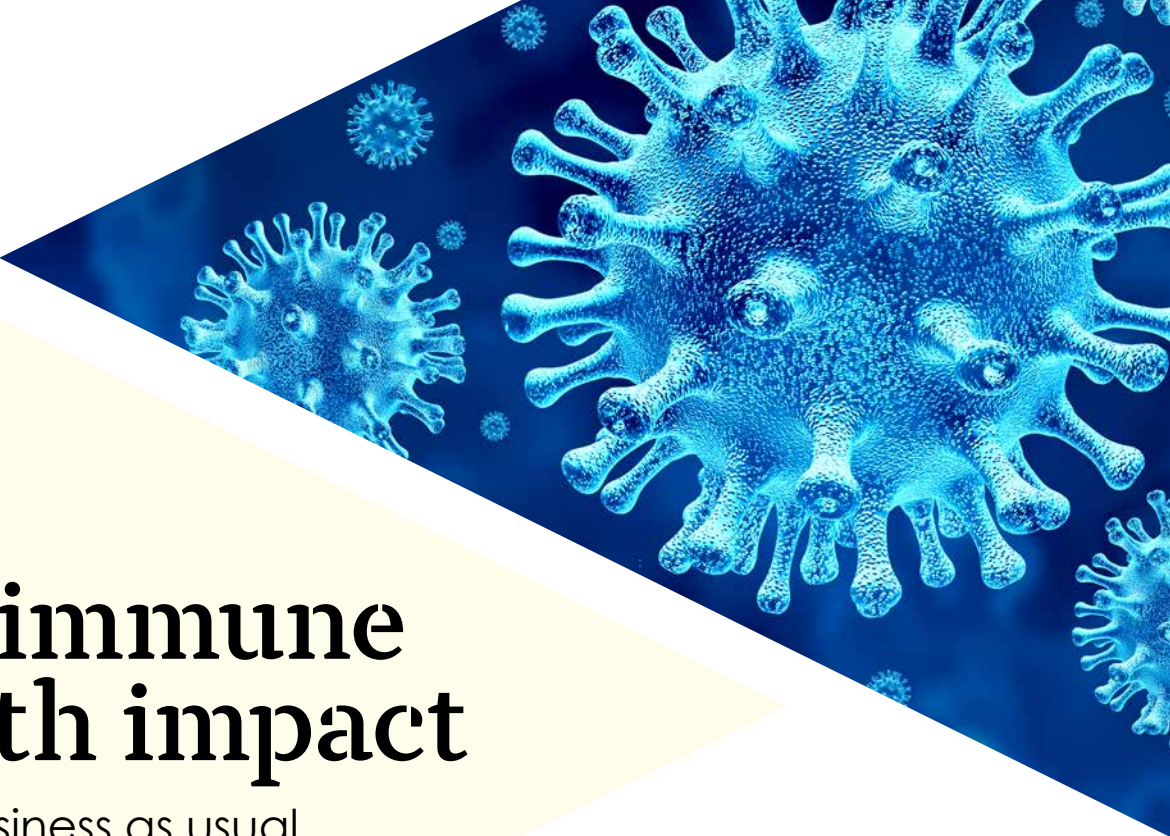





# The immune health impact

It's not  
business  
as usual



# The immune health impact

It's not business as usual

by Charlotte Bastiaanse

**A**t the start of 2020, no one could have quite predicted the situation and restrictions we now find ourselves under as a result of the coronavirus outbreak. For many industries, implications of today's reality and the looming economic crisis stretch far into the years ahead.

In the nutraceuticals world, sales within the immune health category have soared as consumers respond to the COVID-19 threat. Demand for well-researched, immune-boosting ingredients, such as vitamin C, vitamin D, zinc, elderberry and echinacea, are at an all-time high as brands struggle to meet demand for existing SKUs, rush new formulations to market or top up their existing range.

Although the market is being circled by frantic consumers, it's critical that the industry responds responsibly and with a dedicated commitment to safety, efficacy and scientific validation—now and for the long term.

