Smart & solvent-free

A green, economical extraction method uses only pressurised water to produce solvent-free, clean-label botanical ingredients, as **Steve Campbell** explains

Few consumers are aware that the processes by which many natural botanical ingredients are extracted and isolated to make personal care products and supplements are anything but natural. What is not generally well known by the environmentally conscious is that these ingredients are currently extracted from their botanical sources using an energy-intensive, dirty, industrial process that requires the heavy application of industrial solvents such as ethanol, methanol, ethyl acetate and others.

Since some of these processing solvents can be toxic or highly flammable, they must be handled carefully during the extraction process, in accordance with strict government-mandated environmental procedures that are prone to circumvention and – as a result – dangerous working conditions. After use, their disposal presents an environmental challenge because the processed biomass is contaminated with the solvent. There is also the concern that residual amounts of these solvents may remain in the extracted ingredients, and therefore be present in the final consumer products.

This is all problematic for products that advertise natural botanical ingredients as a key selling feature, and indeed for any product that incorporates botanical ingredients. Given consumers' increasing demands today for cosmetics and personal care products that are clean-label and made using natural ingredients and manufacturing processes, a more environmentally friendly way of extracting botanical ingredients would certainly be welcomed by cosmetics manufacturers. Just such an advance toward greener, more fully natural ingredients is now available.

WATER-BASED BOTANICAL EXTRACTION

Mazza Innovation is a Canadian company that is revolutionising the extraction of phytochemicals from plant sources using its proprietary pressurised water-based extraction technology. Called the

During Mazza's PhytoClean extraction process, water is heated but maintained in a liquid state through pressure, which makes it perform like an organic solvent with respect to the dissolution capacity of organic molecules

PhytoClean method by the company, this technology changes the solubility properties of water such that it behaves like an organic solvent in terms of its ability to efficiently extract valuable plant compounds without the numerous drawbacks associated with the use of traditional industrial solvents.

"Mazza specialises in extracting high-quality botanical ingredients and bioactive compounds, including polyphenols, alkaloids, glycosides and specialty carbohydrates that are of significant value and use to the personal care, dietary supplement and food and beverage industries," notes Mazza's President, Benjamin Lightburn. "Manufacturers are not happy with the serious financial and environmental challenges presented by solvents, and they become excited once they see how our cost-effective technology delivers higher yields and optimal compound recovery with a greatly reduced environmental footprint. This is truly a leap forward in extraction technologies."

Mazza introduced its first three ingredients and proprietary technology last year to industry acclaim at the 2015

Engredea natural products trade show in Anaheim, California. At that show, its green tea, blueberry and cranberry extracts won the most innovative ingredient category of the 2015 Editor's Choice Awards.

Standardised to deliver high concentrations of bioactive ingredients and yet free of any carriers or trace industrial solvents, the company's clean ingredients have been recognised as clear advances in natural ingredients. Mazza now has a robust development pipeline of more than forty new ingredients for use in the personal care and supplement industries.

THE PHYTOCLEAN METHOD

Unfortunately for natural products extraction, water has always generally been a poor solvent for the separation of valuable organic molecules from raw biomass. For an organic molecule to be dissolved by water, it must 'compete' with the hydrogen bonds that already exist between the water molecules. Hydrogen bonds are responsible for many of water's unusual properties, including, for example, its relatively high surface tension and high boiling point. Since industrial solvents don't have this strong hydrogen bond problem, they are much more effective at dissolving the target compounds.

According to Lightburn: "The achievement of the Mazza technology is making water perform like an organic solvent with respect to the dissolution capacity of organic molecules." He notes that, when water is heated, the kinetic energy of the heated water molecules increases, improving the solubility of compounds, ie the targets of the extraction. The key, however, is to maintain the water in a liquid state through the use of pressure, even though it is above its atmospheric boiling point of 100°C.

Furthermore, by adjusting the temperature (and thus the solubility), it is possible to selectively target for extraction of certain compounds and not others. Another advantage is that the process includes a built-in 'kill step' to lower microorganism counts for cosmetics and other products.

In essence, the Mazza technology makes water perform as well as (and often better than) some industrial solvents, but without any of the many negative downsides involved in using solvents. Moreover, since the biomass spends only minutes at elevated temperatures in a purged and closed system, heat-sensitive compounds can be successfully extracted.

The PhytoClean extraction processor produces an extract of approximately 1-3% solids in purified water. Subsequently, an evaporator is used to remove most of the water. After that, Mazza uses a cutting-edge drying technology called refractance window drying that is extremely gentle and preserves the extract's bioactive content and viability. This technology removes the remaining moisture in the extract to produce a dry, highly concentrated product that can be ground to meet customers' specific needs.

