This thesis is dedicated

…to my beloved daughter Niyara,

…to my beloved husband Daoharu,

…to my beloved parents and parents-in-law

DECLARATION

I hereby declare that the thesis entitled "**Physical modification of rice starch, its characterization and application**" submitted to the **School of Engineering, Tezpur University** in partial fulfilment for the award of the degree of **Doctor of Philosophy** in the **Department of Food Engineering and Technology** is a record of research carried out by me under the guidance of **Prof. Charu Lata Mahanta, Professor in the Department of Food Engineering and Technology, Tezpur University**.

All assistance received from various sources and people have been duly acknowledged. No part of this thesis has been submitted elsewhere for the award of any other degree.

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CERTIFICATE OF THE SUPERVISOR

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All assistance received by her from various sources have been duly acknowledged. No part of this thesis has been submitted elsewhere for the award of any other degree.

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List of Tables

Table No.	Table legends	Page No.
Table 2.1	Dual modification of starches from different sources by HMT in combination with various modification methods.	31
Table 3A.1	Chemical composition of SBs, MBs and HR flours.	62
Table 3A.2	Loose and packed bulk density, water and oil absorption capacity of SBs, MBs and HR flours.	62
Table 3A.3	Pasting properties of SBs, MBs and HR flours.	65
Table 3B.1	Water and oil absorption capacity, loose and packed bulk density of medium broken rice flours with different particle size.	75
Table 3B.2	Pasting properties and gel hardness of medium broken rice flours with different particle size.	77
Table 3B.3	Cooking properties of rice noodles prepared using medium broken rice flours with three different particle size.	79
Table 3B.4	Textural properties of rice noodles prepared from medium broken rice flours with different particle size.	82
Table 3C.1	Experimental ranges and levels of coded and actual values of independent variables of FCCD for OPT and HMT of rice starch.	87
Table 3C.2	Experimental design matrix of OPT of rice starch with experimental and predicted responses.	90
Table 3C.3	Experimental design matrix of HMT of rice starch with experimental and predicted responses.	91
Table 3C.4	Regression equations of the predicted response variables of OPT and HMT in coded values.	92
Table 3C.5	ANOVA for the response surface quadratic polynomial model for OPT and HMT (Final viscosity).	94
Table 3C.6	ANOVA for the response surface quadratic polynomial model for OPT and HMT (setback).	96
Table 3C.7	ANOVA for the response surface quadratic polynomial model for OPT and HMT (Gel hardness).	98

Table 3C.8	ANOVA for the response surface quadratic polynomial model for OPT and HMT (Swelling power).	101
Table 3C.9	ANOVA for the response surface quadratic polynomial model for OPT and HMT (Solubility).	103
Table 4.1	Chemical composition of native and modified starches.	123
Table 4.2	RVA pasting properties and gel hardness of native and modified starches.	126
Table 4.3	Short-range molecular order of native and modified starches.	131
Table 4.4	Intensity of major peaks and RC of native and modified starches.	133
Table 4.5	Gelatinization parameters of native and modified rice starches.	135
Table 5.1	The nomenclature of composite rice noodles based on the type and quantity of starches added.	150

List of Figures

Figure No.	Figure legends	Page No.
Fig. 2.1	Molecular structure of native and heat moisture treated starch.	20
Fig. 2.2	Formation of amylose-lipid complex in cereal starch after HMT.	22
Fig. 2.3	The model of starch gelatinization, formation and degradation of granule ghost plotted in a hypothetical DSC curve. Images of starch envelope formation (a), rupture of starch (b) and coiling of starch envelope after rupture (c).	29
Fig. 3A.1	Swelling power and solubility of SBs, MBs and HR flours.	63
Fig. 3A.2	Pasting properties of SBs, MBs and HR flours.	65
Fig. 3A.3	Scanning electron micrographs of surface of head rice and broken rice. SBs (A1: 40X, A2: 200X, A3: 2000X and A4: 4500X); MBs (B1: 40X, B2: 200X, B3: 2000X and B4: 5000X); and HR (C1: 40X, C2: 200X, C3: 2000X and C4: 5000X).	67
Fig. 3A.4	Scanning electron micrographs of cross section view of head rice and broken rice. SBs (A1: 40X, A2: 200X, A3: 2000X and A4: 5000X); MBs (B1: 40X, B2: 200X, B3: 2000X and B4: 5000X); and HR (C1: 40X, C2: 200X, C3: 2000X and C4: 5000X).	68
Fig. 3A.5	Scanning electron micrographs of flours of head rice and broken rice. SBs (A1: 200X, A2: 2000X and A3: 5000X); MBs (B1: 200X, B2: 2000X and B3: 5000X); and HR (C1: 200X, C2: 2000X and C3: 5000X).	69
Fig. 3B.1	Swelling power and solubility of medium broken rice flours with different particle size. Values presented in the bar diagram are the means of triplicate determinations. The error bars are the standard deviation of mean values. Significant difference ($p \leq 0.05$) exists between the means in a column group with different letters (a-c) on the column.	75