How much do consumers know and what exactly do they want? What are the areas of major challenge for the supply chain, and how are brands adjusting their

strategy? How can credible brands win now and in the future?

## The changing consumer

Quite rightfully, consumers are anxious about their vulnerability to disease and their ability to recover from illness. They're proactively trying to improve their immunity through diet, supplementation and lifestyle decisions. While the pharma market focuses on vaccination or other potential preventives, nutraceutical brands are delivering immune-boosting solutions.

Natural brands already resonate well with consumers. However, they must underscore brand integrity by formulating finished products with ingredients that are supported by clinical evidence.

"In terms of categories that consumers will turn to, they will more likely turn to everyday food and drink products rather than nutritional supplements," suggests Mike Hughes, head of research and

insight at FMCG Gurus, a consumer insights company. "This is something that can be linked to affordability as well as the ease of incorporating products into daily diets."

Alongside increased consumption of fruit, greens and other foods deemed fresh and nutritious, supplement manufacturers and their partners are reporting tremendous demand and sales growth across Europe, the Middle East and southeast Asia.

Interestingly, George Kuriakose, head of operations at Anaha LifeCare (nutraceutical formulation specialists), says demand for immune-boosting products had almost died down before the outbreak of the COVID-19 pandemic.

Now, says Dr Manfred Eggersdorfer, professor for Healthy Ageing at the University Medical Center Groningen, there are sales spikes in a range of supplement products, particularly multivitamins and omega-3s.

## Demand and interest

Generally, there always is a peak in the winter for immune health products; but, due to the COVID-19 pandemic, Dominique Baum, managing director at Ayanda (nutraceutical private label experts) observes there has been an uptick of interest over this spring season, with further expectations of higher than normal demand over the summer. Additionally, and due to confinement regulations, Baum highlights that many people have limited exposure to sunlight, which raises the demand for vitamin D. Other consumers want to strengthen their respiratory and cardiovascular systems—areas seriously affected in the case of coronavirus infection.

Companies including Kerry, PharmaLinea, Kaneka Pharma Europe and Evolva confirm demand spikes for their immune health ingredients and finished products. Maja Orešnik, science and research director at PharmaLinea, a company specialising in private label, says

their preventive products in the 'Your Immuniq Line' range currently show the highest growth across all product forms (syrup, sachets and capsules), followed by their vitamin C range. It's evident that certain brands are looking to expand upon their current range or introduce a new line to their portfolio, as Orešnik has seen an uptick in new company inquiries.

Many natural ingredients, such as vitamins C, D and E, zinc and echinacea, have a wealth of known science and, importantly, are familiar to

consumers. Others, such as ubiquinol, the antioxidant form of coenzyme Q10, have proven benefits but consumers are less aware of them. However, Filip van Hulle, senior manager at Kaneka Pharma Europe, says the company has is seeing increased demand for its ubiquinol ingredient—encouraging for its potential to protect against influenza virus and its immunity action related to cytokine release.

Another antioxidant ingredient with anti-inflammatory properties, resveratrol, is witnessing renewed interest as reported by David Tetzlaff, director of marketing at Evolva, an ingredients manufacturer, whose flagship ingredient, Veri-te™, positively supports innate and adaptive immunity.

In the marine world, Kevin Krail, business development manager at Marinova, Australian biotech company, shares that a majority of its customers buy the company's certified organic, high-purity fucoidan ingredients for inclusion in immune dietary supplement



formulations. "Many of these customers have increased their ingredient orders to meet the upswing in demand for their finished products. We are also seeing a surge of new interest from brand owners looking for evidence-based ingredients that will enable them to add an immune health product to their existing nutritional supplement range," Krail says.


## Pressure on the supply chain

With the rise in consumer interest mirrored by brands quickly moving to increase their inventory or add onto existing portfolios, how is the supply chain coping with demand in and amongst a range of challenges including closed manufacturing sites, paused operations, reduced workforce and significant transport restrictions?

Fast-thinking ingredient companies have gotten ahead of imminent limitation challenges, and Orešnik shares that PharmaLinea was quick to invest and ensure a safe stock of raw materials at the early stages of the pandemic. She highlights main challenges as increased strictness of customs, or even closing of borders, and increased prices of transport.

