



Technology Match Maker | Sustainable Ingredients for Skin & Personal Care | 12 Oct 2023

High-Yielding Bioprocess For Pullulan Using Novel Indigenous Strain



Lead Scientist: Dr Anirban Roy Choudhury
Organization: CSIR-IMTECH

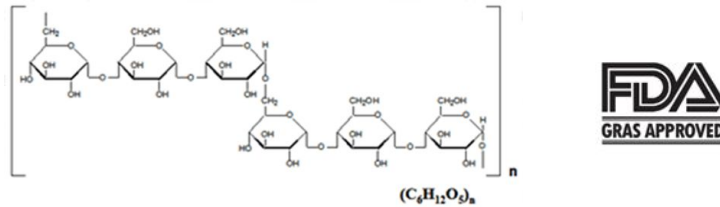
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Pullulan

- ❖ Pullulan is a water soluble exopolysaccharide commonly produced by *Aureobasidium pullulans*.
- ❖ It is a homopolymer of maltotriose where the subunits are linked with α -1,4 and α -1,6 glycosidic linkages.



- ❖ Pullulan is a tasteless, odorless, white powder that is, non-toxic, non-mutagenic, non-carcinogenic, edible and biodegradable.
- ❖ GRAS status ensures safety and usability across diverse consumer groups.
- ❖ Pullulan is known to be non-comedogenic, i.e., does not block skin pores.

Pullulan is an extremely versatile ingredient with capability of providing a technology platform for product innovation.

Physico-chemical Properties of Pullulan

- ❖ Pullulan has distinct film and fiber forming capacity.
- ❖ Films formed by Pullulan are impermeable to oxygen.
- ❖ This molecule can be derivatized easily to alter its solubility as well as reactivity.

Applications of Pullulan

Unique Properties	Functional Applications
Film forming & adhesive properties	<ul style="list-style-type: none"> ◆ Tightening of the skin in facial masks such as peel-off and wash-off masks exhibiting anti-aging effects. Usage levels - 10-20%^[1].
	<ul style="list-style-type: none"> ◆ Formulation of flexible solid thin films like breath-freshening strips with high heat stability and anti-static properties.
	<ul style="list-style-type: none"> ◆ Biodegradable thin films having low oxygen permeability and moisture retention which prevent fungal growth while increasing shelf-life of products in food preservation and packaging.
Water-binding & texture enhancing properties	<ul style="list-style-type: none"> ◆ Thickener and viscosity regulator in emulsion formulations. ◆ Viscosity of pullulan solutions is stable to heating, changes in pH as well as salt concentration unlike other ingredients like xanthan gum. ◆ Usage levels of 0.1-3% in skin tightening gels, lotions, serums and skin lifting products^[1]. ◆ Usage levels of 2 to 5.0% in hydrating and rejuvenating products including sheet masks^[1].
Stable, chemically inert, tasteless & odourless	<ul style="list-style-type: none"> ◆ Better alternative to gelatin and plant-based capsule shells materials due to excellent oxygen barrier, high stability and chemical inertness that results in extended shelf life of capsules^[2]. ◆ Low calorie food additive and coating of food products.



Market Opportunity

Advantages of Pullulan technology for existing market players:

- **High yield of over 70g/l**, higher than any reported process.
- **Higher average molecular weight** of Pullulan (280–300 KDa) final product.
- **No melanin by-product** produced in the bioprocess, use of unique microbial strain.
- **Reduced steps in downstream**, no need for melanin removal which is present in other existing bioprocesses for Pullulan.
- **Low cost** starting materials.
- **Process media optimised** to reduce inhibitory effects of high sugar concentration.
- **High quality of product**, comparable to United States Pharmacopeia (USP) specifications.

