DEDICATED

TO

PAPA AND MAA

For endless love, support, and encouragement

DECLARATION

I hereby declare that the thesis entitled “Development and evaluation of an optimized passion fruit based-beverage enriched with Pickering nanoemulsion of fibre and oil extracted from its byproducts” submitted to the School of Engineering, Tezpur University in partial fulfilment of the requirements for the award of the Doctor of Philosophy in Department of Food Engineering and Technology is a record of original research work carried out by me. Any text, figures, theories, results or designs that are not of my own devising are appropriately referenced in order to give credit to the original author(s). all the sources of assistance have been assigned due acknowledgement. I also declare that neither this work as a whole nor a part of it has been submitted to any other university or institute for any degree, diploma, associateship, fellowship or any other similar title or recognition.

Hemanta Chutia

(Hemanta Chutia)

Registration No. TZ203788 of 2021

Place : Tezpur University

Date : 09-11-2023

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CERTIFICATE OF THE SUPERVIOSR

This is to certify that the report entitled "Development and evaluation of an optimized passion fruit based-beverage enriched with Pickering nanoemulsion of fibre and oil extracted from its byproducts" submitted to the School of Engineering, Tezpur University in partial fulfilment of the requirements for the award of the Doctor of Philosophy in Department of Food Engineering and Technology, is a record of original research work carried out by Mr. Hemanta Chutia under my supervision and guidance.

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

Charu Lata Mahanta

Place: Tezpur University
Date: 09-11-2023

(Prof. C. L. Mahanta)

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LIST OF ABBREVIATIONS

Abbreviations	Full form
CC_r	Ratio of extracted content that did not diffuse out
$\rho_{aerated}$	Aerated bulk density
ρ_{tapped}	Tapped bulk density
AA	Ascorbic acid
AAI	Antioxidant activity index
ABTS	2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)
ADF	Alkaline extracted dietary fibre
ANN	Artificial neural network
ANOVA	Analysis of variance
atm	Atmosphere
AUDF	Combination of alkaline-ultrasonication extracted dietary fibre
AV	Acid value
BBD	Box–Behnken design
BET	Braunauer-Emmett-Teller
BNESPFJT	Passion fruit seed fibre and oil based nanoemulsion added passion fruit based HPH treated blended beverage
BSPFJT	Sensory optimized passion fruit based HPH treated blended beverage
BSPFJTT	Sensory optimized passion fruit based heat treated blended beverage
BSPFJU	Sensory optimized passion fruit based untreated blended beverage
CAC	Codex Alimentarius Commission
CDV	Conjugated diene value
CE	Conventional extraction
CEOO	Carotenoids enriched olive oil
C-HP-US-StNP	Carotenoids Ultrasonicated followed by high pressure homogenized starch nanoparticles
d.w.	Dry weight
DF	Dietary fibre
DLS	Dynamic light scattering
DPPH	2,2-diphenyl-1-picrylhydrazyl
DSC	Differential scanning calorimetry
EC	Emulsion capacity

ESI	Emulsion stability Index
FAO	Food and Agricultural Organization
FCCD	Face-centred central composite design
FCR	Folin–Ciocalteu Reagents
FF	Free-flowing
FFF	Fairly free flowing
FTIR	Fourier transform-infrared spectroscopy
f.w.	Fresh weight
GA	Genetic algorithim
GAC	Glucose-adsorption capacity
GAE	Gallic acid equivalents
GAE	Gallic acid equivalents
GRAS	Generally recognised as safe
HPH	High pressure homogenization
HPLC	High performance liquid chromatography
HP-US-StNP	Ultrasonicated followed by high pressure homogenized starch nanoparticles
HR	Hausner ratio
IC50	50% effective radical inhibition concentration
IDF	Insoluble dietary fibre
IDF	Insoluble dietary fibre
LSD	Least significant difference
MAE	Microwave-assisted extraction
min	Minute
NS	Native starch
OD	Over all desirability
OHC	Oil holding capacity
OO	Olive oil
OPFJUS	Optimized thermosonicated treated sugar added passion fruit juice
PDI	Polydispersity index
PFJ	Passion fruit juice
PFP	Passion fruit peel
PFS	Passion fruit seed

PFSDF	Passion fruit seed dietary fibre
PFSO	Passion fruit seed oil
PV	Peroxide value
p-value	Probability value
RSM	Response surface methodology
RSM	Response Surface Methodology
S/L	Solid-to-liquid ratio
S/L	Solid to liquid
SDF	Soluble dietary fibre
SDF	Soluble dietary fibre
SEM	Scanning electron microscope
SGF	Simulated gastric fluid
SO	Sunflower oil
SPFJ	Sensory optimized passion fruit juice
SPFJT	Sensory optimized sugar added HPH treated passion fruit juice
SPFJU	Sensory optimized sugar added untreated passion fruit juice
SPSS	Statistical Package for the Social Sciences
SSF	Simulated saliva fluid
TCC	Total carotenoids content
TEAC	Trolox Equivalent Antioxidant Capacity
TGA	Thermogravimetric analysis
TPC	Total plate count
TS	Thermosonication
TTA	Total titrable acidity
UAE	Ultrasonic assisted extraction
UDF	Ultrasonication extracted dietary fibre
UOO	Untreated olive oil
US	Ultrasonication
US-StNP	Ultrasonicated starch nano-particles
UV	Ultraviolet
Vis	Visible
WHC	Water Holding Capacity
XRD	X-ray diffraction

LIST OF SYMBOLS

Symbols	Full form
C_{sa}	Carotenoids concentration at saturation conditions
h_0	Initial extraction rate
k_s	Extraction rate constant of the Pseudo second-order model.
B_i	Biot number
CC_r	Ratio of extracted content that did not diffuse out
C_p	Specific heat
D_e	Effective diffusion coefficient
D_p	Particles Size
$E_{1\ cm}^{1\%}$	Extinction coefficient
E_a	Activation energy
E_v	Energy density
K_{eq}	Equilibrium constant
P_m	Power per unit mass
R^2	Coefficient of determination
k_0	Initial extraction rate constant
k_1	Washing rate constant
k_2	Unhindered diffusion constant
k_3	Hindered diffusion constant
k_{mt}	Coefficient for mass transfer
k_s	Pseudo second order extraction rate constant
°K	Kelvin
µg	Micro gram (10^{-6}kg)
℃	Degree Celsius
CV	Coefficient of variance
D	Dilution factor
f	Fraction of extractable materials located at external surfaces,
g	Grams
h	Hour
Kg	Kilogram
KOH	Potassium hydroxide

L	Litre
m	Mass
mg	Milligram
min	Minutes
mL	Millilitre
P	Power
R	Gas constant
r	Radius of particle
RMSE	Root mean squared error
S	Solid
sec	Seconds
SSE	Sum square error
SSR	Sum square of regressions
SSTO	Total sum square errors
t	Time
T	Temperature
V	Volume
W	Watt
ΔG	Gibbs free energy
ΔH	Change in enthalpy
ΔS	Entropy change
α	Repose angle