### Don't compromise on quality

Similarly, Randal Kreienbrink, vice president of marketing at Martin Bauer (botanical specialists), states the company has



“Central to this is the security of supply of these resources and the determination of market leaders to become exemplars of sustainability.


also been successful in maintaining sufficient raw material supply. He cautions other manufacturers to uphold trust within their supply chain, but to tighten up authentication measures within in-house or third-party labs to verify all incoming ingredients. He adds: "There may be challenges in terms of quality of ingredients as manufacturers try to keep up with increased demand. Some sites in Asia are up and running again, but air freight at any level is almost impossible and very expensive, which may cause delays with manufacturing."

In light of current challenges, there is a wider emphasis on the importance of supply guarantee and back-up measures in order to survive future crises. With many companies searching for alternative supply, Baum reiterates the importance of remaining committed to sourcing ingredients that are produced under current Good Manufacturing Practices (cGMPs) and hazard analysis and critical control points (HACCP)-based food safety conditions, and are free from contaminants such as pesticides, polyaromatic hydrocarbons, furans and dioxins, and polychlorinated biphenyls.

### Cost to customers

Multiple industry corporates maintain manufacturing sites on different continents for supply and geographical positioning reasons, with some currently looking to invest in additional future sites in light of the current logistical challenges. Many ingredient suppliers rely on external partners for transportation between manufacturing sites and mainland Europe, and with the current costs and limitations associated with travel and freight, could prices be ramped up at the consumer level? Van Hulle shares that although delivery terms are longer and more costly, it's not the best time to pass these extra costs to customers; however, restrictions






and cost fluctuation over the next few months will dictate price increases to supply chain customers and consumers.

## Adapting and overcoming

Regular monitoring of raw material availability and securing stock should be the cornerstone of any ingredient manufacturer. During the COVID-19 pandemic, supply chain communication and quick action is of utmost importance. Baum shares that many brands, like Ayanda, have increased their inventory to ensure that operations run smoothly through the crisis period, but notes stakeholders still need oversee compliance and incessantly monitor the reliability of their external partners.

As part of a long-term vision, Krail says Marinova has continuously invested in its production capabilities over the last decade, including improvements to its seaweed harvesting, warehousing infrastructure, processing efficiencies and global supply chain networks. Reflecting now, these investments have paid off with the company placed in a strong position to diversify where necessary. "There has been no interruption to either our seaweed harvesting or fucoidan extraction operations," Krail says. "We adopt a conservative approach to our inventory holdings which enables us to comfortably respond to any surges in demand like the one we are currently experiencing."

Beyond infrastructure



“Although delivery terms are longer and more costly, it’s not the best time to pass these extra costs to customers.

and process, businesses are having to adapt to new channels of communication and market reach. Purchasing has largely moved to online, with successful stakeholders demonstrating agility and quick uptake of a new digital reality.

## Launching to market now

COVID-19 is resulting in health-conscious consumers re-evaluating their diets and lifestyles. In addition to this, and irrespective of any concerns about their financial wellbeing because of the risk of recession, they are still willing to sample new products and trade up on products that meet their need states, says Hughes.

### Is it now or never?



There are big questions around current market opportunities for brands with shares in the immune health category. Simply put, there's an option to turn a simple and uncomplicated product to market in a matter of 45 days to meet demand for immune boosters. Legacy brands concerned with credibility damage associated with opportunism are less in favour of this approach. Alternatively, there's the option to hold back and develop innovative products for wider market need and sustainable sales growth—an approach with more complex layers that could take years to oversee from start to finish.

Regardless of the current market opportunity, businesses cannot compromise on their commitment to verifiably safe and high-quality products. "In times of uncertainty, consumers tend to adopt a strategy of risk avoidance and scrutinise the practices and policies of brands more closely, including

marketing and product claims," says Hughes. This means they will be especially conscious about whether health claims are misleading in order to try and charge a premium price and capitalise on health concerns. As such, he adds that any strategy needs to be positioned around offering consumers maximum transparency and promoting products as part of an overall balanced and healthy diet, instead of positioning products as a quick and easy way to deal with all health problems.

