

Contents

1. Introduction	1
1.1 Background of the study	1
1.2 Research gap.....	5
1.3 Justification	6
1.4 Objectives.....	7
1.5 Arrangement of thesis.....	7
1.6 Summary of Chapter I.....	8
1.7 Reference for Chapter-I	9
2. Review of Literature.....	12
2.1 Parboiling of rice	12
2.1 Ageing of rice	16
2.3 NIRS and its application.....	18
2.4 NIR based PAT.....	23
2.5 ML techniques for predictive modeling	24
2.6 Portable spectra-based sensors	27
2.6.1 Advantages of portable sensors for analysis purpose.....	28
2.7 Recent works on similar field	30
2.8 Summary of Chapter II.....	31
2.9 Reference for Chapter-II	32
3. Material and Methods	46
3.1 Materials.....	47
3.1.1 Raw Materials	47
3.1.2 Instruments.....	48
3.1.3 Software	50
3.2 Methodology	50
3.2.1 Methodology for kinetic study of parboiling process and spectral calibration	51
3.2.2 Methodology for spectral calibration of parameters during parboiling using ML models	61
3.2.3 Methodology for studying the physicochemical properties during ageing.....	70
3.2.4 Methodology for prediction of ageing time.....	74
3.3 Summary of Chapter III	76
3.4 Reference for Chapter-III	77
4. Results and Discussion	79
4.1 Results and discussion of the kinetic study of parboiling process and spectral calibration	79

4.1.1 Soaking Kinetics.....	79
4.1.2 Steaming Kinetics.....	87
4.1.3 Drying kinetics	91
4.1.4 Rehydration kinetics	98
4.1.5 Calibration of processing parameters using spectra	98
4.2 Results and discussion for spectral calibration of parameters of parboiling process using ML models	103
4.2.1 Soaking spectral modeling	103
4.2.2 Steaming spectral modeling	107
4.2.3 Drying spectral modeling	109
4.3 Results and discussion for studying the physicochemical changes during ageing	112
4.3.1 Study on changes in cooking or softening quality of <i>Komal Chaul</i>	112
4.3.2 Changes in composition.....	113
4.3.3 Changes in textural parameters.....	115
4.3.4 Changes in pasting properties.....	115
4.3.5 Changes in molecular bonds	116
4.3.6 Changes in crystalline pattern	117
4.3.7 Temperature-based storage study of parboiled <i>Komal Chaul</i>	118
4.4 Results and discussion for prediction of ageing time.....	124
4.4.1 Estimation of ageing time of <i>Komal Chaul</i> by ML model	124
4.4.2 Estimation of cooking quality of <i>Komal Chaul</i> by ML model	128
4.4.3 Prediction of age of <i>Komal Chaul</i> by classification ML model	129
4.5 Summary of Chapter IV	132
4.6 Reference for Chapter-IV	134
5. Summary and Conclusion.....	139
5.1 Summary	139
5.2 Conclusion.....	139
5.3 Scope for future work.....	143
Bibliography	144
Appendices	162

List of tables

Table 1.1 Key features and advantages of NIRS	3
Table 2.1: Types of ML and their respective models	26
Table 2.2: Statistical metrics for performance evaluation	26
Table 2.3: Brief details about the available portable NIR sensors used in the field of agriculture	29
Table 3.1: List of major instruments used	48
Table 3.2: Semi-empirical models and their equations	59
Table 4.1.1: Peleg's constant for the soaking kinetics data at 40, 50, and 60 °C	81
Table 4.1.2: Midili-Kucuk coefficient at different temperatures	83
Table 4.1.3: Grain dimensions and physical parameters	86
Table 4.1.4: Saturation moisture and Diffusivity comparison	86
Table 4.2.1: First order kinetics rate equation accuracy metrics	89
Table 4.3.1: Showing the performances of the models for 60°C data	92
Table 4.3.2: Showing the performances of the models for 50°C data	93
Table 4.3.3: Showing the performances of the models for 40°C data	93
Table 4.3.4: Statistical metrics of Midili-Kucuk prediction	95
Table 4.3.5: Midili-Kucuk coefficient at different temperatures	95
Table 4.3.6: Coefficients and statistical metrics of linear plots of soaking spectral calibration	99
Table 4.3.7: Coefficients and statistical metrics of linear plots of steaming spectral calibration	101
Table 4.3.8: Coefficients and statistical metrics of linear plots of drying spectral calibration	102
Table 4.4.1: Probability values of prediction class during soaking	107