Bioprocess Design for Human Hemoglobin Production in *Saccharomyces cerevisiae*
Part III – Project Analysis

Bachelor's degree Final Project – Biotechnology
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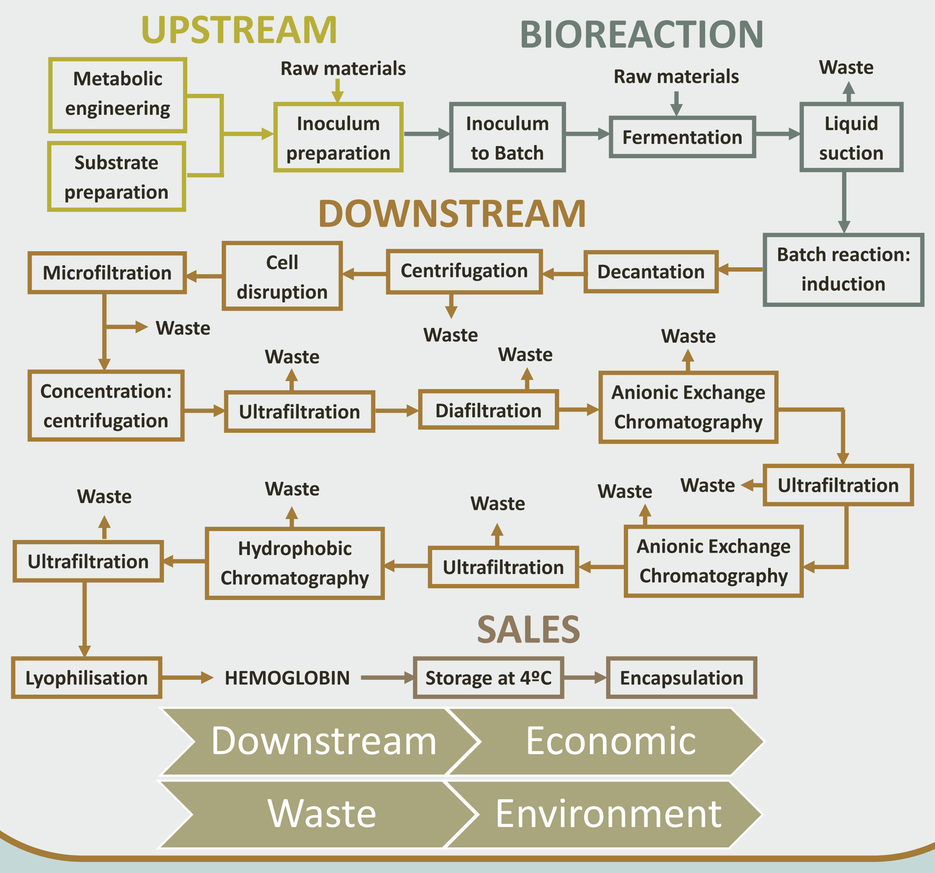
Introduction

Current blood donations cannot meet the demand of blood transfusions. For that reason, it is needed another pathway to get it and solve the problem of lack of blood donations. One possibility is through recombinant protein using *Saccharomyces cerevisiae*.

Objective

1. Analyze viability project in economic, environmental and social terms.
2. Get the final conclusions of the project.
3. Give some alternatives in order to improve project results

Block Diagram

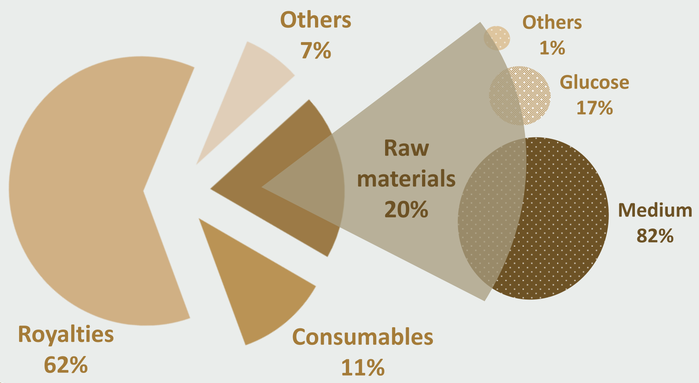


Economic summary

Profit
1.047.000 $/kg hemoglobin

Total Capital Investment	**336.375.000 $**
Operating Cost	1.357.787.000 $/year
Unit Production Cost	80.807 $/kg hemoglobin
Unit Production Revenue	1.127.500 $/kg hemoglobin
Revenues	18.945.177.000 $/year
Payback Time	0,03 years (11 days) + 2 years
NPV (at 7.0% interest)	82.347.000.000 $