"If there was any time to launch an immunity product, it is now," Kuriakose says. "The world is looking for easy access to products that boost immunity, preferably over-the-counter, safe and effective natural dietary supplements." However, there are industry concerns about soft science and exaggerated label claims affiliated with emerging or first-time products. Dietary supplements can certainly help to boost one's immune system but cannot, by any means, be sold with the promise to treat or cure diseases. It is categorically unethical to take advantage of the current outbreak to promise a solution without evidence, says Tetzlaff.

“In times of uncertainty, consumers tend to adopt a strategy of risk avoidance and scrutinise the practices and policies of brands more closely, including marketing and product claims.

## Regulatory considerations

Although many new immunity products contain a tailored composition of key nutrients for the immune system, Eggersdorfer notes an additional consideration—the very different regulatory requirements in different countries, as not all regulations allow dosages that are optimal for immune health. "The legal status for certain ingredients used for food supplements or the fortification of food is clear in Europe, and brands still need to comply with the framework provided by European regulators and approved European Food Safety Authority (EFSA) health claims," says Klaus Brockhausen, sales director of the food business unit at Dr Paul Lohmann.

Understanding regulations pertaining to different regional authorities is of utmost importance to sales compliance. For example, in Europe, Mariko Hill, product development executive at Gencor Pacific (an ingredients manufacturer), outlines that in order to have an immune-boosting claim featured on a product, brands must formulate with ingredients that have been approved by the EFSA. On the other hand, in the United States, brands can formulate products to carry structure-function claims but must maintain their own clinical substantiation files.

For brands looking to launch to market at this time, it's essential to take the necessary time to check all boxes as the implications of a non-compliant or unsafe product are very serious. Reliable sourcing, organoleptic development, stability studies, as well as a range of other studies simply cannot be performed in a matter of weeks, and cutting corners comes with risks, warns Orešnik. "Supply could fail, the product could turn out to be unstable in real time shelf life, and subsequent recalls and enormous damage can follow. For brands that are steadily building consumer trust

and have a strategic vision for long-term success, a product should be based on research and development closer to the scale of years," she adds.

## Protecting integrity through transparency

There is a wider responsibility for immune brands to not only serve customers and consumers with credible products, but to promote messaging around the role daily nutrition plays in long-term health and illness prevention. The immune system is incredibly complex, there's no way to measure its strength (other than when it underperforms) and there's certainly no such thing as a quick-fix—it's important that consumers know that for their better judgement of pop-up products offering 'silver bullet' solutions. The fact that sales of health boosting products are on the rise indicates that as a result of a pandemic, many consumers have questioned their overall health and immunity, Hughes says. "This is something that they will

