partner in India, a company called Jasmine CE Pvt. Ltd., processes more than 300 tonnes of fenugreek seeds in one of its facilities near Madurai.

S. Palaniswamy Raja, director of Jasmine CE Pvt. Ltd., says, "Our operational challenges include designing a production plant able to handle such large volumes, tackling processing complexities of a multiple solvent process, control process parameters to assure a consistent quality, all

the while ensuring [that] safety, health and environmental standards are maintained. A key element was to design a falling film evaporator and vacuum concentrator to ensure the material is not degraded by heat, and boasts minimal residual solvent. Extraction yields reach 5.5–6.0%.”

Formulating Flavors and Fragrances with Fenugreek

According to Charabot flavorist Philippe Gavini, “Fenugreek is formulated in savory flavors, for example in snacks or vegetable cubes, beef or chicken bouillon. This is where the absolute performs at its best, with its cuisine celery note reminiscent of Indian curry.” Gavini also confirms relying on fenugreek for sweet flavors to enhance dark chocolate or roasted coffee notes. “Both the oleoresin and the absolute are effective tools in sweet flavors, with a flavor impact commensurate to their difference in price. The absolute is indeed much more powerful and expensive, so I can only use it when the cost of the finished flavor allows for a premium top-performing ingredient. I formulate the oleoresin in dry fruit notes, like prune, apricot or raisin and even nuts. The oleoresin is wonderful to enhance the dry facet of a fruit, while preserving the fruitiness of the rest of the formula.”

Fenugreek extract, absolute and oleoresin are also commonly used by the tobacco industry.² Tobacco flavorists have long known that fenugreek has a salivating effect, thereby compensating for the otherwise dry mouth feel of some harsher tobacco blends. Furthermore, tobacco and fenugreek complement each other very well not only for unlit cigarette aroma, but also upon combustion wherein the roasted character of fenugreek enhances tobacco smoke. The 3-hydroxy-4,5-dimethyl-5H-furan-2-one constituent in fenugreek contributes to the sweet, caramel, maple and brown sugarlike notes. A typical Maillard reaction sequence will generate desirable furans, similar to fenugreek, which accentuates the natural sweetness of tobacco. Flue-cured tobacco is one of the sweeter tobacco components in a traditional “American” tobacco blend. A tobacco flavorist may use fenugreek to build the natural sweetness for a flue-cured taste signature or concentrate on the herbaceous and warm balsamic notes to enhance the rich, spicy accents of burley tobacco.

In fragrance formulation, however, perfumers rarely rely on fenugreek extracts. Charabot perfumer Dorothee Piot says, “It does not lend itself well to fragrances because its strong food notes are reminiscent of vegetable cubes and lack refinement. It can be useful, however, for its nutty, chocolate, celery facet. I do like fenugreek for its hay, immortelle, tobacco and fig notes, making it an unusual asset to complement patchouli, vetiver or orris in men’s fragrances. I imagine fenugreek could enhance the leather facet of a cigar lounge fragrance, where leather, cigar, wood and whisky notes collide in harmony.”

The Fenugreek Market

Estimating the annual production of fenugreek is more guesstimation than simple math. Dozens of develop-

ing countries grow fenugreek in relative quantity, most having unreliable production tracking. Furthermore, the vast majority of local crops are used domestically, thereby making export data irrelevant.³

India, however, wins the consensus for being the heart of it all, with an estimated 90% of the global production. Some reports assess the 2008 Indian production at 54,000 tonnes—versus 63,000 tonnes in 2007. This drop stems from low prices that have motivated farmers to switch from fenugreek to other, more beneficial crops. Over the last few years, prices have been under pressure. The Indian Spice Board reports the following price trend for untreated raw fenugreek seeds:

- 2005: 15.67 rupees/kg
- 2006: 16.71 rupees /kg
- 2007: 27.50 rupees /kg
- 2008: 33–36 rupees /kg

Demand for fenugreek is expected to grow significantly. Beyond the obvious pressure on demand generated by the fast-growing population of India, demand will be further impacted by five key factors:⁴

1. The trend for natural flavorings along with increased consumer demand for ready-made meals and takeout/dining out meals will boost the need for spices, including fenugreek.
2. Naturally occurring diosgenin has been found in fenugreek. This molecule is a raw material used in the pharmaceutical industry to make steroids, hormones and oral contraceptives. If successfully brought to market, this natural diosgenin ex-fenugreek may weigh heavily on demand.
3. Liquid fenugreek flavor is now sprayed on animal feed, a more efficient alternative to dry powder. While the use of fenugreek liquid extract in livestock feed as a palatability factor is already well established in Europe, it may spread worldwide and spur further demand.
4. While diabetes can be treated with simple fenugreek bread, the market for high-tech nutraceutical-driven extracts is opening. The diabetes epidemic in the United States, an effect of an increasingly obese culture that is spreading throughout the Western world, may further grow demand for the raw material.
5. With an ever-expanding world population and a limited supply of protein, developing countries are working on tapping the nutritional potential of neglected sources. Fenugreek is nearly as rich in lysine as are soybeans.⁵

In terms of supply, Charabot technical and sourcing manager Yannick Lavenu says, “Global weather changes are a major threat to a consistent plentiful supply of seeds. Going downstream, from a finished extract point of view, the seemingly endless consolidations in our industry keep shrinking the landscape of suppliers.”

Going to the Source: Gujarat, India

A successful sourcing strategy must focus on India, where



A fenugreek farmer and his savory crop.