Fig. 3B.2	Pasting properties of medium broken rice flours with different particle size: PV: Peak viscosity; HPV: hot paste viscosity; BD: breakdown; SB: setback; and FV: final viscosity. Values presented in the bar diagram are the means of duplicate determinations. The error bars are the standard deviation of mean values. Significant difference ($p \leq 0.05$) exists between the means in a column group with different letters (a-c) on the column.	76
Fig. 3B.3	Sensory evaluation of rice noodles made from medium broken rice flours of different particle size. MRN: marketed rice noodle, 150N: Noodle made from 150F, 180N: noodle made from 180F and 212N: noodle made from 212F.	83
Fig. 3C.1	Response surface 3D plots: (a) Effect of time and temperature on final viscosity of OPT starch, (b-d) effect of time, temperature and moisture content on final viscosity of HMT starch.	95
Fig. 3C.2	Response surface 3D plots: (a) Effect of time and temperature on setback of OPT starch, (b-d) effect of time, temperature and moisture content on setback of HMT starch.	97
Fig. 3C.3	Response surface 3D plots: (a) Effect of time and temperature on gel hardness of OPT starch, (b-d) effect of time, temperature and moisture content on gel hardness of HMT starch.	99
Fig. 3C.4	Response surface 3D plots: (a) Effect of time and temperature on swelling power of OPT starch, (b-d) effect of time, temperature and moisture content on swelling power of HMT starch.	102
Fig. 3C.5	Response surface 3D plots showing (a) Effect of time and temperature on solubility of OPT starch, (b-d) effect of time, temperature and moisture content on solubility of HMT starch.	104
Fig. 4.1	Amylose content (a), swelling power (b), and solubility (c) of native and modified rice starches. Results presented in the bar diagram are the means of duplicates. The error bars indicate the standard deviation of the mean. Significant difference ($p \leq 0.05$) exists between the mean values with different letters (a-e) on the bars.	124

Fig. 4.2	Plane polarized light micrographs (1000X) of native rice starch and modified starches at 20 µm scale bar.	128
Fig. 4.3.	Scanning electron micrographs of native and modified rice starches at 3 µm scale bar; 5 kV acceleration voltage and 5000X magnification; black arrow shows inward folding or indentation; white arrow shows eroded or rough surface of the modified starches.	130
Fig. 4.4	FTIR spectra of native and modified rice starches.	131
Fig. 4.5	X-ray diffractograms of native and modified starches. The numbers 1 to 5 represent the highest peaks detected in the X-ray diffractograms at 2θ=15°, 17°, 17.8°, 20° and 23°, respectively.	133
Fig. 4.6	Angular frequency (ω) dependence of storage modulus (G') (a), loss modulus (G'') (b), phase shift angle (δ) (c) and complex viscosity (η*) (d) for NRS, HMTS, OPTS, HMT-OPTS and OPT-HMTS gels at 25 ^{o}C.	137
Fig. 4.7	Estimation of the RDS, SDS and RS of native and modified rice starches. Results presented in the bar diagram are the means of duplicates. The error bars indicate the standard deviation of the mean. Significant difference ($p \leq 0.05$) exists between the mean values with different letters (a-e) on the bars.	139
Fig. 5.1	Physical properties of dry noodles viz. water absorption (a), and soluble loss (b). Results presented in the bar diagram are the means of duplicate determinations. The error bars indicate the standard deviation of the mean. Significant difference ($p \leq 0.05$) exists between the mean values with different letters (a-h) on the bars.	154
Fig. 5.2	Cooking properties viz. cooking time (a), rehydration (b), cooking loss (c) and swelling index (d) of noodles prepared from blends of rice flour and native, single and dual modified starches. Results presented in the bar diagram are the means of duplicate determinations. The error bars indicate the standard deviation of the mean. Significant difference ($p \leq 0.05$) exists between the mean values with different letters (a-g) on the bars.	156