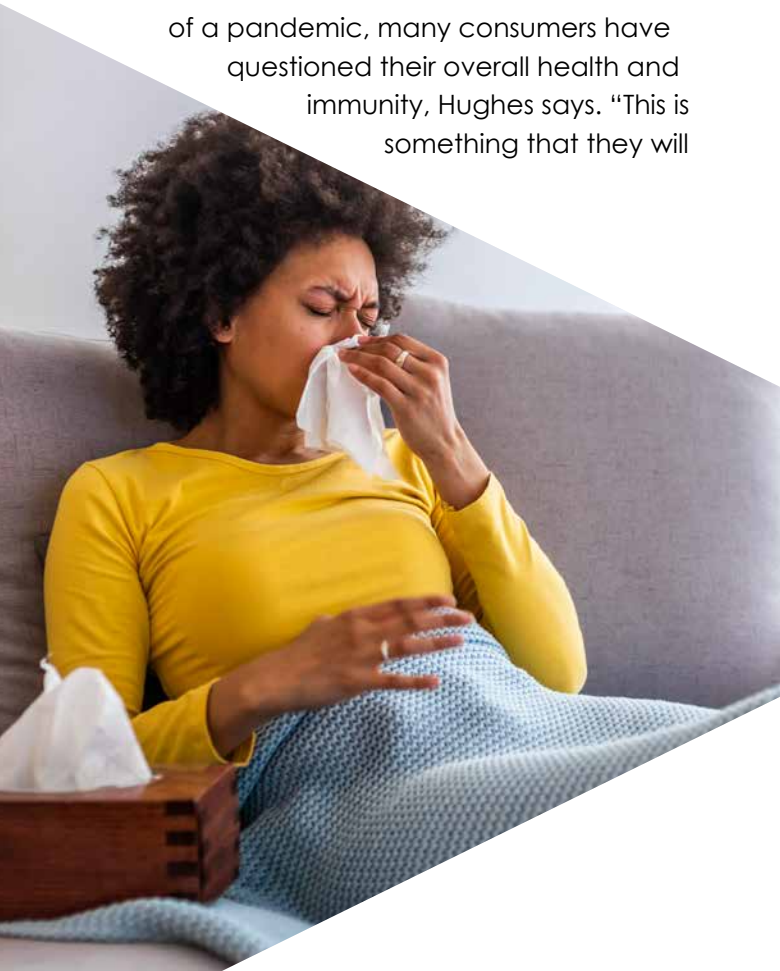
do throughout their life when the risk of disease and illness intensifies. Brands need to respond to this by encouraging consumers to try and maintain their health, even after the pandemic has peaked."


It's worth exploring how industry can work closer with health organisations to identify vulnerable demographics and present combined information about what can be done to minimise the risk of illness in the long-term, adds Hughes. In agreement, Kreienbrink believes this time needs to be about expanding scientific studies and partnering with credentialed and trusted institutions.

"We are witnessing popularity of virologists and other healthcare disciplines, even if their messages are complex," says Baum. "Consumer interest in various health topics is rising as well as their willingness to learn about complicated issues. Evidence-based information, which marketers can provide on- and offline, will be a major factor for consumer purchasing choices."

In conjunction with broadening consumer education and knowledge, the supplement industry has a duty to improve consumer confidence by upholding the principles of integrity and transparency.



Transparency and the honest communication of scientific benefits should be the pillars of every company's messaging. John Quilter, VP and general manager at Kerry Group, shares insights from the company's recent global survey, where consumer value of clear label information is clearly reflected: "In China, 48% of respondents said they like to see the benefits of products explained and





supported on the packaging. In Mexico, the figure is 50% and in Indonesia it is as high as 63%.” Scientific backing from high-quality, peer-reviewed studies helps consumers understand the real benefits of immune health products, ultimately simplifying their purchase decisions. This is important in a market where they face increasing choice and a cacophony of claims—not all of which they can trust, adds Quilter.

Certified and validated claims will significantly influence the nutraceutical industry, especially because some claims can be subjective. As such, Hughes believes that products that carry trusted claims will benefit most from consumers becoming more health conscious.



While brands can do a lot in their position to educate and help consumers understand the science of immunity, Eggersdorfer identifies the missing commitment of the medical community and governments to communicate and advocate for the role of a strong immune system to reduce risk, duration and severity of viral infections. “A joint engagement of industry and science is required to address these shortcomings and inconsistencies to open the opportunities for public health,” he says. Supporting a strong immune system should be of relevance and importance to public healthcare and government institutions, offering a greater rationale to tighten the relationship between industry and regional bodies.

## Changing attitudes for the long run

Through a collaborative and committed effort, the industry can achieve its goal of broader consumer awareness, understanding and appreciation for immune health and

its associated science—but even with the information at hand, will it be enough to change mindset and willingness to invest for the long-term?

“This is something that will be determined by the length and severity of COVID-19,” Hughes says. Over the last couple of decades, consumers have been subject to pandemics such as MERS (Middle East Respiratory Syndrome), SARS (Severe Acute Respiratory Syndrome), bird flu, swine flu and many others, with little evidence of long-standing behaviour change. However, these pandemics have not been on the same scale as the current coronavirus in terms of infections and fatalities.

