# OPTIMAL OPERATING CONDITIONS & EQUILIBRIUM CHARACTERISTICS OF RICE BRAN OIL EXTRACTION

**M.Sc ( Chemical and Process Engineering )**

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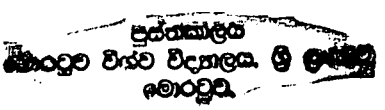



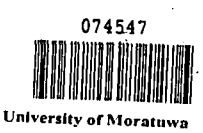

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By

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This thesis was submitted to the Department of Chemical and Process Engineering of the University of Moratuwa in partially fulfillment of the Degree of Master of Science in Chemical and Process Engineering



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January, 2002

" I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any University and to the best of my knowledge and belief it does not contain any material previously published, written or orally communicated by another person except where due reference is made in the text"

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Signature of the candidate

(. N. C. Gangodavilage)

" To the best of my knowledge, the above particulars are correct"



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# ABSTRACT

Rice bran is the cuticle between the paddy husk and the rice grain and is obtained as a byproduct in rice processing. The bran contains 12-25 wt% oil and approximately 98% is extractable. Rice bran oil is a very important source of oil, both as an edible oil and non-edible oil. The oil has high medicinal value, due to presence of anti-oxidants, anti-cancer agents, cholesterol reducing agents, skin improving agents, anti-dandruff and anti-itching agents. The oil can also be used for production of soap, surfactants, cosmetic formulations, emulsifiers, textile auxiliaries, synthetic rubber products etc.

In this work, extraction of rice bran oil from various brands of rice bran available in Sri Lanka has been studied. Experiments were conducted using pilot plant scale leaching unit and the soxhlet apparatus to extract rice bran oil using hexane as the solvent. The key factors controlling the extraction have been identified. Results show that the bran obtained from parboiled paddy has a higher yield of rice bran oil compared to the raw rice bran. Method of bran pretreatment, extraction temperature, extraction time, pellet size and free fatty acid content are the factors affecting oil extraction. Comparison of extraction results by various pretreatment methods shows an enhancement of oil extractability due to steaming. Analysis of the extracted oil shows that steaming is the most effective method of bran pre-treatment with respect to the FFA content. Pelletization of bran provides easy percolation and avoids channeling of the solvent and contamination of the oil from fine solids. Results show a decrease in extraction rate with time and this may be due to the fact that the solute has to diffuse from the interior of the pellet in the later stages of extraction.

Extraction of rice bran oil using organic solvents was compared with aqueous extraction. The highest yield for aqueous extraction was obtained at 70 °C and pH 12. Refined and raw rice bran oil and commonly used vegetable oils were analyzed and the results were compared. Tie line and mass transfer data necessary for batch and continuous leaching equipment design were determined.

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## CONTENTS

## Chapter 3

## Chapter 4

## Chapter 5

## LIST OF FIGURES

## LIST OF TABLES

## NOMENCLATURE

| | |
|---|---|
| $A_i$ | –area of solid liquid interface |
| A | –solute |
| AOCS | - American oil chemist association |
| ASTM | – American Standard Testing Methods |
| C | - concentration of the solute in the bulk of the solution |
| C* | - concentration of the solute at the surface of the solid |
| $C_0$ | - initial concentration of solute in the solution |
| D | – inert or solid phase |
| $D_{co}$ | – Diffusion coefficient |
| DOB | – deoiled bran |
| dt | – change in time |
| dw | – change in mass |
| E | – extract |
| Ef | - Weight faction of extract |
| F | - feed |
| FFA | - free fatty acids |
| IPA | – isopropyl alcohol |
| $K_{co}$ | – mass transfer coefficient |
| N | – normality |
| ppm | – parts per million |
| R | –raffinate |
| RBO | – rice bran oil |
| Rf | - Weight faction of raffinate |
| Rh | – relative humidity |
| rpm | – Rounds per minute |
| S | –Solvent |
| SCC | – Supercritical Carbon Dioxide |
| Sf | - Weight faction of solvent |
| t | – time |
| V | – volume |
| Xf | – Weight faction of Feed |
| $\rho_s$ | - reduced density |