Fig. 5.3	Texture properties of noodles viz. hardness (a), adhesiveness (b), springiness (c), cohesiveness (d), gumminess (e), and chewiness (f). Results presented in the bar diagram are the means of 5 replicates. The error bars indicate the standard deviation of the mean. Significant difference ($p \leq 0.05$) exists between the mean values with different letters (a-k) on the bars.	159
Fig. 5.4	Tensile properties viz. tensile strength (a) and breaking distance (b) of noodles prepared from blends of rice flour with native, single and dual modified starches. Results presented in the bar diagram are the means of 5 replicates. The error bars indicate the standard deviation of the mean. Significant difference ($p \leq 0.05$) exists between the mean values with different letters (a-g) on the bars.	160
Fig. 5.5	Sensory attributes of noodles prepared from blends of rice flour with native, single and dual modified starches.	161
Fig. 5.6	Rice starch fractions viz. RDS (a), SDS (b), and RS (c) of noodles obtained by *in vitro* starch digestibility study. Results presented in the bar diagram are the means of 2 replicates. The error bars indicate the standard deviation of the mean. Significant difference ($p \leq 0.05$) exists between the mean values with different letters (a-h) on the bars.	162

Glossary of terms, symbols, and units

%, db	Percentage in dry basis
<	Lesser than
>	Greater than
× g*	Relative centrifugal force
≤	Less than or equal to
150F	Rice flour with 150 μm particle size
150N	Noodle made from 180 μm particle size rice flour
180F	Rice flour with 180 μm particle size
180N	Noodle made from 180 μm particle size rice flour
212F	Rice flour with 212 μm particle size
212N	Noodle made from 212 μm particle size rice flour
2θ	Bragg's angle of diffraction
a.u.	Arbitrary unit
AACC	American Association of Cereal Chemists
AAS	Atomic absorption spectrometer
AGU	Amyloglucosidase
ANN	Annealing
ANOVA	Analysis of variance
AOAC	Association of Official Analytical Chemists
Approx.	Approximately
B.C.	Before Christ
bar	Metric unit of pressure
BD	Breakdown
cm	Centimetre
cm^{-1}	Per centimetre/ centimetre inverse
cP	Centipoise
CV	Coefficient of variation
DF	Degree of freedom
DMRT	Duncan’s multiple range test
DP	Degree of polymerization
DSC	Differential scanning calorimetry

ET	Extrusion
etc.	Et cetera
FCCD	Face-centred central composite design
FG	Free glucose
FTIR	Fourier transform infrared spectroscopy
FV	Final viscosity
g	Gram
G'	Storage modulus
G"	Loss modulus
g/g	Gram per gram
g/ml	Gram per millilitre
G_{120}	Glucose released during 120 min of enzymatic hydrolysis
G_{20}	Glucose released during 20 min of enzymatic hydrolysis
GH	Gel hardness
GI	Glycaemic index
h	Hour
HHP	High hydrostatic pressure
HMT	Heat moisture treatment
HMT-OPTS	Heat moisture and osmotic pressure treated starch
HMTS	Heat moisture treated starch
HOSN10	Noodle made from blends containing 10% heat moisture-osmotic pressure treated rice starch
HOSN20	Noodle made from blends containing 20% heat moisture-osmotic pressure treated rice starch
HOSN30	Noodle made from blends containing 30% heat moisture-osmotic pressure treated rice starch
HPV	Hot-paste viscosity
HR	Head rice
HSN10	Noodle made from blends containing 10% heat moisture treated rice starch
HSN20	Noodle made from blends containing 20% heat moisture treated rice starch

