

Krakatoa™ Media Manufacturing System

Reduce Greenhouse Gas Emissions by 65% per Pod with the World's First Point-of-Use Media Maker

Krakatoa is the sustainable cell culture media tool of the future designed with sustainability, convenience, quality, and scalability in mind.

- Employs reusable and recyclable consumables for an environmentally friendly approach to producing high-quality custom or classical cell culture media.
- Interfaces seamlessly with Nucleus Biologics cloud-based platforms for formulation (NB-AIR™) and customization (NB-Lux™) of media.
- Ensures media at peak quality and potency as media remains in powder format stored at room temperature until needed.

Krakatoa represents a seismic shift in the way cell culture media is consumed.



Instrument Features



Fresh, Convenient Media at Point-of-Use

Manufactures fresh, small-batch, custom or classical media in just minutes

Solubilizes RUO media on-site in sterile 500 mL glass bottles using pods filled with your desired powdered media formulation



Informative and Intuitive User Interface

Touch screen UI walks users through the media-making process

Stored device information allows users to easily troubleshoot



Fully Sterile Process and Final Product

Proprietary bottle uncapping and capping mechanism and sterilization process

Sterilizing UV-C lights in pod and bottle compartments ensures a fully sterile product

Integrated 0.2-micron filter guarantees sterile media during solubilization



Synergistic Media Solutions

Designed to complement our portfolio of innovative products and services to support programs from design to delivery

- NB-AIR: Design your formulation
- NB-Lux: Customize any aspect of your media
- Krakatoa: Dispense media at point of use

Mobile app provides updates on media production status and real-time pod inventory

Media Pod Features



Reusable and Recyclable Materials

Media pods are constructed from 96% biodegradable and recyclable components

Media is dispensed into 500 mL autoclavable glass bottles

Bring Quality, Convenience, and Sustainability to Your Programs

Reduced Environmental Impact

Krakatoa media maker significantly reduces the carbon footprint of your lab by reducing single-use plastics and the energy usage associated with your cell culture media. Through our independent in-depth life cycle analysis of the Krakatoa system, **Krakatoa greenhouse gas (GHG) emissions represent a 65% reduction** compared to conventional liquid media over the life cycle of a typical 500 mL volume of media. See Figure 1.

Transportation Impact

Shipping and storing Krakatoa's light, compact pods at ambient temperatures requires significantly less energy than shipping heavy liquid media that requires refrigeration **reducing transportation GHG emissions by 86%**.

End-of-Life Impact

Unlike traditional liquid media, which is shipped in PET bottles that can take up to 400 years to decompose or are incinerated in biohazard waste, Krakatoa powdered media comes in pods constructed from biodegradable shells capable of losing 90% of their mass in just one month **reducing the end-of-life GHG emissions by 88%**.

Improved Media Quality

Key amino acids and vitamins degrade following media solubilization due to light exposure⁽¹⁾ and storage temperatures^(2, 3), amongst other factors affecting media potency. Other components, such as L-glutamine which breaks down into ammonia, may even have detrimental effects on cell growth and development efforts⁽²⁾. Solubilizing media at point-of-use with Krakatoa provides users with cell culture media containing fresh components that have not been subjected to any degrading factors, producing media that is at peak potency and quality. Moreover, the ability to store media in powder form until it's ready for use results in a longer shelf life, more reliable supply chain, and fresh media for your cells. Krakatoa's novel cell culture media has been demonstrated to support healthy cell growth at an equivalent or superior level relative to proprietary-off-the-shelf formulations (see Figure 2). Krakatoa media has been rigorously tested for sterility and endotoxin levels showing no contamination and acceptable endotoxin levels. Data is available upon request.

Simplified Scale-Up Process

Krakatoa accelerates and streamlines the fulfillment, testing, and iteration of small-batch custom media, ultimately expediting and simplifying your small-scale process optimization. Backed by NB-Lux, our online portal for custom media configuration, users can customize each component of their Krakatoa media formulation, facilitating the quick and efficient creation of media optimized for your cell ecosystem. All formulas are stored in our secure formula repository and can be easily reordered in volumes up to 2000L, streamlining your transition to large-scale production.

