“If we meticulously keep on working upon the known things, Allah will grant us knowledge of the unknown things.”

----Abba

To my Father, a gem of a person, a true philanthropist, and above all a very affectionate Father.

This thesis is dedicated to my father, who have encouraged me to do Ph.D. and always inspired me to be honest and not to take hardships seriously and keep going.

DECLARATION BY THE CANDIDATE

The candidate certifies that the thesis entitled "Near-Infrared based Solutions for Quality Assessment during Manufacturing and Storage of a Ready to Eat Rice" submitted to the School of Engineering, Tezpur University in partial fulfillment for the award of the degree of Doctor of Philosophy in the Department of Food Engineering and Technology is a record of research work carried out by me under the supervision of Prof. Manuj Kumar Hazarika.

All assistance received from various sources has been appropriately acknowledged. No part of this thesis has been submitted elsewhere for the award of any degree.

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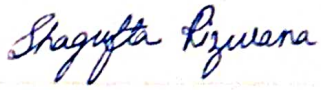
Place: Tezpur University



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All help received by her from various sources has been duly acknowledged.

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List of notations

ρ_b	**Bulk density**
ρ_t	True density
M	Moisture
k_1	Peleg's rate constant
k_2	Peleg's capacity constant
M_i	Initial moisture content
M_e	Equilibrium moisture content
MR	Moisture ratio
C_A	Volumetric concentration
C_{As}	Volumetric concentration in saturation
C_{A0}	Initial volumetric concentration
β	Rate constant estimated using experimental data
ρ_w	Volume of pure water
ρ_s	Volume of pure solid
d_p	Equivalent diameter
D_{ρ_A}	Diffusion coefficient
κ	Arbitrary constants used in Fick's diffusion
k_f	Arbitrary constants used in Fick's diffusion
k	First order rate constant
D_G	Degree of gelatinization

** A few arbitrary constants for the empirical drying model are kept as same as literature and those have been reported accordingly.

List of abbreviations

ANFIS	Adaptive Neuro Fuzzy Inference System
ANP	Aged Non-Parboiled
AP	Aged Parboiled
ANN	Artificial Neural Network
BP-ANN	Back propagation-ANN
BiPLS	Backward PLS
CFTRI	Central Food Technological Research Institute
CART	Classification and Regression Tree
CNN	Convolutional Neural Network
DSC	Differential Scanning Calorimetry
db	Dry basis
EMC	Equilibrium moisture content
EDM	Euclidean distance measure
FiPLS	Forward PLS
GI	Glycemic index
KNN	K-Nearest Neighbors
LS-SVM	Least-squares support vector machines
LDA	Linear Discriminant Analysis
LR	Logistic Regression
LSTM	Long short-term memory
ML	Machine Learning
m.c.	Moisture content
MLP-ANN	Multilayer Perceptron ANN
NB	Naïve Bayes
NIR	Near Infrared
NIRS	Near Infrared Spectroscopy
PLS	Partial Least Square
PLSR	PLS regression
PCA	Principal component analysis
PAT	Process Analytical Technology
RF	Random Forest
RVA	Rapid Visco Analysis
RNN	Recurrent Neural Network
SIMCA	Soft Independent Modeling Class Analogy
SAM	Spectral angle measure
SCM	Spectral correlation measure
SVM	Support Vector Machines
UANP	Unaged Non-Parboiled
UP	Unaged Parboiled
UVE–SPA–LS-SVM	Uninformative variable elimination (UVE) and successive projections algorithm (SPA) LA-SVM
wb	Wet basis