

Extracting the Future of Herbs



The ancients knew that a certain leaf, a specific root, a type of mushroom or a kind of bark had healing or nourishing properties. Sophisticated technology has revealed exactly which of the naturally occurring constituents within those organic substrates provide the healing or nourishing action.

But there's a third, critical step: extracting those active elements, intact and safely, for processing into consumables. Interestingly, the idea of extracting the goodies is not new, but rather ancient, pointed out Giuseppe "Joe" Mazza, PhD, founder and CSO, Mazza Innovation Ltd (Summerland, BC, Canada). "Extraction of natural products has been used probably since the discovery of fire," he said. "Egyptians and Phoenicians, Hebrews and Arabs, Indians and Chinese, Greeks and Romans, and even Mayans and Aztecs, all possessed extraction processes used for producing perfume, medicine and food."

According to Mazza, traditional methods of extracting botanical bioactives include Soxhlet extraction, maceration, percolation, turbo-extraction (high speed mixing) and sonication. These techniques have been used for several decades but their downsides are that

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they are often time-consuming and require large quantities of polluting and dangerous solvents. In the past decades, he said, "several novel techniques including ultrasound-assisted extraction, microwave-assisted extraction and supercritical fluid extraction have been introduced to reduce the use of solvents and/or increase the efficiency of the extraction process."

Other older techniques of extracting plant actives, said Jith Veeravalli, president, Gencor Nutrients Inc., based in California, was steam distillation or using solvents such as ethanol or ethanol-water mixtures. Introduced in the 1970s, supercritical CO₂ extraction allowed for what has been considered as solvent-free extraction, because the process completely removes CO₂.

"This technology," he explained, "is particularly well suited to some lipid products and shows good selectivity for others. However, it is not applicable to all natural product classes since it requires high pressures (typically > 100 bar). This creates high capital equipment costs and operating safety con-

cerns. Also, since it is inherently a batch process with small tank sizes, operating costs tend to be high."

There have been some key evolutions in extraction technology in recent years, and a more pressing emphasis on "cleaner" extraction technologies and heavy metal removals. Overall, in 2014, according to James H. Johnson, PhD, director of Process Chemistry, Avoca Inc., in North Carolina (a division of New Jersey-based Pharmachem Laboratories Inc.), there has been a need for higher levels of purification, a need for tighter and more detailed specifications, and a need for continuous operations.

Johnson explained, "One change we have seen over the last several years is the need for higher levels of active component purification. In the past, it was acceptable to simply extract a botanical and then evaporate the extract to form a concentrate or perhaps spray-dry it to a powder. Now more and more processes only begin with extraction but require secondary purification steps to generate higher levels of active ingredients."

Equally, he added, extraction experts are witnessing a push for tighter and

more detailed specifications. Specifications now typically require more numerous parameters to be tested as well as having lower limits for elements such as residual solvents, heavy metals, pesticides and microbiological contamination. "The driving forces behind these changes are the desire to differentiate one's product from that of a competitor as well as a more informed consumer base which demands it," he asserted.

Another change Johnson noted is the increased use of continuous processes in an effort to reduce costs and to produce products with little lot-to-lot variation and more uniformity. Continuous processes have been employed in the chemical industry for many years and it is being used more frequently in the botanical extractions arena. "Avoca's entire clary sage processing line is a continuous operation and we have two separate Crown Model 4 extractors that operate in continuous mode," he added.

Ultra-sound and microwave-assisted methods, said both Mazza and Veeravalli, are newer and have been studied extensively, "but," said Mazza, "they have not been scaled up for the successful production of botanical extracts."

Overall, observed Lynda Doyle, vice president of global marketing for OmniActive Health Technologies, in New Jersey, "expert and specialized companies focus on constant and continuous improvements in extraction technology. Such improvements include gentler conditions to ensure that the active components profile of the resulting extracts match that of the raw material and continuous efforts to reduce residual solvent loads in extracts—and doing so without using chlorinated solvents. In addition, companies are focused on higher environmental efficiencies, such as better use and recovery of solvents, minimal wastage and better energy efficiency. These improvements reflect the concerns of the market for extracts which are closer to nature, and operations which are greener and more sustainable."

Cleaner is Greener

As with so many other industry sectors, cleaner materials, processes and resulting products are imperative to preserve the environment. When endeavoring to mine a plant part for its active constituents, there are some inherent challenges to ensuring resulting integrity.