Moreover, Hughes perceives: “With COVID-19, there are a number of concerns that will be on the minds of consumers, such as the risk of second and third waves of the disease, how long it will take to find a vaccine and what happens when governments begin exit strategies from country lockdowns. For some there will be concerns that governments are not taking the virus seriously enough or are being premature with restrictions on lockdown.” These consumers are especially likely to continue to seek out products that boost their health and minimise the risk of disease and illness. Meanwhile any spikes in infection and fatality after initial lockdown measures have been lifted will also drive demand for immunity health boosting products—exactly how far that will stretch remains to be seen.

Among our experts, the general belief is that for as long as fear of coronavirus persists, the immune health category will remain the main market of focus as awareness for immunity grows as a priority. Viral and bacterial infections will never go away, and perhaps this pandemic will rekindle interest, bring some harsh realities to light and pave the way for long-term attention.

Tetzlaff references two scenarios: One



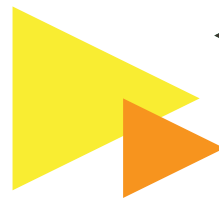
is that the spike in immunity-boosting supplements will quickly die down once life normalises, and the other is that it could lead to increased consumption of dietary supplements as part of life-long routine. “The reality is probably somewhere in the middle—with some new users becoming lifetime consumers of supplements and some users going back to ‘life as usual’ with minimal use, but it’s too early to conclude from current demand spikes,” he says.

## The new normal

It is fairly certain that COVID-19 will influence the health and wellness market for at least the next two to three years. This is because the reality of developing an effective vaccine is some ways off, Hughes explains, and consumers will remain concerned for their vulnerability to disease and illness. But what will the ‘new normal’ look like for immune health stakeholders, and what key learnings will help businesses evolve for the better?

“I think there will be a great deal of innovation bringing new market players into the category,” says Kreienbrink. “Market trajectory will continue to increase as we now will anticipate the threat of a new pandemic or the reoccurrence of COVID-19.”

“The value of working with responsible companies who are prepared, agile and able to respond well is being tested now.”



In Orešnik’s view, the pandemic stresses the importance of strategic long-term relationships with suppliers versus spot-buying and placing too much sole focus on price. The latter model was heavily impacted now by price increases and lack of supply altogether. “Additionally, the value of working with responsible companies who are prepared, agile and able to respond well is being tested now,” she says.

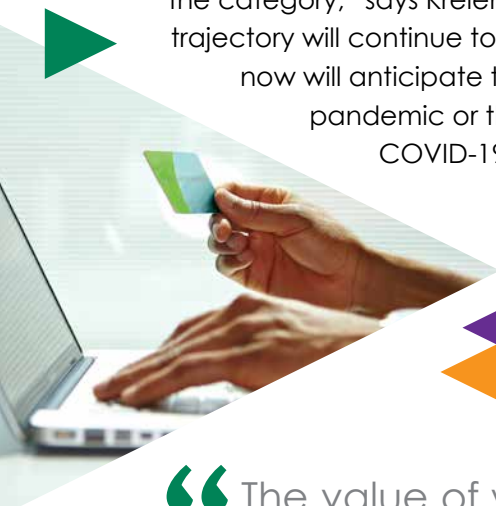
Krail agrees that many businesses have been forced to address underlying shortfalls—from manufacturing processes right through to deficiencies in their supply chain and distribution channels. He states: “Companies with established processes that can withstand the current market shocks will emerge as the true industry leaders.”

Current experiences will inform how many companies go in search for new suppliers that fit wider strategies and vision. In the event of a future outbreak, businesses will want the reassurance that their partners can see them through the process. Strong partnerships will be one of the key lessons strengthening the industry, says Orešnik, and will simultaneously raise the quality standard for both raw materials and finished products.

Similarly, Kuriakose believes the industry will emerge with further focus on preventive and prophylactic remedies, customised to suit modern day challenges dedicated to the health of the global population.

## Future product development

While the rest of the year appears dedicated to maintaining supply of current portfolios that meet demand for immune boosters, certain brands will be thinking



about future product development and the untapped gaps of opportunity that existed before the coronavirus outbreak.