References

1. Hans Ingolf Nielsen, et al. (1991). *Production of Biologicals from Animal Cells in Culture* (pp. 82-84). Butterworth-Heinemann.
2. L. Tritsch, G.E. Moore. (1962). *Exp. Cell Res.* (pp. 360-364). Volume 28, Issue 2.
3. Amandine Calvet, Alan G. Ryder. (2014). *Anal. Chimica Acta.* (pp. 58-67). Volume 840.

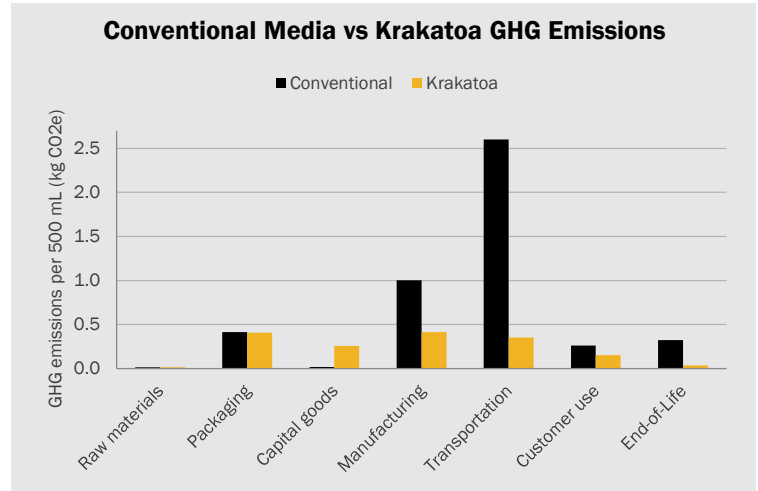


Figure 1. GHG emissions associated with the production, use, and disposal of 500 mL conventional media relative to 500 mL Krakatoa media

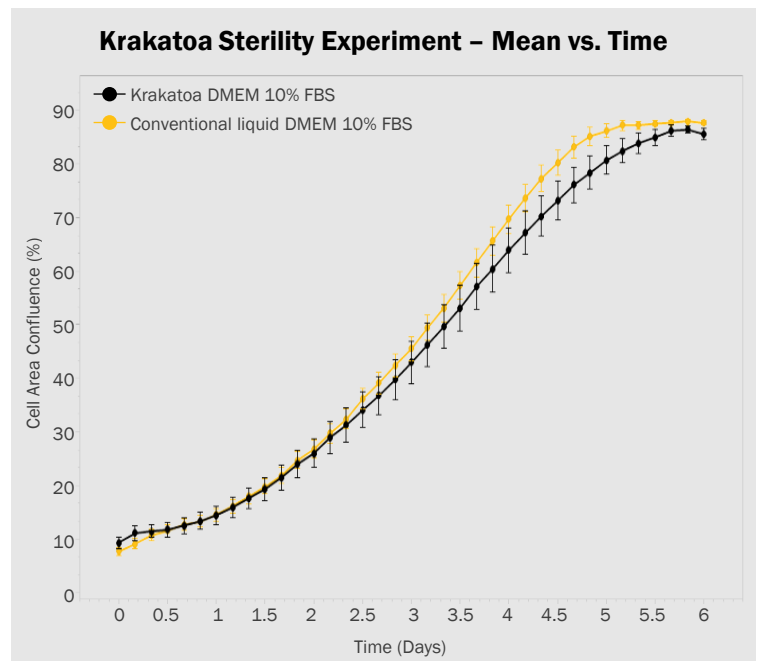
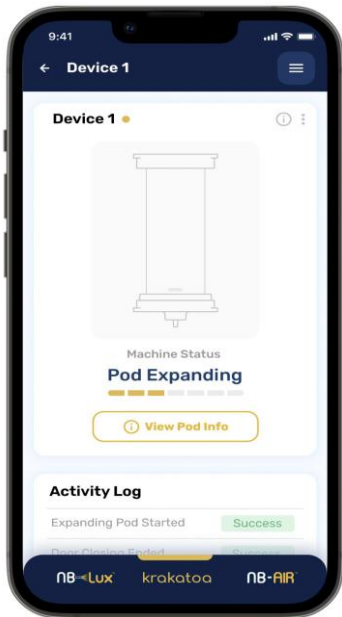