- ❖ **Post-covid global market** for pullulan was estimated at USD 68M in 2022 and expected to grow at CAGR 4.5% reaching USD 89M by 2028.
- ❖ **Market players:** Nagase, Jinmei, Freda, Henbo, Hierand Biotech, Kangnaxin.
- ❖ **Market price** – Rs. 2500/kg to Rs. 9000/kg
- ❖ **Quality of Pullulan** defined by colour, viscosity, molecular weight as well as end use as Pharmaceutical, Cosmetics and Food grades.

Pharma Grade^[1]



Cosmetics Grade^[2]

Food Grade^[3]



Who Should be interested?

Who?	Why?
Manufacturers of Skin Care, Personal Care and Cosmetics	<ul style="list-style-type: none">• New value proposition for customers• Competitive edge
Manufacturers of Pullulan	<ul style="list-style-type: none">• Novel strain and process• Competitive edge
Manufacturers of bio-synthesized value added chemicals	<ul style="list-style-type: none">• New products and forays into newer segments• Opportunity to disrupt the market• Competitive edge
Food processing and packaging industry	<ul style="list-style-type: none">• New value proposition for customers• Competitive edge
Manufacturers of Formulations and Capsule Shells	<ul style="list-style-type: none">• New value proposition for customers• Competitive edge

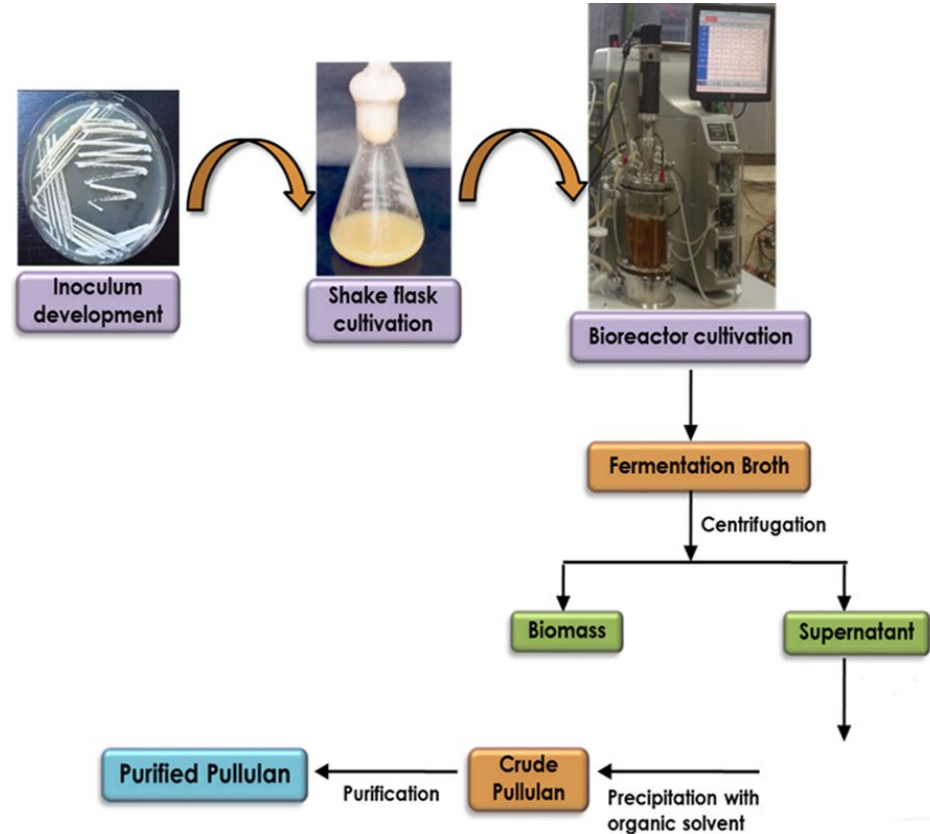
About the Technology

Process features:

- **Unique strain of *Aureobasidium pullulans* for production of Pullulan:**
 - ◆ **Novel osmotolerant and non-pigmented strain** for synthesis of Pullulan.
 - ◆ **Low cost of starting material** < USD 1.50, utilizing agri-industrial residues or a defined process media.
 - ◆ **Process media optimised** to reduce inhibitory effects of high sugar concentration.