HSN30	Noodle made from blends containing 20% heat moisture treated rice starch
HTT	Hydrothermal treatment
HTT-GRF	Hydrothermally treated glutinous rice flour
Hz	Hertz
IMC	Initial moisture content
IR-RS	Indica rice resistant starch
J	Joule
K^{-1}	Kelvin inverse
kg	Kilogram
kPa	Kilo Pascal
kV	Kilo volt
L	Litre
LBD	Loose bulk density
LBs	Large brokens
L-W	Length-width
M	Molarity
mA	Milli ampere
MBs	Medium brokens
mg	Milligram
min	Minute
ml	Millilitre
mm	Millimetre
mm/s	Millimetre per second
mol^{-1}	Mole inverse, mol is the SI unit of substance
MRN	Market rice noodle
N	Normality
n	Number of replicates
N	Total number of experiments
n_a	Number of experiments carried out at $+a_m$ and $-a_m$
n_c	Number of experiments carried out at the centre point
n_f	Number of factorial design experiments
nm	Nanometre

NRS	Native rice starch
NSN10	Noodle made from blends containing 10% native rice starch
NSN20	Noodle made from blends containing 20% native rice starch
NSN30	Noodle made from blends containing 30% native rice starch
OAC	Oil absorption capacity
^{o}C	Degree centigrade
OHSN10	Noodle made from blends containing 10% osmotic pressure-heat moisture treated rice starch
OHSN20	Noodle made from blends containing 20% osmotic pressure-heat moisture treated rice starch
OHSN30	Noodle made from blends containing 30% osmotic pressure-heat moisture treated rice starch
OPT	Osmotic pressure treatment
OPT-HMTS	Osmotic pressure and heat moisture treated starch
OPTS	Osmotic pressure treated starch
OSN10	Noodle made from blends containing 10% osmotic pressure treated rice starch
OSN20	Noodle made from blends containing 20% osmotic pressure treated rice starch
OSN30	Noodle made from blends containing 30% osmotic pressure treated rice starch
Pa.s	Pascal second
PBD	Packed bulk density
PT	Pasting temperature
PV	Peak viscosity
R	Gas constant
R^2	Correlation coefficients of determination
rad/s	Radian per second
RC	Relative crystallinity
RDS	Rapidly digestible starch
RF	Rice flour
RFN	Rice flour noodle
rpm	Revolution per minute

RS	Resistant starch
RS type 3	Resistant starch type 3
RS type 5	Resistant starch type 5
RSM	Response surface methodology
RVA	Rapid visco analyser
s	Second
SB	Setback viscosity
SBs	Small brokens
SD	Standard deviation
SDS	Slowly digestible starch
SEM	Scanning electron microscope
SL	Soluble loss
SNT	Sonication treatment
SOL	Solubility
SP	Swelling power
T	Temperature
T_c	Conclusion temperature
T_c-T_o	Gelatinization temperature range
TG	Total glucose
T_o	Onset temperature
T_p	Peak temperature
TPA	Texture profile analysis
U/ml	Units per millilitre
USD	United states dollar
Viz.	Namely
w/w	Weight by weight
WA	Water absorption
WAC	Water absorption capacity
wb	Wet basis
X_1	Coded value of temperature
X_2	Coded value of time
X_3	Coded value of moisture content
X_i, X_j	Coded independent variables

XRD	X-Ray diffraction
Y_{FV}	Experimental or predicted value of final viscosity
Y_{GH}	Experimental or predicted value of gel hardness
Y_{SB}	Experimental or predicted value of setback
Y_{SOL}	Experimental or predicted value of solubility
Y_{SP}	Experimental or predicted value of swelling power
β_i	Regression coefficient of variables for linear terms
β_{ii}	Regression coefficient of variables for quadratic terms
β_{ij}	Regression coefficient of variables for interaction terms
β_o	Regression coefficient of variables for intercept term
δ	Phase shift angle
η*	Complex viscosity
λ	Amplitude
μl	Microlitre
μm	Micrometre/ micron
π	Osmotic pressure