### Market trends

Over the course of 2019, three key areas were trending in relation to immunity: cognitive health, sports nutrition and gut health. From a consumer specialist position, Hughes identifies that consumers are increasingly conscious of their mental wellbeing, recognising that issues such as anxiety and disrupted sleep patterns can have a greater impact on health other than simply influencing mood and energy levels. In light of the mental health concerns arising from COVID-19, this trend will likely intensify. In addition, Hughes says: "Consumers are embracing the concept of active nutrition and looking to take a proactive approach to health, as well as ensure their diets contain a variety of functional ingredients. This means moving away from traditional dieting patterns focused around avoidance and moderation to actively looking to improve health through diet instead."

Quilter expands on the growing relationship between immune health and sports nutrition, where a more mainstream consumer base means a wider variety of health goals. He notes that both amateur and professional athletes want to avoid being derailed by an infection, and references a 2017 survey in the United Kingdom which found that 37% of consumers would buy a sports drink that supported their immune system.<sup>1</sup>

As current restrictions have led to mass athletic events and competitions being cancelled, there could be a slight dip in demand for high performance products. However, as society normalises, van Hulle predicts that focus will be pulled back to how athletes of all levels can perform better,

become stronger, and recover faster.

### Innovate and change the game


Orešnik witnesses an evident trend surrounding the growing complexity of products—especially in ingredients, building on simpler vitamins and minerals to develop more intricate combination products. One such refined intersection is between the gut and the immune system. Improved science has brought the combination into the spotlight and this was clearly

reflected in new product launches that took place over 2019, she says.

There are further opportunities to develop products tailored to age. Right now, improving immunity is of interest to consumers of all ages, but Eggersdorfer explains that catching an illness or flu has always been of concern to high risk groups, like the elderly and sickly patients, as there are potential life-threatening implications. The immune system naturally weakens as we age, and Eggersdorfer recognises the need for solutions tailored to the elderly and other high-risk individuals.

At the other end of the spectrum, one area of largely untapped potential is children's immune health. "Despite the fact that immune support is one of the health benefits parents are most likely to seek for their kids, immune system claims were found on only 2% of children's food and drink products launched globally between 2012 and 2017," says Quilter. "Furthermore, the global drive to





reduce added sugar and artificial ingredients means many beverages could use a 'halo polish'. The enrichment of products with benefits for immunity can help increase the appeal of kids' drinks in the eyes of parents."

### Future winners

Staying close to consumers, breaking down the science for buyers, maintaining reliable supply chain partnerships, monitoring the market for opportunity, and innovating to meet overlapping demand is a recipe for success—but there's still work to do around differentiation and clinical substantiation for the immune health category.

Hill suggests brands can differentiate and innovate from existing 'me-too' products by incorporating unique ingredients with immune-modulating properties. She references palmitoylethanolamide (PEA), which has slowly been gaining traction for its anti-inflammatory and analgesic properties, backed by over 25 clinical studies. With potential to address pain management, immune-modulation and performance-enhancement, PEA could surface as an ingredient for sports nutrition and immune health combinations.

As well as the choice of ingredients for final application, bioavailability is still an important topic. Chemical and technical revision, and optimisation of food supplements may lead to a higher consumer compliance and therefore gain of market shares, says Brockhausen.

In addition to innovative ingredients, Kuriakose says brands need to move on to new and novel delivery formats. In the recent years, developments have trended toward gummies which offer enjoyable sensorial experiences and snacking applications in comparison to tablets and powders—a certain format favoured by children and adults alike.

Additionally, Baum highlights that consumer demand for organic, GMO-free, and plant-based food supplements is clearly on the rise. "This growth will be on top of conventional over-the-counter products," she says. "Well-known brands will add portfolio extensions that respond to consumers' wish for sustainable, natural food supplements."

Finally, Krail believes natural ingredients that are sustainably sourced and backed by credible evidence will remain at the forefront of the market. "Central to this is the security of supply of these resources and the determination of market leaders to become exemplars of sustainability. A focus on rapidly renewable resources, harvesting in line with world's best practice, and innovative green chemistry technique will all be placed under the spotlight."