Product features:

- **Highest reported yield:** More than 70 g/l
- **Quality of product:** Pharma grade as per USP specifications.
- **Estimated Cost:** Rs. 1000-1500/Kg (Pharma Grade)



Pullulan As Per USP Specification

USP specification of Pullulan		CSIR-IMTECH Pullulan	
Parameters	USP standard	Pullulan from agri-industrial residues	Pullulan from defined media
Appearance	White to off white powder	White to off white powder	White to off white powder
Reactivity with pullulanase	Loses viscosity	Complies	Complies
Kinematic Viscosity (10% solution)	100-180 mm ² /s	114	136
pH (10% solution)	4.5-6.5	5.5	5.8
Loss on drying	<6%	2.49	1.5
ROI	<0.3%	0.26	0.28
Mono, di, oligo	<10%	0.69	0.55
Total Nitrogen	0.05%	<0.05	<0.05
Heavy Metals	NMT 5ppm	-	-
Residual Solvents	Ethanol 5000ppm	-	-
Microbial Count	NMT 100 cfu/g	<100	<100
E.coli/salmonella	Absent in 25g	Absent	Absent

Current Status

Technology Status:

- ❖ **Scale-up of upto 500L fermentation has been carried out with downstream processing to be fine tuned.**

IP Status:

- ❖ **Knowhow**

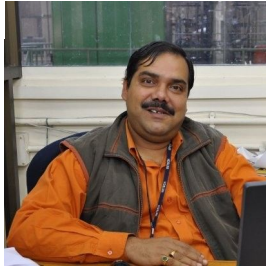
Publications:

- ★ Ananya Mehta, G.S. Prasad, Anirban Roy Choudhury, Cost effective production of pullulan from agri-industrial residues using response surface methodology, International Journal of Biological Macromolecules, Volume 64, 2014, Pages 252-256.





Team & Organisation



Lead Scientist:

Dr Anirban Roy Choudhury

- ★ **Senior Principal Scientist,** CSIR -IMTECH, Chandigarh.
- ★ **Expertise:** Bioprocess Development and Scale up, Fermentative production of polysaccharides, Polysaccharide based biomaterials.
- ★ More than 2 decades of experience in the industry and academia.
- ★ **Successfully delivered many industry sponsored projects.**

CSIR-Institute of Microbial Technology (IMTech) national laboratory is the forerunner in the domain of microbial biotechnology research and development.

Key assets and strengths of the team:

- ★ 35+ publications in bioprocess development microbial technology.
- ★ **Team Strength:** 5
- ★ **Well equipped labs and analytical** Lab-to-pilot-scale fermenters of varying from 2 to 1,500 litres for continuous batch fermentation, high-capacity centrifugal separators, ultrafiltration, vacuum filter, spray drier; Large-scale downstream processing equipments.
- ★ **Industry projects/ Tech transfer:** Panacea IFB Agro, ExcelEx Biopolymers, Dhampur Sugar Mills



Next Steps

- ❑ The team has developed the background science and demonstrated at 500L fermenter scale process as early stage validation.
- ❑ The team has expertise as to how the process can be modified to get desired output.
- ❑ Next phase will be to work closely with industry partners to:
 - ❑ Fine tune and scale-up of downstream processing.
 - ❑ Late stage pilot demonstration of the entire process as per industry requirements.

Seeking:

- **Industrial partners interested in technology licensing.**
- **Industrial partners interested in sponsoring further technology advancement and scale up.**
- **Industrial partners interested in raising 3rd party funds for a collaborative project.**
- **Industry interested in tapping scientist capabilities as an expert/consultant.**



For More Information Contact:

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References

- Slide 3 - [1] <https://www.aromalab.gr/product-details.asp?lang=en&cid=514&pid=1713>
- Slide 3 - [2] <https://www.sunilhealthcare.com/products/pullulan-capsules>
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