Doyle explained that solvents remain

the talking points, and that because of sensitivity about using them, the only acceptable means is water, followed by CO₂. "However," she asserted, "a universal solvent cannot meet the market need for specialized, proprietary and customized extracts with high levels of active ingredients within a precise profile. That's where extraction processes provide their invaluable service of creatively, selectively and safely drawing out the useful and valuable components of raw materials for a particular end-use. So, the need for specialized solvents—singly and in combination, is never going to go away."

In most extractions, Veeravalli explained, a carrier is needed to recover the active of interest. Ethanol, hexane, any polar or non-polar solvents, CO₂, or any other solvent may be used. For any extraction process, solvent selection will depend on the solubility of the compounds of interest, solvent penetration and interaction with the biomass.

Another important factor is the choice of a solvent, and there are only a few consumers accept. Gencor and Radient's microwave assisted processing extraction technology (MAPTM), he said, provides more flexibility with the solvents of choice. For example, extracts can be made directly into oils, glycerines or other carriers that contain the active of choice and have high consumer demand.

"The truth is," he asserted, "many botanicals contain active constituents that are not very water soluble and therefore require solvent extraction. Examples of these include; saw palmetto, carotenoids such as beta-carotene and astaxanthin, and curcuminoids from turmeric to name a few. In fact, many components that may be sufficiently water-soluble may still require the use of solvents during secondary purification steps. An example of this would be the purification of various polyphenolics from fruit or berry juices by resin chromatography. In some cases, supercritical CO₂ may be an option, however this requires very specialized and expensive capital equipment."

Another example comes from California-based Axiom Foods, who's Oryzatein® rice protein is the first to use a natural rice protein extraction method. "Hexane is a chemical solvent, most parts of which are gasoline and used in the creation of glues for footwear and roofing, to extract oil and grease from water and soil and come from the refining of crude oil," described David Janow, CEO. "Ironically enough, U.S. grain processors were accountable for

more than two thirds of the hexane emissions in this country, using it to remove oil from grains and protein from soy. The toxicity of hexane in humans is well known and chronic exposure can result in extensive nervous system damage. Hexane is on the U.S. Toxic Inventory list and the Environmental Protection Agency (EPA) has issued regulations on the control of hexane gas due to its potential carcinogenic properties."

Steam extraction has been gaining traction, and according to Johnson, this has been a huge part of the fragrance industry for years. Steam distillation involves passing live steam through the herb or plant that causes its components to "volatilize and condense along with the steam in a water phase. Since most of these volatile components are not water miscible, they form a separate layer which is removed from the water," he described.

Veeravalli added that overall, the methods using steam or water are limited to a narrow range of natural product classes. "The process is limited to volatile oils, whereas active ingredients extracted from botanicals are non-volatile. As non-volatiles, botanical actives such as carotenoids, phenolics, glycosides and alkaloids require a liquid solvent for extraction. Since it's often necessary to use an organic solvent such as ethanol to extract the actives of interest, it's beneficial to use methods that consume less solvent and are more energy-efficient. In turn this can result in benefits such as reduced fugitive solvent losses and reduced greenhouse gas emissions."

Industry Innovations

Extraction specialists continue their focus on improvements for higher and cleaner yields. Avoca, said Johnson, has recently installed a molecular sieve unit for the purification of recycled ethanol, which is widely considered the most benign organic solvent to use for botanical extractions. Ethanol containing approximately five percent water (called 190-proof) is often used because it is not possible to remove the last bit of water by normal distillation. A 200-proof ethanol is available that contains no water, but when this is used for extraction, it tends to absorb water from the botanical and it is then not possible to recycle that ethanol back to 200-proof solely by distillation. "In one particular process that we run at Avoca, a product

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is a core part of our culture—even more common than drinking beer. We identified this niche sports fan market as one of the premium targets for reducing sodium consumption. Zarubi Pitzuchai Hagalil, one of the leading nut companies in Israel, recently added it to their line with great success. Our next step is to introduce this low-sodium ingredient into the global market."

The new low-sodium ingredient keeps the same salty taste in a formulation, but has much less sodium, according to the company. It contains high-value potassium chloride derived from the Dead Sea, plus natural, sustainable Red Sea salt. Salt of the Earth said it relies on Mother Nature's powers to produce sea salt, without chemical processing and with a minimal ecological footprint. Red Sea salt is rich in essential minerals and microelements that are vital to well-being, according to the company.