The immune health market is undoubtedly having its turn at the top of the podium. How closely consumers will resonate with the importance of lifelong prevention remains to be seen over the coming years. Currently, brands have the opportunity to act responsibly, deepen the science, and drive consumer trust through transparency and innovation.



1 Mintel, Sports and Energy Drinks — UK, August 2017

2 Mintel, Children's Nutrition Insight, December 2017



Company Name: Chenland Nutritionals Inc.

Contact: Gale Acabal  
[info@chenland.com](mailto:info@chenland.com)

Title: Product Manager  
[www.chenland.com/](http://www.chenland.com/)

## 1 What specific ingredients do you offer brands in products that support immune health?

Jadeimmune™ is a synergistic herbal extract complex comprised of Astragalus membranaceus root, Atractylodes macrocephala rhizome and Saposhnikovia divaricata root. The formulation has been studied extensively for its immune boosting effect, with over 1,000 cases confirming a reduction in respiratory distress caused by the flu, other viruses, and allergies alongside an overall balancing of the immune system.

Atractylodes macrocephala and Saposhnikovia divaricata hold an immunomodulatory role and regulate immune cytokine levels in the blood serum respectively.

Astragalus has more than 2,000 years of edible history and a wide range of applications worldwide. It is suitable for strengthening fitness and has been used in a variety of dietary supplement products promoting healthy respiratory function.

## 2 What advancements, innovations, or services do you offer to support specific formulations and product applications?

At Chenland Nutritionals, our R&D team consists of over 50 members featuring experts from Cornell University, the University of Chicago, and other advanced research institutions specializing in product development and formulation. We specialize in TCM-based brand ingredients scientifically backed through in-vitro and in-vivo testing, alongside rigorous preclinical and clinical trials.

## 3 How do you define your company's point of differentiation and advantages in the market?

Chenland Nutritionals is a leading supplier of natural brand ingredients. We work with the world's top nutrition experts when designing our dietary supplements, undergoing rigorous safety and efficacy tests to ensure their quality. Only GAP-verified herbal and marine products are selected in our formulations, which utilize over 2,000 years of TCM history whose health benefits are scientifically validated through our in-vitro and in-vivo testing, preclinical and clinical human studies. Our goal is to provide innovative product solution to our customers, all while meeting the increasing demand for natural ingredients and health.

## 4 Do your ingredients carry studies behind them that support specific structure/function claims?

To study the safety and efficacy of Jadeimmune™ we analyzed several randomized, placebo-controlled parallel studies. Results from the series of experiments demonstrated Jadeimmune™ constituents exerted immune regulation and enhanced immunity of immunosuppressed rats, in addition to reducing pulmonary tissue inflammation in rats with chronic bronchitis. (1,2) Further studies involved treating COPD patients with Jadeimmune™ constituents with results showing strengthened immune systems and improved symptoms.<sup>3</sup>

In addition, Chenland's R&D team is studying the effect of Jadeimmune™ on animals infected by strains of coronavirus, which will help provide evidence to support further clinical studies. We are also in the process of conducting human clinical trials with a CRO to further study the effect of Jadeimmune™ on immunity.

1. Xue L, Jiawen S, Danping F, et al. Yupingfeng San Inhibits NLRP3 Inflammasome to Attenuate the Inflammatory Response in Asthma Mice[J]. *Frontiers in Pharmacology*, 2017, 8:944.
2. Yu S, Jun L, Shi-Rui Z, et al. Anti-Inflammatory and Immunoregulatory Effects of Yupingfeng Powder on Chronic Bronchitis Rats[J]. *Chinese Journal of Integrative Medicine*, 2013, 19(5):353-359.
3. Ma J, Zheng J, Zhong N, et al. Effects of YuPingFeng granules on acute exacerbations of COPD: a randomized, placebo-controlled study[J]. *International Journal of Chronic Obstructive Pulmonary Disease*, 2018, Volume 13:3107-3114.

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