COMMERCIAL EXTRACTION

Early in 2016, Mazza announced the opening of its first large-scale commercial extraction processing facility to produce its award-winning cranberry, green tea and blueberry extracts, as well as other clean-label ingredients, for its customers and collaborators. Located in Vancouver, Canada, the company's PhytoClean laboratory and manufacturing operations include a 3,500sqm facility with bench-, pilot- and production-scale extractors; a fully equipped laboratory for research, development and QA/QC; and 17 full-time employees in production, research and management.

Each extractor can process 1,000kg (dry weight) per day of biomass with an acceptable input moisture of 0-90% and a minimum particle size of 1-3mm. It has a footprint of approximately 15sqm, with

five columns that operate sequentially or semi-continuously. In comparison with conventional techniques, the PhytoClean method eliminates the need for multiple environmental certifications, uses a common material handling process, improves operator safety (since no flammables are involved), produces usable by-products with limited waste and is environmentally friendly (figure 1).

A key emerging aspect of the clean-label movement for manufacturers is supply-chain visibility, traceability and transparency for the ingredients they purchase from suppliers, both local and overseas. Mazza's process is able to successfully extract from whole raw biomass – which has not yet been dried and ground up – helping with initial identification and verification of the raw material being processed while it is in a state to still be visually identified. This delivers on the full supply-chain visibility increasingly being demanded by product manufacturers and consumers alike.

FIGURE 1: THE PHYTOCLEAN METHOD VERSUS OTHER EXTRACTION TECHNOLOGIES

	Clean	Fast	Low complexity	Scalable	High yields	High selectivity
PhytoClean	Yes	Yes	Yes	Yes	Yes	Yes
Solvent	No	No	Yes	Yes	Yes	Yes
Supercritical CO_2	Yes	Yes	No	No	Yes	Yes
Hot water	Yes	No	Yes	Yes	No	No

GMP-REGISTERED AND CERTIFIED ORGANIC

Mazza's GMP-registered facility is fully compliant with the quality requirements of dietary supplements and natural health product manufacturers. The company has also already achieved organic certification under the US, Canadian, European and Japanese organic regimes. Since the PhytoClean method uses only water as its solvent, it was not necessary to include costly solvent-handling environmental safety permits or explosion-proof equipment in the facility's design and construction, translating into competitive pricing for the quality ingredients and the contract processing services Mazza provides to customers.

"Opening our new facility is an exciting and important milestone for Mazza. We have now initiated large-scale commercial production of our advanced premium extracts," says Lightburn. "We have significant processing capability to fulfill demand, and our extraction technology can be applied to source many different botanical ingredients with higher purity than is typically available from water-based extraction methods."

SOLVENT-FREE DEMAND

Existing technologies leave manufacturers with poor choices. For one, organic solvent extraction can yield products that contain residues of highly toxic solvents. Operating safely with organic solvents also requires complicated, expensive physical and regulatory infrastructure. A further and very important concern is that some extracting companies may not be meeting standards for minimising solvent residuals in the extracted botanicals, or in handling and disposing of solvents properly.

If manufacturers desire an ingredient that is free of solvent residue, they must either rely on low-performing water extraction or expensive and complicated supercritical carbon dioxide extraction. Mazza's technology provides the solution: a cost-effective process that can achieve the high extraction performance of industrial solvents without any of the inherent cost and clean-label drawbacks to be found using the older, solvent-based extraction technologies.

Beyond commercialising its proprietary ingredients, Mazza is also seeking projects for joint venture and collaborative research with established market players. Mazza works with companies that have specific research projects in mind, for which they would like to develop solvent-free, standardised extracts to meet the growing demand for truly pure products.

Lightburn notes that there continues to be ongoing and growing concerns in the global ingredients marketplace about the ability of traditional solvent-based extraction methods to deliver high-quality, clean-label products. "As our PhytoClean extraction technology continues to displace these antiquated extraction technologies, we expect significant sales opportunities and growth in Asia, as well as continued growth in Europe. We are confident that the cost-benefit analysis of quality, environmental friendliness and price makes a compelling business case for switching to our advanced extraction process for manufacturers who want their ingredients to be fully natural," he says.

LOOKING AHEAD

Having signed an exclusive processing agreement with Naturex earlier this year for its cranberry extract production, Lightburn comments: "The partnership in cranberry with an industry leader such as Naturex shows excellent third-party confirmation of our premium-quality ingredients and advanced, environmentally friendly process. It also provides justification for our aggressive expansion plans, and gives us an incentive to go to the market even more intensively with a wide range of premium-quality botanical extracts far beyond our first three products of cranberry, blueberry and green tea extracts. Mazza is now open for business and looking to discuss collaborations with customer partners in the personal care and cosmetics, nutraceuticals, functional foods and supplements industries."

Beyond its first three cranberry, green tea and blueberry products, the company has tested more than forty different potential botanical extraction ingredients, and confirmed that the process is effective and commercially scalable for an large variety of botanicals for the personal care and beauty markets. Lightburn is confident the company's technology is well positioned to help deliver the fully natural, clean-label products being demanded by consumers. cb

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