



## Declaration by the Candidate

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The thesis entitled “**Supercritical fluid extraction of bioactive compounds from haritaki (*Terminalia chebula*) using novel pre-treatments and its application in development of functional food**” is being submitted to *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 bonafide research work accomplished by me under the supervision of **Prof. Nandan Sit**.

All helps from various sources have been duly acknowledged.

No part of the thesis has been submitted elsewhere for award of any other degree.



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**Certificate of the Supervisor**

This is to certify that the thesis entitled “**Supercritical fluid extraction of bioactive compounds from haritaki (*Terminalia chebula*) using novel pre-treatments and its application in development of functional food**” submitted to the **School of Engineering**, Tezpur University in partial fulfilment for the award of the degree of Doctor of Philosophy in **Food Engineering and Technology** is a record of research work carried out by **Mr. Avinash Kumar Jha** under my supervision and guidance.

All help received by him from various sources have been duly acknowledged.

No part of this thesis has been submitted elsewhere for award of any other degree.

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## List of Abbreviations

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ANN	Artificial Neural Network
SEM	Surface Electron Microscopy
CM	Centimeter
QE	Quercetin Equivalent
RSM-CCRD	Response Surface Methodology-Central Composite Rotatable Design
TA	Titration Acidity
TFC	Total Flavonoid Content
TPC	Total Phenolic Content
L*	Lightness
a*	Redness
b*	Blueness
MR	Moisture ratio
FTIR	Fourier Transform Infrared
DPPH	2,2-diphenyl-1-picryl-hydrazyl-hydrate
R <sup>2</sup>	Coefficient of determination
RMSE	Root mean square error
GAE	Gallic Acid Equivalent
LC-MS	Liquid Chromatography Mass Spectrometry
<i>t</i>	Time, min
$\chi^2$	Chi-square
UAE	Ultrasound-assisted extraction
scCO <sub>2</sub>	Supercritical carbon dioxide
DW	Distilled water
kg	Kilogram
g	Gram
mm	Millimeter
mm <sup>2</sup>	Square millimeter
RW	Refractance window
k	Consistency
DT	Drying temperature
FT	Foam thickness

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$\text{kJ mol}^{-1}$	Kilojoules per mole
$\text{m}^2 \text{s}^{-1}$	Metre per second squared
$\text{m s}^{-1}$	metre per second
$\text{kWh kg}^{-1}$	kilowatt-hour per kilogram
kWh	Kilowatt hours
MSI	Moisture Sorption Isotherm
aw	water activities
EMC	Equilibrium Moisture Content
GAB	Guggenheim, Anderson, and deBoer
BET	Brunauer-Emmett-Teller
LDPE	Low Density Polyethylene
ALP	Aluminium Laminated Polyethylene
$t_{1/2}$	<i>Half-life</i>
MW	Microwave
W	Watt
kHz	<i>Kilohertz</i>
HCl	Hydrogen chloride
EAE	Enzyme-Assistant Extraction
MHz	Megahertz
ABTS	<i>2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid</i>
DW	Dry weight
CRE	Conventional reflux extraction
UMAE	Ultrasound–Microwave-Assisted Extraction
IL-UMAE	Ionic Liquid-based Ultrasonic-Microwave-Assisted Extraction
EMImBF <sub>4</sub>	1-ethyl-3-methylimidazolium tetrafluoroborate
v/v	volume per volume
EUMAE	Enzyme-based Ultrasound-Microwave-Assisted Extraction
UV	Ultraviolet
GA	Gallic acid
CA	Caffeic acid
DNA	Deoxyribonucleic acid
HPLC	High Performance Liquid Chromatography

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FGIDs	Functional Gastrointestinal Disorders
G'	Storage modulus
G''	<i>Loss modulus</i>
MUFA	Monounsaturated fatty acid
PUFA	Polyunsaturated fatty acids
MPE	Microencapsulated Phenolic Extract
CW	Carrot Waste
GSE	Guarana Seed Extract
L	Length
B	Breadth
T	Thickness
W <sub>t</sub>	Weight
AMD	Arithmetic Mean Diameter
GMD	Geometric Mean Diameter
SA	Surface Area
M <sub>t</sub>	Moisture content of sample at any time (kg water/ kg dry matter)
M <sub>0</sub>	Initial moisture content (kg water/kg dry matter)
M <sub>e</sub>	Equilibrium moisture content (kg water/kg dry matter)
D <sub>eff</sub>	Effective diffusivity
D <sub>0</sub>	Effective moisture diffusivity at infinite temperature (m <sup>2</sup> /s)
R	Gas constant (8.314 × 10 <sup>-3</sup> kJ/ mol)
mL	Milliliter
Na <sub>2</sub> CO <sub>3</sub>	Sodium Carbonate
NaNO <sub>2</sub>	<i>Sodium nitrite</i>
AlCl <sub>3</sub>	<i>Aluminium chloride</i>
NaOH	Sodium hydroxide
μL	Microliter
mg/L	Milligrams per liter
M	Molar
nm	Nanometer
ΔE*	Colour difference
Q <sub>st</sub>	Net isosteric heat of sorption

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LiCl	Lithium chloride
MgCl <sub>2</sub>	Magnesium chloride
K(CO <sub>3</sub> ) <sub>2</sub>	Potassium Carbonate
Mg(NO <sub>3</sub> ) <sub>2</sub>	Magnesium nitrate
KI	Potassium iodide
NaCl	<i>Sodium Chloride</i>
KCl	<i>Potassium chloride</i>
RH	Relative humidity
SSE	Sum of square errors
R <sub>min</sub>	Minimum radius
R <sub>max</sub>	Maximum radius
V	Volume
CO <sub>2</sub>	Carbon dioxide
SFE	Supercritical fluid extraction
GA	Genetic algorithm
H <sub>2</sub> O	Water
MAE	Microwave assisted extraction
ANOVA	Analysis of variance
CV	Coefficient of variation
FD	Freeze dried
VD	Vacuum dried
TD	Tray dried
MW+E	Microwave assisted -Enzymatic extraction
US+MW	Ultrasound assisted -Microwave extraction
US+E	Ultrasound assisted - Enzyme extraction
US+MW+E	Ultrasound- Microwave- Enzyme assisted extraction
DF	Desirability function
FF	Feed-forward
BP	Backpropagation
MLP	Multilayer perceptron
DMRT	Duncan Multiple Range Test
MAE	Mean absolute error

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FW	Fresh weight
AA	Ascorbic acid
AC	Anthocyanins
DSC	Differential scanning calorimetry
CH <sub>2</sub> OH	<i>Methanol</i>
CH <sub>2</sub>	<i>Methylene</i>
XRD	X-Ray Diffraction
TGA	Thermogravimetric Analysis

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