Figure 2. Confluence of MSCs (mesenchymal stem cells) in DMEM supplemented with 10% FBS comparing conventional liquid media to media produced using Krakatoa.



Designed With Convenience in Mind

Incorporating a fully custom media solution designed to address the specific critical quality attributes you desire for your cells has never been easier.

Compact Design and Convenient Storage

Media pods require a fraction of the space necessary to store solubilized media and most do not require refrigeration. Additionally, its sleek benchtop design fits nicely in any lab.

Automated Media at the Touch of a Button

Intuitive user interface and automated workflows for calibration and cleaning provides a hands-free, point-of-use media manufacturing solution without any hassle.

Expedited Ordering and Production

Small-batch custom media pods delivered in 2- to 3-weeks. Krakatoa can manufacture multiple pods per hour.

Innovative Integration

Convenient mobile app provides media production status updates and real-time pod inventory, so you know when it's time to reorder your formulation. Additionally, instrument and app seamlessly integrate with NB-AIR and NB-Lux, offering you solutions for formulation, customization, and delivery of your media in the palm of your hands. Furthermore, all information related to each batch of media manufactured is stored and easily accessible in NB-Lux.

Figure 3. The Nucleus Biologics app updates users on the current status of Krakatoa media production. Monitor the progress of your media solubilization from your mobile device.

Reduced Media Cost

Krakatoa pods filled with your custom formulation are significantly less expensive than competitors' liquid custom media. We compared the cost of a competitors' standard custom formulation, shipping, and storage to the Krakatoa model. Krakatoa pods are, on average, 1/5th the cost of liquid custom media. Even considering the initial instrument cost, users can realize cost benefits in the first year, even if only 2 pods of custom media are run per month (Figure 4). Overhead and maintenance drop in the second year, providing even more cost advantages in subsequent years of use.

Krakatoa was designed to support fast, small-batch custom media iteration and testing. Most competitors require minimum quantities of 1-10L for custom media. However, with Krakatoa, users can order media in volumes as little as 500 mL, allowing you to test your formulation in smaller volumes, ultimately reducing total costs and media waste.

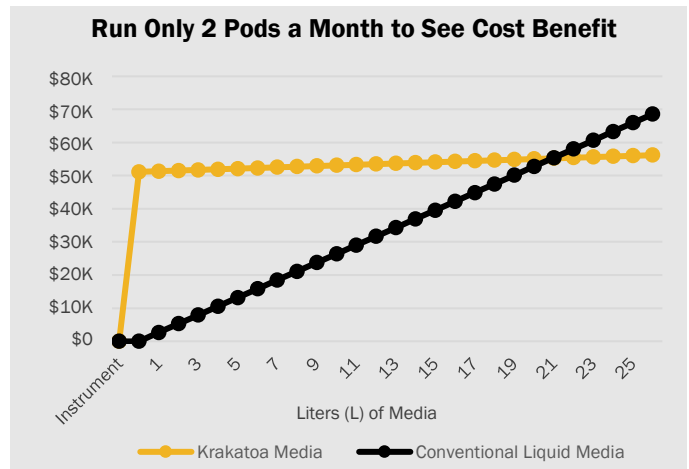


Figure 4. Cost model comparing the price of two 500 mL custom Krakatoa media pods to 1L of a competitor's custom conventional liquid media. When ordering 1L (2 pods) of the same formulation, the cost of materials, shipping, and storage of Krakatoa pods is significantly less than that of conventional liquid media. Thus, after ordering just 38 pods, users completely recoup the cost of the instrument. In subsequent years, cost savings are magnified.

