

Solid State Fermentation

What it is

In contrast to Submerged (liquid state) Fermentation, Solid State Fermentation (SSF) is the cultivation of micro organisms under controlled conditions in the absence of free water. Examples of products of Solid State Fermentation include industrial enzymes, fuels and nutrient enriched animal feeds. The application of modern biotechnical knowledge and process control technologies can lead to significant productivity increases from this ancient process.

Advantages of Solid State Fermentation over Submerged Fermentation

- Higher volumetric productivity
- Usually simpler with lower energy requirements
- Might be easier to meet aeration requirements
- Resembles the natural habitat of some fungi and bacteria
- Easier downstream processing



Typical process characteristics

Solid Matrix	Rice bran, sawdust, sugar beet pulp, etc.
Liquid Medium	Basic Mineral Medium
Inoculation	1 to 20% (w/w) of fungi or bacteria suspension
Temperature	5 to 95 C
Moisture content	50 to 85%
Agitation	Intermittent or constant rotation
Aeration	0.5 to 5 vessel volumes per hour
Duration	1 to 5 days
Downstream processing	None or centrifugation for many applications



Solid State Fermentation

Case Study

Objective

Produce pure cultures of thermophilic xylanase secreting bacteria and develop a production process for thermophilic xylanase enzymes. Applications of thermophilic xylanase enzymes include waste paper de-inking, biopulping and fuel ethanol production from lignocellulosic materials.

Results

Using the Terrafors 15L bioreactor, MADEP SA developed a thermophilic xylanase production process using previously isolated bacteria strains (Lyon, P-F, Beffa, T., Blanc, M., Auling, G. and Aragno, M. Isolation and characterization of highly thermophilic xylanolytic *Thermus thermophilus* strains from hot composts. Can. J. Microbiol. 46: 1029-1035 (2000) and unpublished results).



Product and production process characteristics

Microbial source	Natural (not genetically modified) bacteria strain
Production process	Solid state fermentation
Volumetric productivity	8 times greater than submerged fermentation productivity (submerged fermentation with pure xylan inducer (expensive) and SSF without inducer). The only source of xylan in the SSF process is the solid matrix material (a low cost food processing waste product).
Formulation	Crude fermentation product (bacteria, enzymes, water and solid matrix) or crude enzyme extract in basic mineral medium.
Enzyme pH optimum	pH 6
Enzyme temperature optimum	75 C
Cellulase activity	< 10% by DNS assay using CMC as substrate
Microbial purity	100% at the end of fermentation

➤ Using 110 liter and 15 liter bioreactors, MADEP SA is currently prepared to supply dried fermentation product and liquid crude enzyme extract.

➤ The bacterial strains and production process are available for licensing or partnership.