The most upstream point in the supply chain of bulk fenugreek is the spice market of Unjha, in the state of Gujarat.

fenugreek is primarily grown in the state of Gujarat. The region lies along India's northwestern coast, its northern border a stone's throw away from Pakistan. Its capital, Ahmedabad, has more than 4 million inhabitants. For Western and Indian professionals, a candid culture shock awaits in Gujarat: flying square over Kabul, Afghanistan to reach the area from the western world; the no-meat, no-alcohol tradition vigorously enforced throughout the state; and the scope of investments in infrastructure, roads, power and water supply that have turned a barren, arid countryside into a pivotal agricultural area for the spice trade. Everything adds up to make Gujarat a very unique and awe-inducing place. However, according to Jasmine CE Pvt. Ltd.'s Palaniswamy Raja, there are two key challenges in sourcing fenugreek: ensuring uniform seed blend quality, which is difficult in an agricultural commodity cultivated over a widespread area, and securing the best possible price by continuous tracking of a volatile market.

Sourcing Fenugreek from Unjha's Spice Market

The most upstream point in the supply chain of bulk fenugreek is the spice market of Unjha, in Gujarat (**pictured**). This huge open-air platform is the benchmark against which all other spice markets in Asia are judged. In clouds of dust, under the scorching sun, farmers and traders congregate here to exchange fenugreek, cumin, mustard, fennel, dillseed and 20 other spices. Farmers ride their camel carriages, trucks and mopeds to Unjha from all corners of the state to do business with the 800 spice trading shops there. Tens of thousands of canvas spice bags line the streets here, awaiting their turn at the auction. The market buzzes with excitement and frenzy. In a carefully organized chaos, auctioneers make their way from one lot

to the next, carefully monitoring crews of buyers attempting to outbid each other. Small spice traders make their deals here, blending their small purchases into larger lots for resale to spice houses. The largest spice companies from around the world also shop here, eventually shipping the raw spices to their cleaning and grading facilities—"raw" indicating that further processing is required to wash away the high foreign matter content and make the spices safe for human consumption.

It is there, amidst the crowd, dust, mopeds and piles of spices as far as the eye can see that companies can build a long-term relationship with key local fenugreek traders and keep a finger on the pulse of the largest trading platform.

Improving Raw Material Selection for Extraction

An inspection of the local spice cleaning facility revealed that as much as 10% in weight is lost through the fenugreek cleaning process. Dust, dirt, sand, rocks, plastic debris and metallic foreign matter are systematically removed through a series of vibrating screens, density separation blowers and magnetic fields. Of particular interest to this author, who started his career under the wing of French spice legend Gilbert Ducros, is a high-speed seed sorting machine, which is able to sort every single fenugreek seed according to various parameters including size and shape. The process separates the seeds in various grades referred to by spice traders as:

- Bold color sortex clean: a premium quality selection of pure large golden seeds
- Color sortex clean: smaller seeds of nice pure color

- Hand-sorted quality: a more traditional grade, sometimes contaminated with cumin
- Animal food quality: for feedstock

Local wisdom notes that nature is always surprising: it may not be the cheapest, prettiest, most golden or consistently sized seeds that will deliver the most attractive value for extraction purposes. Charabot R&D director Sophie Lavoine says, “Four key elements [are] studied in this fenugreek seed selection process: extraction yields, organoleptic profile and performance, analytical readings vs. standard specifications, and most importantly, cost of finished extract.”

Fenugreek Ingredients and Next Generation Nutrafunctional Flavors

Supermarket shelf space is increasingly devoted to “good for you” foods, the health claims of which are marketed as the key selling point and added value. Stores have evolved from simple reliance on plain oats claiming to reduce cholesterol; they are now stocked with breakfast cereals enriched with omega 3 and soft drinks boosted with vitamins. All major food and beverage manufacturers are appealing to health-conscious consumers. As a result, some are already turning to flavor houses for good tasting and healthy flavors—so called nutrafunctional flavors. Just as some fragrance houses charge a premium

for a fragrance pre-blended with colorants, audacious flavor houses are formulating “good for you” naturals into conventional flavors and promoting them specifically to achieve higher added value. In the right application, fenugreek has this type of potential. The ingredient has been used for millennia in traditional medicine, having still today a key role in ayurvedic medicine. Its virtues are reported in countless ancient and modern writings. In antiquity, fenugreek was used for rejuvenation purposes, or in ointments to treat gynecological issues. A considerable body of scientific literature on both animal and human model studies has shed further light on fenugreek and its numerous medicinal properties.⁵

- Hypoglycemic and antihyperglycemic effects in the treatment of diabetes
- Anti-fertility/contraceptive effects in both males and females
- Treatment of cardiovascular disorders
- Advanced healing for gastric ulcers
- Anti-tumor activity in the treatment of cancer
- Antimicrobial effects in bacteria control
- Appetite-boosting effects in the treatment of eating disorders

In addition, Charabot’s R&D team discovered very high levels of omega 3 and omega 6 fatty acids in a by-product of fenugreek extraction (the non-volatile oil of fenugreek), opening new avenues in nutraceutical applications.

Exploiting the ancient health and flavor aspects of fenugreek in leading-edge applications presents an opportunity for the flavor industry. While the absence of a major short-term supply crisis may lead fenugreek ingredient manufacturers toward complacency, they would do well to recognize it as the perfect time to optimize management. Questioning ingredient strategy every step of the way, affirming the strongest possible foothold at the most upstream point of the supply chain, selecting custom seed blends for optimal extraction yields, fine-tuning extraction techniques, and researching tomorrow’s applications will spur the progress of this ancient spice.

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