XPURE
innovative continuous chromatography

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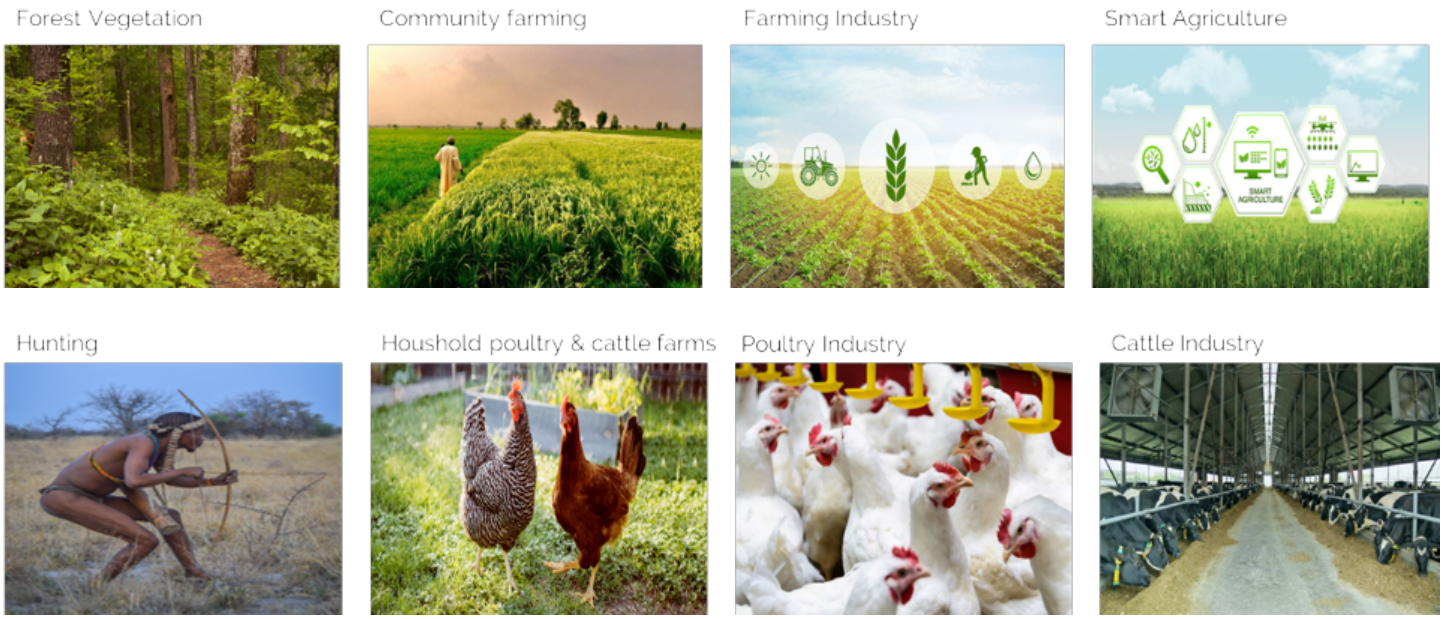
Separation Technologies for Sustainable Plant-Based Food Industry

The portfolio of plant-based products in the supermarkets is expanding. In 2018, a study indicated that the plant-based food market is growing at a 10 fold higher rate compared to overall food market growth (Schroeder, 2019). Market share of plant-based products like meat alternatives, vegan foods (milk, cheese, and yogurt) and nutraceutical compounds have seen a steep increase.



Over the centuries, both plant-based and animal-based diets for humans have gone through an evolution to feed the growing population and meet nutritional requirements. The evolution in agriculture resulted in higher productivity and a reduced environmental footprint through the adaptation of modern and smart agricultural practices. On the other hand, the evolution of cattle and poultry farming resulted in higher output at the cost of increased nitrogen and methane gas emissions, inefficient utilization of natural resources like water, and protein-rich feedstock from agriculture (cattle feed). Therefore, plant-based foods are still considered to be more sustainable.

The overall sustainability of the agricultural industry depends on the processes involved in converting the harvest to marketable food products. Therefore, it is critical to employ efficient processes to handle plant-based input streams, where complimentary choice of

feedstock and process technologies defines techno-economic feasibility. In this blog, we provide an overview of how traditional versus highly-selective separation techniques in plant protein purification can influence the outcome with respect to selectivity, operability, scalability, OPEX, and CAPEX. Evaluation basis is:

Selectivity: Degree of freedom to optimize the operating window for high separation efficiency.

Operability: Number of critical process parameters to be monitored and controlled.

Scalability: Number of scale-limiting factors.

OPEX: Raw material, utilities, and energy consumption.

CAPEX: Capital investment and technology lifetime.

Traditional Separation Technologies:

Process Technology	Selectivity	Operability	Scalability	OPEX	CAPEX
Extraction	Good	Average	Good	High	Medium-high
Precipitation	Good	Good	Good	Medium	Medium
Solid-liquid separation	Average	Good	Very good	Medium	Medium
Neutralization	Poor	Very good	Very good	Low	Low
Drying	Poor	Very good	Good	High	High

In the case of the above-mentioned traditional technologies for plant protein purification, selectivity is one of the major concerns because these technologies employ only one separation principle. Even though extraction and precipitation exhibit better selectivity due to the higher degree of freedom to use optimum solvents and precipitating agents, they are often not sufficient enough to handle complex plant-based feed streams with a number of off-flavor compounds and other impurities. Therefore, in this scenario, often the process selectivity becomes a bottleneck to achieve desired product quality.

Separation Technologies with High Selectivity:

Process Technology	Selectivity	Operability	Scalability	OPEX	CAPEX
Adsorpti	Excellent	Good	Excellent	Medium-	Medium-

on/ Chromatography				high	high
Crystallization	Very Good	Very Good	Good	Medium-high	Medium-high
Hybrid Technologies	Excellent	Good	Average-good	Medium-high	Medium-high

Separation techniques like crystallization, adsorption/chromatography are traditionally known for improved selectivity and hybrid technologies like adsorption-membranes, pervaporation, centrifugal extraction etc. are also used to efficiently address complex separation challenges. Among these technologies, crystallization is an easy technique to operate, while chromatography and hybrid technologies are excellent with respect to selectivity. However, proteins can be sensitive to aggressive process conditions (very high temperatures, etc.) in the case of hybrid technologies and crystallization can be energy-intensive at very large scales. Among the three options, adsorption/chromatography in batch or SMB mode is one of the few techniques operated under close to atmospheric conditions and ideal for both selective removal of off-flavors and protein capture. However, in order to enable its application, robustness and operational efficiency must be improved by reducing buffer consumptions and resin utilization through approaches like continuous processing. This will promote the SMB mode of chromatography operation as a possible solution to enable sustainable processing of plant-based feedstock.

We are looking at the future of food market and current developments in plant-based food ingredients. XPure is committed to developing innovative SMB solutions to purify complex plant-based feed streams into high-value food products/nutraceuticals that meet people, planet, and profit demands. For more information, please visit xpure-systems.com or contact us at info@xpure-systems.com.