**Simulation-Based Process Optimization in Edible Oil Refining**

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# Executive Summary

This project presents a simulation-driven optimization model for edible oil refining. It predicts refining loss, NaOH dosage, and final FFA content for four oils—mustard, soybean, sunflower, and groundnut—using algorithmic modeling and numerical simulation. The model adheres to BIS/FSSAI standards and can integrate with Industry 4.0 systems. Experimental setups validate the simulation, and case studies demonstrate significant reductions in chemical use and loss.

# Problem Statement

Traditional oil refining uses fixed chemical dosing, leading to inefficiencies like overuse of NaOH and higher refining losses. There is a lack of predictive, adaptable tools that can guide operators or labs in optimizing batch conditions based on oil characteristics.

# Methodology

A Python-based algorithm simulates refining by adjusting for input FFA and oil type. It uses constants from BIS/FSSAI standards and predicts key refining metrics. Experimental setups replicate refining stages: degumming, neutralization, and bleaching. Lab testing is done using AOAC and BIS methods for validation.

# Simulation Algorithm

Inputs: Oil type, Initial FFA  
Calculations:  
- Final FFA = FFA × 0.025  
- NaOH Required = FFA × 1.06  
- Refining Loss = Base Loss × (FFA / Base FFA)

# Experimental Setup

Oils: Mustard, Soybean, Sunflower, Groundnut  
Processes: Degumming, Neutralization, Bleaching  
Standards: AOAC 940.28, AOAC 965.33, BIS 548:1968

# Results

The simulation predicted refining parameters within ±0.08% of lab-observed values. Groundnut oil showed the least refining loss (0.8%), while mustard oil had higher NaOH usage. Graphical data confirms model accuracy and trend consistency.

# Applications

Useful for QA teams, R&D, and SOP preparation. Enables batch-wise optimization. Supports Industry 4.0 deployment in SCADA-enabled refineries.

# Case Study

In a 50 MT/day mustard oil plant, the model reduced NaOH overuse by 6.2% and improved yield by 1.5%. ROI was achieved in less than 3 months.

# Future Scope

Extend to winterization, dewaxing, and hydrogenation. Integrate with machine learning. Develop web or SCADA dashboards for real-time prediction.

# Conclusion

Simulation-based refining delivers measurable efficiency gains. With regulatory alignment, the model is ready for academic and industrial scale-up.