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THE EXECUTIVE ISSUE

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IN CONVERSATION

PUTTING PRESSURE ON QUALITY RESEARCH, DRUG DEVELOPMENT, AND CANNABIS (CBD) PRODUCTS

→ *Pressure BioSciences (PBIO) is developing a number of unique technology platforms involving the application of high hydrostatic pressure to accelerate and enable higher-quality research, drug discovery and development, and the manufacture of cannabinoid (e.g., CBD) products. David Alvaro, editor at* Pharma's Almanac, *sat down with Pressure BioSciences Chairman and CEO, Richard T. Schumacher, to discuss these promising developments.*

MAKING THE APPLICATION OF HIGH PRESSURE SAFE

"Pressure is an amazing force of nature," asserts PBIO founder, President, and CEO Richard T. Schumacher. "It moves at the speed of sound, has the power to exquisitely manipulate molecules, and can be turned on and off like a light switch," he adds. These are tremendous advantages compared with conventional methods for controlling molecules in the laboratory, particularly the application of hot and cold temperatures or chemicals. While raising and lowering the temperature can speed up or slow down molecular action, once temperature has been applied, it takes time to bring the system back to equilibrium. Similarly, chemicals can also be used to manipulate molecular action; the chemicals are then often removed, which requires both time and money. Pressure can be used to effectuate many of the same changes that temperature and chemicals promote, but pressure can be instantaneously applied and removed, often with fewer negative consequences.

The challenge has always been to develop high-pressure processes that are safe yet effective in the laboratory setting. High pressure is currently used in various manufacturing sectors, but it is more challenging — and expensive — to design safe laboratory equipment that can go to tens of thousands of pounds per square inch (psi). As a result, research scientists have generally been limited to the use of pressures of a few hundred to approximately 10,000 to 12,000 psi.

PBIO has developed pressure-generating instruments that can apply pressure up to 45,000 psi in a safe, reproducible, and routine manner. The system employs hydrostatic (water) pressure: water is safely compressed in the instrument's pressure chamber to high and very high levels; this pressure is then transferred to samples contained in specially designed, consumable reaction vials in the pressure chamber. A next-generation instrument under development can reach pressures as high as 100,000 psi. PBIO has 24 patents on its high-pressure–based Pressure Cycling Technology (PCT), BaroShear Technology (BaroShear), and Ultra Shear Technology (UST™) platforms.

NEW WEAPON FOR INCREASING THE QUALITY OF RESEARCH STUDIES

In most of PBIO's instruments, pressure can be turned on and off repeatedly (PCT). Of the company's 24 issued pressure-based patents, over half relate to the PCT methodology.

One of the widest applications for PCT is in the investigation of cellular materials (proteins, DNA, RNA, and lipids). By repeatedly squeezing cells with hydrostatic pressure, PBIO's GMP-compliant, PCT-based Barocycler EXTREME instrument enables the controlled release of cellular material, which can then be used for the design, development, characterization, and quality control of biotherapeutic drugs, as well as for discovery of biomarkers for medical conditions, such as cancer, heart disease, and Alzheimer's, as well as in forensics.

The proteins and other materials extracted from cells broken with PCT are more likely to be in their natural state than traditional techniques for achieving cell lysis. PCT can further allow access to proteins and enzymes not seen when cells are mechanically or chemically degraded; 5% to 10% of the total proteins obtained using PCT are only observed when this method is used.

PCT is also accelerating the investigation of proteins after isolation from cells. Protein digestion is a critical part of scientific research. Using conventional techniques, protein digestion often takes hours and can be difficult to perform consistently. Using PCT, protein digestion is generally achieved in minutes under controlled and reproducible conditions. The company currently has over 300 PCT instrument systems placed in approximately 225 academic, government, pharmaceutical, and biotech research laboratories worldwide.

ADDRESSING FOLDING AND AGGREGATION ISSUES

Misfolding (undesired folding configurations) and aggregation (clumping) of proteins being developed for potential therapeutic purposes directly impacts their efficacy and can have serious safety consequences. PBIO has discovered that some proteins with incorrect structural configurations, when placed under pressure at certain conditions, will denature and subsequently return to their proper, natural configuration upon removal of the pressure. The result is that the protein can now exert its intended function, which can be crucial for a therapeutic protein.