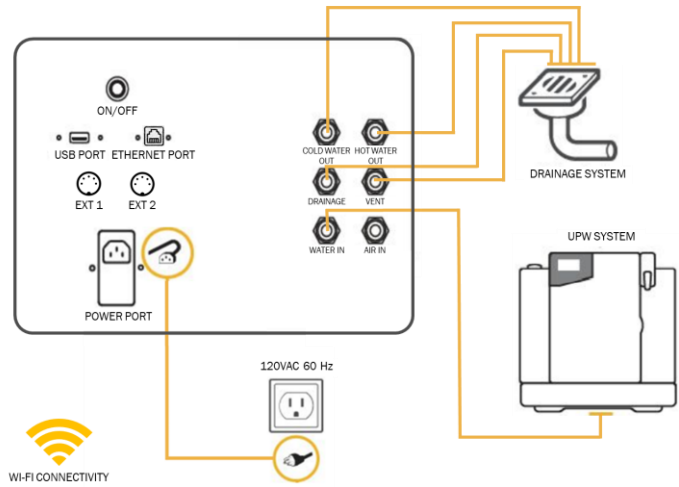
Krakatoa Media Pods

Pods are filled with custom or classical media in powder form and delivered straight to your lab. These compact pods weigh just 125g with media and are constructed from 96% biodegradable materials, making them an environmentally-friendly alternative to single-use plastics. With their sustainable and convenient design, most media pods are shipped and stored at ambient temperatures and ready to be solubilized into sterile glass 500 mL bottles with the Krakatoa Media Maker whenever you need it. Moreover, each pod is marked with a QR code that will be scanned by the instrument to record date and time of media solubilization. Users can track their on-hand stock as well as ingredients and pertinent product documentation through NB-Lux or the Nucleus Biologics app. Easily order media pods through your NB-Lux account.



Figure 5. Krakatoa media pods are designed to simplify your cell culture media. The instrument scans the QR code upon use and records the pod in your NB-Lux account and the Nucleus Biologics app.

Product Specifications



Device Dimensions (W x H x D)	17.1 in (434.45 mm) x 27.6 in (700 mm) x 19.1 in (485.3 mm)	Energy Consumption (Wattage)	Standby Mode: 30W Standby mode can be reduced by optimizing power saving features such as disabling lighting and idle motor currents when the machine is not in use. Active Mode: Heating system disengaged: 160W (30 mins per pod) Heating system engaged: 1550 W (approx. 10 mins per pod)
Suggested Footprint (W x D)	25 in (635 mm) x 31 in (787.4 mm)	Power Source	Outlet: Type B socket power outlet (120VAC 60 Hz). Power cord can be plugged directly into the outlet; no voltage convertors or other materials necessary. Supplied Materials: NEMA 5-15 type B plug, IEC C13 plug cable; appropriate cables will be provided based on region
Weight	120 lbs.	Water System Hook-Up	Recommended System: Ultrapure water (UPW) system or lab water system Minimum System Requirements: Type II water or better, according to American Society for Testing and Materials (ASTM) Supplied Materials: Silicone tubing; pneumatic tube cutter
Lighting	Philips 9W UV-C bulbs	Drainage	System Requirements: Drainage system; if standard system is unavailable, provision for 1L of drainage Supplied Materials: Silicone tubes; pneumatic tube cutter Length of provided tubes is 32.8 ft; users may determine where to place the instrument relative to the drainage area within this length
Pod Filter	0.2-micron pore size PES membrane	Starter Kit Materials	10 x 500 mL empty Duran glass bottles 10 pods Silicone tubes Footprint mat
Internet	Wi-Fi connectivity; requires minimum of -57 dB signal strength or ethernet connection	Plug-ins	Please refer to schematic. USB port is only to be used by the field service engineer for validation and troubleshooting purposes.

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For more information, please visit our website at www.nucleusbiologics.com/krakatoa-media-maker