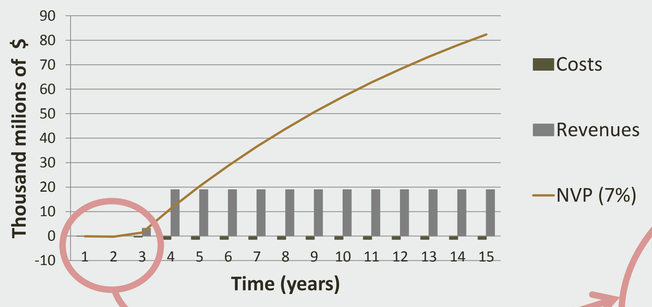
Annual operating cost



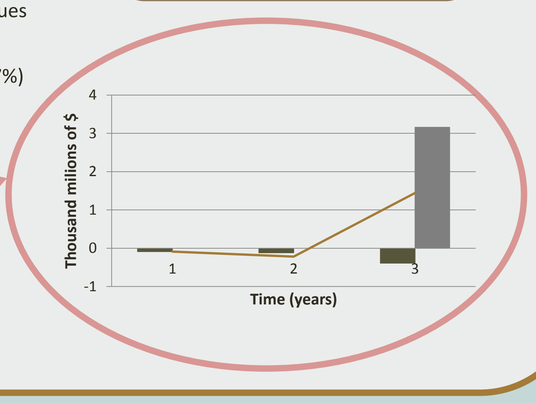
Royalties
- Use of a patented process

Medium
- Huge volume of fermenters
- Current price → 0.826 $/kg
- Profitable until 16.42 $/kg

Cash flow



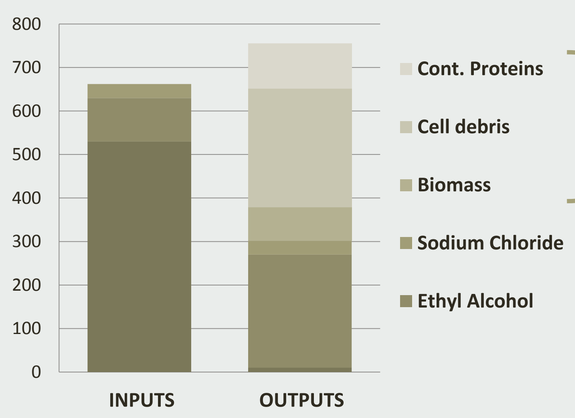
Final NVP
82.347.000.000 $



- ❑ **2 years for construction**
- ❑ **3rd year starts production**

Environmental Analysis

Environmental Index



Genetically Modified Organism

Biotechnology Process	General Chemical Process
650 – 750	6.500 – 7.500

x10

Social Analysis

1. Hemoglobin will be used to solve the problem of lack of donations
2. In Brazil there is a good view of biotechnological products → Public perception
3. 60 operators with a salary of 50 $/hour → Contribution to economic growth

Alternatives

x **Recombinant plasmid and genetically modified organism construction** → hemoglobin only represents 4% of protein production in *Saccharomyces cerevisiae*.

✓ Modify recombinant plasmid (R&D)

x **Reduction of work volume** → huge equipment imply more costs.

✓ Increase biomass concentration (R&D)

x **Purification process** → loss of hemoglobin in each step of separation and purification.

✓ Recirculation

x **Culture's medium** → medium is the most sensible raw material

✓ Develop new culture's medium (R&D)

Conclusions

PROBLEM
Lack of blood donations

SOLUTION
Liposomes encapsulating hemoglobin

✓ **Economic:** profitable process

✓ **Environmental:** "friendly"

✓ **Social:** acceptable by community

x **Production:** only cover 10% of current blood donations in Brazil

References

[1] Liu L, Martínez JL, Liu Z, Petranovic D, Nielsen J. Balanced globin protein expression and heme biosynthesis improve production of human hemoglobin in Saccharomyces cerevisiae. Metab Eng [Internet]. Elsevier; 2014;21:9–16.

[2] Montagne K, Huang H, Ohara K, Matsumoto K, Mizuno A, Ohta K, et al. Use of liposome encapsulated hemoglobin as an oxygen carrier for fetal and adult rat liver cell culture. J Biosci Bioeng [Internet]. The Society for Biotechnology, Japan; 2011;112(5):485–90.