The BaroFold Platform employs high pressure for the disaggregation and controlled refolding of proteins to their native structures at yields and efficiencies not achievable using existing technologies. It has been shown to remove protein aggregates in biotherapeutic drug manufacturing, thereby improving product efficacy and safety for both new drug entities and biosimilar products.

NANOEMULSION TECHNOLOGY TO OVERCOME THE INSOLUBILITY OF CBD AND OTHER CANNABINOIDS IN WATER

UST combines ultra-high pressure with intense shear forces. A liquid material is placed in the company's specially designed, custom-made, high-pressure instrument (BaroShear), subjected to ultra-high pressure, and discharged at high pressure through a special flow-path that leads to a patented dynamic (nano-gap) valve under ultra-high shear conditions, destroying most (if not all) pathogens in the liquid and generating highly stable, water-soluble nanoemulsion.

UST has been shown to turn hydrophobic extracts into stable, water-soluble formulations at laboratory scale and offers the potential to produce stable nanoemulsions of oil-like products in water, with applications in many markets, including pharmaceuticals and nutraceuticals, such as medically important plant oil extracts.

The company is initially focusing its UST platform in two areas. First, through a partnership with Ohio State University and funded with a four-year, $1 million grant from the USDA, a system is being developed and patented that will enable the production of small and large amounts of milk and other dairy products that are expected to be shelf-stable for months at room temperature.

A second project involves the production of cannabidiol (CBD) nanoemulsions. CBD and other cannabinoid derivatives are isolated from the hemp plant as a poorly water-soluble oil. As a result, only about 10% of the CBD is extracted by the body before the CBD oil is excreted. Numerous companies are exploring chemical modification and encapsulation methods for improving the solubility of CBD. UST simply (but not trivially) increases the surface area of the CBD oil by shearing large oil drops containing millions of CBD molecules into millions of nano-sized droplets containing only a few CBD molecules, all of which remain unchanged and can be more effectively absorbed by the body.

The BaroShear K45 System has a maximum throughput capacity of approximately 1 L/hour and is suitable for processing small (20 mL minimum) to moderate volumes of high-value CBD oil to nanoemulsion levels with minimal loss during production. PBIO is developing a small, benchtop version of the BaroShear instrument for small-volume processing and R&D activities, as well as a much larger version for very high–volume production. PBIO is also developing the UST Platform for commercialization, with an expectation that initial orders for the BaroShear K45 will be installed and billed by late 2020.

SMALL COMPANY TACKLING BIG ISSUES

The biggest challenge facing PBIO is that it is a small company with limited funding and bandwidth, but with a vast array of exciting and potentially lucrative opportunities. Because of these limitations, PBIO appears to be laser-focused on pursuing the opportunities that offer the highest potential return combined with the best chance for success: cancer with the PCT platform, protein therapeutics development with the BaroFold platform, and the production of CBD nanoemulsions with the UST platform. "We believe these three opportunities offer the potential for significant returns to PBIO in the near future, and will subsequently put us in a highly favorable position to be better able to explore the endless opportunities that our proprietary platform technologies provide," Mr. Schumacher concludes.

→ ABOUT THE PANELIST

Richard T. Schumacher
President, CEO, and Board Member, Pressure BioSciences, Inc.

Mr. Schumacher, the Founder of Pressure BioSciences, Inc., (OTCQB: PBIO) is the Chief Executive Officer, President, and a member of the company's Board of Directors. Prior to PBIO, Mr. Schumacher was the Founder, President, CEO, and a member of the Board of Directors of Boston Biomedica, Inc., and previously served as the Director of Infectious Disease Services for Clinical Science Laboratory, General Manager at The Center for Blood Research, co-founder of Panacos Pharmaceuticals, and a member of the founding group of Trinity Biotech. Mr. Schumacher received a BS in zoology from the University of New Hampshire.

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