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THE BIOPOTENCY OF *YARROWIA LIPOLYTICA* IN BIOREMEDIATION-REVIEW

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ABSTRACT

Yarrowia lipolytica is not just a mere yeast species in the fungal kingdom. It has several biopotential . The efficiency of *Yarrowia lipolytica* in degrading the lipid compound make the species unique from other yeast species like *Candida albicans, Saccharmomyces sp*. As the species name emphasize as lipolytica meaning the abilt to kill or degrade the lipid molecules. It has varied applications in environmental sector, industrial sector and in pharmaceutical sector.The other exciting perspective of this species is in the use of microbial oil.

Keywords: *Yarrowia Lipolytica, Candida Albicans, Saccharmomyces Sp,* Environmental Sector, Industrial Sector.

1. INTRODUCTION

In the fungal kindom most intriguing species is Yarrowia lipolytica, the peculiar feature of this Yarrowia lipolytica is it is a strict aerobe that precisely generate pivotal chemical compounds like metaboloties and it also release certain compounds into the environmental surface.Because of this feature it has been mainly used in the industrial sector. It also has biocatalystic nature)(Hashem et al.,2018).This fungal species is considered non-pathogenic and aerobic and is categorized as generally recognized as safe (GRAS) by the Food and Drug Administration (F.D.A, USA) (Finogenova et al., 2005). Additionally, the eukaryote Y. lipolytica, which belongs to the fungal kingdom, has been recognized as a suitable model for studying and assessing the dimorphism phenomena in yeasts(Sauer et al.,2007). This is certainly due to its efficient systems for genetic engineering biotransformations, genetic analysis, and with frequent step by step evaluations, along with its clear morphological forms and characteristic features, unlike Saccharomyces cerevisiae (the common yeast type), which fails to generate the true filaments structurally and instead shows the false-hyphal growth under the specific nutrient lacking condition specifically nitrogen-limited conditions, creating the restrictive nutrient environments. The biotransition from yeast to mycelium is associated with the unipolar development , asymmetric divisions, the large vacuoles located at the poles, and the static growth and development of cell separation following the division(Förster et al.,2007).

Hence in the fungal kingdom, the yeast dimorphism serves as a crucial process of defense mechanism primarily against the adverse conditions, encompassing differing physical conditions like temperature and nutrition. The eukaryote Y. lipolytica has been found to be a dependable, most versatile, and widely availed system for the expression of the heterologous proteins, benefiting both the academic research and has biopotential for commercial uses(Fig-1).

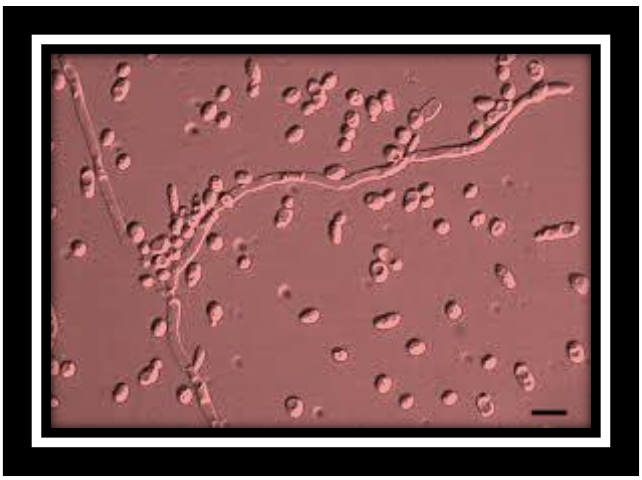

Fig 1:

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The eukaryote Yarrowia species is an yeast variety , it has natural ability to release a range of proteins (macromolecules) through the cotranslational translocation garners significant advantages. The other features and characteristics of the Y. lipolytica encompass the low over glycosylation, there also other peculiar features like high secretion efficiency, efficient product yield, and reproducibility of performances(Rymowicz et al., 2008).

Of the lipolytic fungi, Yarrowia lipolytica is that species which has the most biopotent substance production, that substrance synthesized from the precise fungi is lipase, lipase is a chemical compound classified as an enzyme or monikered as bioenzyme that captures the attention of the environmetntal researchers in both scientific and industrial fields due to its biopotential for various applications in the arena of detergent synthesis, food production industries,and it also reap the pharmaceutical industry, and environmental terrains(Rehm et al.,2001).This eukaryote is an aerobe which does not survive anaerobic conditions(obligate aerobe), the development of this fungi and the capability to release the specific chemical entities like metabolites mainly depends on the amount of the gaseous oxygen in the nutritional cultural medium. Because of the involvement of the crucial chemical element named perfluorodecalin in the culture medium , also provide the safe environment for the Yarrowia species to grow.The precise chemical compound perfluorodecalin act as oxygen carrier which again promotes the growth of the fungal species Yarrowia lipolytica. By the enriched nutrition this fungi starts to biosynthesize the enzyme named lipase . The other pivotal strategy which can be implemented instead of using the oxygen carrier or aerobic condition is the use of hyperbaric air(Lotfy et al.,2007).