This sodium-reduction ingredient is heat stable and enables a "low-sodium" label claim. It contains no artificial ingre-



dients or preservatives, and is produced under strict inspection to ensure potency, purity and safety. Zarubi tested the ingredient in multiple lab applications using several kinds of nuts and based on these results decided to launch the low-salt nuts line in Israel.

"The test results should encourage savory snack makers to develop low-sodium nut snacks," added Carmi. "Nuts and seeds are highly nutritious, but a key challenge is to reduce sodium without impacting the salty flavor."

A&B Marketing Director, Gil Bakal, noted that sea salt continues to gain prominence among consumers. The New Jersey-based company recently introduced the natural sea salt, Two Seas Sea Salt, noting that its success is not only related to the reduced sodium chloride content, but the exceptional retention of the product's taste profile.

"Although potassium chloride has generally become the choice substitute for sodium chloride by the industry, the bitter notes of potassium chloride impacts the taste profile of the finished product. This often leaves consumers with a bad taste. The properties of Two Seas Sea Salt, however, offer the food service industry a sea salt that not only provides 50 percent less sodium, but does not affect the taste profile of foods."

Bakal noted that the company has

observed Two Seas Sea Salt against other salts and the new A&B Ingredients' product has consistently outperformed rival products. He pointed to the proprietary manufacturing process and the combination of salts from the mineral-rich Dead Sea and the Red Sea as one of the many reasons for its natural taste. The combination of natural elements also enables A&B Ingredients to offer the new sea salt in cost effective manner.

"While much has been written on the differences between sea salt versus table salt. We note that the effectiveness of the natural properties of sea salt contain many essential trace minerals the body requires, and is a natural means of assisting the body build a stronger immune system which can assist in fighting autoimmune disorders," he said.

Bakal also pointed to the 50 percent lower sodium content of the Two Seas Sea Salt, which helps counter high sodium intake that has been directly associated to hypertension, a major cause of cardiovascular disease. **NIE**

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ProductionLine

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of higher quality can be obtained if 200-proof ethanol is used. The molecular sieve unit allows us to remove the remaining five percent of water that distillation will not. Thus allowing us to recycle a greater percentage of our ethanol and produce a better product for the consumer," he explained.

Gencor tested the MAP extraction technology, offered by Radient Technologies, and, Veeravalli reported, within weeks, a proof of concept at laboratory scale demonstrated a higher recovery of actives and a higher purity using a 15-minute extraction process, which previously required three days.

The MAP process features a patented microwave system to cause instant pressure-driven extraction of natural compounds from bio-masses—"a system that's faster, more environmentally friendly and produces high yields of higher purity compounds," he described. "The result is a superior

product and a sustainability message that resonates strongly with brand marketers and consumers."

Radient subsequently confirmed scalability by processing a significant throughput at its commercial processing plant in Canada. Gencor recently committed to a strategic partnership with Radient which uses their technology for more extracts.

Mazza Innovation Ltd.'s PLPW extraction technology "gives the brand marketer the opportunity to market high-value botanical extracts that are green, and meet the demands of the increasingly health conscious consumer who is demanding more transparency into what is in their food," Mazza said.

"PLPW extraction has been compared with and found to be equal or superior to aqueous-ethanol extraction which is a huge benefit for brand marketers. Additional benefits that have been observed include higher selectivity, cleanliness, speed and cost savings of both raw materials and energy."

He explained that PLPW extraction

technology optimizes the extraction of phytochemicals by modifying the structure of the water molecule through manipulation of pressure and temperature, allowing for enhanced extraction of botanical feed stocks. "It is known that the physical and chemical properties of water within sealed systems can be manipulated by concurrently controlling the temperature and pressure, whereby the water remains in the liquid state even though its temperature may be significantly increased above its atmospheric boiling point of 100 degrees Celsius," Mazza detailed. "Pressurized low polarity water can easily solubilize organic compounds such as phytochemicals, which are normally insoluble in ambient water."

Plant life has been a part of human life for millennia, since the days of hunter-gatherers. Modern lifestyles and sophisticated technology allows for the best parts of those plants to help provide wellness for millions of consumers. **NIE**