

## TABLE OF CONTENTS

|   | Page no |
|---|---------|
| Tile page                                     | i       |
| Declaration of Researcher                     | I       |
| Declaration of Supervisor                     | II      |
| Anti-plagiarism Report                        | III     |
| Abstract                                      | IV      |
| Preface                                       | VII     |
| Acknowledgements                              | VIII    |
| List of Figures                               | IX      |
| List of Tables                                | XI      |
| Table of Contents                             | XIII    |
| <b>Chapter 1: Introduction</b>                |         |
| 1.0 Introduction                              | 2       |
| 1.2 Objectives                                | 7       |
| <b>Chapter 2: Review of Literature</b>        |         |
| 2.1 Classification of fermented fish products | 9       |
| 2.2 Origin and Distribution                   | 14      |
| 2.2.1 Asian Sub-continent                     | 15      |
| 2.2.2 European Sub-continent                  | 20      |
| 2.2.3 African Sub-continent                   | 21      |
| 2.2.4 Indian Origin                           | 24      |
| 2.3 Microorganisms                            | 27      |
| <b>Chapter 3: Materials and Methods</b>       |         |
| 3.0 Culture Media                             | 35      |
| 3.1 Dehydrated Media                          | 35      |
| 3.2 Compounded Media                          | 36      |
| 3.3 Reagents                                  | 40      |
| 3.4 Methodology                               | 44      |
| 3.4.1 Survey                                  | 44      |

|   |    |
|---|----|
| 3.4.2 Collection of Samples                   | 44 |
| 3.4.3 Enumeration of Bacterium                | 44 |
| 3.4.4 Maintenance of Isolates                 | 46 |
| 3.5 Identification of Bacteria                | 46 |
| 3.5.1 Gram staining                           | 46 |
| 3.5.2 Cell morphology                         | 47 |
| 3.5.3 Motility                                | 47 |
| 3.5.4 Production of catalase                  | 47 |
| 3.5.5 Hydrolysis of arginine                  | 48 |
| 3.5.6 Effect of pH on growth                  | 48 |
| 3.5.7 Growth at different temperatures        | 48 |
| 3.5.8 Salt Tolerance                          | 48 |
| 3.5.9 Oxidation/fermentation of carbohydrates | 49 |
| 3.5.10 Voges-Proskauer test                   | 49 |
| 3.5.11 Nitrate Reduction                      | 50 |
| 3.5.12 Anaerobic growth                       | 50 |
| 3.5.13 Starch hydrolysis                      | 50 |
| 3.6 Characterization of the yeast isolates    | 51 |
| 3.6.1 Cell morphology                         | 51 |
| 3.6.2 Mycelium structure study                | 52 |
| 3.6.3 Characteristics of asci and ascospore   | 52 |
| 3.6.4 Reduction of nitrate                    | 52 |
| 3.6.5 Growth at 37° C                         | 52 |
| 3.6.6 Sugar fermentation                      | 53 |
| 3.6.7 Sugar assimilation                      | 53 |
| 3.7 Pathogenic contaminants                   | 53 |
| 3.7.1 <i>Bacillus cereus</i>                  | 54 |
| 3.7.2 <i>Staphylococcus aureus</i>            | 54 |
| 3.7.3 Enterobacteriaceae                      | 55 |
| 3.8 Identification                            | 55 |
| 3.9 Proximate composition                     | 56 |
| 3.9.1 Determination of sample pH              | 56 |
| 3.9.2 Determination of Titratable Acidity     | 56 |

|   |     |
|---|-----|
| 3.9.3 Determination of Moisture content                             | 56  |
| 3.9.4 Determination of Ash content                                  | 57  |
| 3.9.4 Determination of Protein                                      | 57  |
| 3.9.6 Determination of Fat  | 58  |
| 3.9.7 Minerals  | 59  |
| <b>Chapter 4: RESULTS</b>   |     |
| 4.1 Fish Products of North Bengal                                   | 61  |
| 4.2 Indigenously (locally) produced fish products from North Bengal | 61  |
| 4.2 Microorganisms  |     |
| 4.2.1 Microbial load  | 76  |
| 4.2.2 Lactic Acid Bacteria (LAB)                                    | 77  |
| 4.2.3 Spore-forming rods  | 82  |
| 4.2.4 Aerobic cocci   | 86  |
| 4.2.5 Yeasts  | 88  |
| 4.3 Prevalence of microorganisms                                    | 94  |
| 4.4 Occurrence of pathogenic contaminants                           | 96  |
| 4.5 Proximate composition   | 98  |
| <b>Chapter 5: DISCUSSION</b>  |     |
| 5.1 Fish products   | 101 |
| 5.2 Microorganisms  | 102 |
| 5.3 Pathogenic contaminants   | 108 |
| 5.4 Proximate composition   | 110 |
| <b>Chapter 6: SUMMARY AND CONCLUSION</b>                            | 112 |
| <b>BIBLIOGRAPHY</b>   | 115 |
| <b>INDEX</b>  | 142 |
| <b>APPENDICES</b>   | 147 |