There are much pressure exerted by the gases for the growth of the fungal species. Presence of oxygen plays a evident role, other than that the composition of gases and the methods of pressurization, as well as the specific microobes and the secificstrain involved(Hassanshahian et al.,2012). Lipase production is significantly copioused by the involvement and the presence of oxygen. The oxygen transfer rate is due to elaevated pressure, but the main factor to be taken care of is ,it negatively impacts the Yarrowia lipolytica cell's growth.Hence bioindicating that the oxygen requirements for lipase production are greater than those for cell growth. Moreover, it is quiet well-established that both oxygen percentage and the total pressure play a crucial role in regulating intracellular bioenzymes(Liu et al.,2015), particularly those in the β-oxidation pathway, this β-oxidation pathway is a sequential process and is crucial in lipid metabolism. In each step of the lipid anabolism and catabolism there is biotransformation of chemical compounds like ricinoleic acid into aroma compounds. The macromolecule lipid derivatives mainly like the castor oil, methyl ricinoleate are frequently availed as substrates for the biosynthesis of aroma, hence proved to be lipase inducers in Y. lipolytica(Escamilla-García et al.,2009).

The lipase degrading fungus Yarrowia lipolytica it mainly disintegrates the water hating substrates.Researchers are intrigued by the nature and features of fungus.The potent lipid degrading microorganisms Yarrowia lipolytica is availed as model organisms for understanding the dimorphism, heterologous proteiomic expressions, the salt tolerance and also the lipid bioaccumulation(Csutak et al.,2023).There are enormous application of Yarrowia lipolytica, which has wide arena of importance environmentally,pharmaceutically, industrially etc.The pollutionof landscape and the environment are because of the obnoxious chemicals like aliphatic and aromatic compounds, metals organic pollutants,and the 2,4,6-trinitrotoluene.There is serious assessment and research on synthesis of beta-hydroxy butyrate, L-dopa, and emulsifiers are taking place worldwide (Waché et al.,2001).

GENE LEVEL FINDINGS

The fungi which has most lipid degrading feature :The Yarrowia lipolytica is researched for the anabolism and catabolism of lipid synthesis(Navas-Cáceres et al.,2023).Followed by the byproducts formed from lipid metabolism are also viewed. Astonishingly there are number of chambered models that have been build for the species of Y. lipolytica that mainly add the knowledge acquired from the uniform proteins in the other set of microorganisms.The specific action of the biopotent lipid degrading fungi Y. lipolytica,is invoved in the synthesis of the triglyceride from the monosaccharide glucose(Lim et al.,2016). The pionner in initiating the fatty acid biosynthesis is Acetyl-CoA, which is hence syntheized from six carbon compound named citrate.Which is then produced with the aid of ATP-ctirate lyase (ACL).The involvement of ATP-ctirate lyase in the microorgainism Y. lipolytica holds a major distinguishing feature from metabolic wiring and that of non-oleaginous organisms.The eradication of ATP-ctirate lyase results in reduced ability to bioaccumulate lipids(de Oliveira Barros et al.,2024).

ATP-ctirate lyase has two subunits, they localize to cytosol where they respond to the lipid bioaccumulation. Acetyl-CoA Carboxylase (ACC) is a crucial compound which helps in converting AcetylCoA to Malonyl-CoA. This is a pivotal step when come to the biosynthesis of fatty acids.In the other forms of yeast variety like Saccharomyces cerevisiae, the enzyme Acetyl-CoA Carboxylase (ACC) is expressed by hfa1 gene and acc1 gene which mainly bounds the data's of cytosol(Kosiorowska et al.,2021).In comparision to Saccharomyces cerevisiae, the lipid

degrading potent fungi named Y. lipolytica has only one copy of the acc1 gene.The two entities , mainly Acetyl-CoA and the Malonyl-CoA are used by the bioenzyme Type I Fatty Acid Synthase enzyme complex, the species of the yeast variety S. cerevisiae consists of six copies each of cytoplasmically located Fas1p and Fas2p and the Beta-ketoacyl-ACP synthase to make acyl-CoA molecules which primarily consist of the ratio 16:0, 18:0, 18:1 chains when grown on glucose as the monosaccharide biosource(Ferreira et al.,2023) .

The importance of lipolytic enzymes has crucial role to play with biosurfactants(S.Sreeremya,2017a).The importance of the fungal flora in degrading the lipid compound makes paradigm shift in the process of bioremediation(S. Sreeremya et al.,2018).The fungal biofilm also is responsible for clearing the chemical pollutants (S.Sreeremya, 2017b) by degrading it(S.Sreeremya,2015).There are many biopotent microbial consortium were potent microbes with degrading ability can be isolated (Sreeremya.S et al.,2017c). The biotechnological(Dr.S.Sreeremya,2024a) , pharmacological(Dr.S.Sreeremya, 2024b),bioinformatics (Dr.S.Sreeremya,2025) innovations has made leap and bounce advancements in the field of environemtal science, biopolymers(A.K.Midhul et al.,2025) , the concept of biomining, the technique of bioleaching and the integrated strategy in biofertilizers synthesis are some of them.

2. CONCLUSION

One among the most potent and environmentally helpful fungal species is *Y. lipolytica* .There are other fungal species and other microorganisms which produce fatty acids and PUFA's . Among those fungal species *Y. lipolytica* has the ability to make the smaller and disintegrated components of the lipid molecules *Y. lipolytica* has the biopotential to degrade it.The varying applications of *Y. lipolytica* is discussed in this paper.

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