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HEAT AND MICROWAVE REFLUX EXTRACTION, OPTIMIZATION, AND PHYSICOCHEMICAL CHARACTERIZATION OF OLEORESINS FROM MALAYSIAN PEPPER (*Piper nigrum*)

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Doctor of Philosophy

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy

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LIST OF SYMBOLS

h_1	Extraction time in heat reflux extraction
h_2	Feed particle size in heat reflux extraction
h_3	Feed-solvent ratio in heat reflux extraction
x_1	Irradiation time in microwave refluxation
x_2	Microwave power in microwave refluxation
x_3	Feed particle size in microwave refluxation
x_4	Feed-solvent ratio in microwave refluxation
y'_w	Extraction yield from heat refluxed white pepper
y'_b	Extraction yield from heat refluxed black pepper
y_w	Extraction yield from white pepper microwave refluxation
y_b	Extraction yield from black pepper microwave refluxation
$y'_{w(av)}$	Average extraction yield from heat refluxed white pepper
$y'_{b(av)}$	Average extraction yield from heat refluxed black pepper
$y_{w(av)}$	Average extraction yield from white pepper refluxation
$y_{b(av)}$	Average extraction yield from black pepper refluxation
$Q_t'_w$	Absorbed energy by heat refluxed white pepper sample
$Q_t'_b$	Absorbed energy by heat refluxed black pepper sample
$Q_{t\,w}$	Absorbed microwave energy by white pepper sample
$Q_{t\,b}$	Absorbed microwave energy by black pepper sample
$Q_t'_{w(av)}$	Average absorbed energy by heat refluxed white pepper sample
$Q_t'_{b(av)}$	Average absorbed energy by heat refluxed black pepper sample
$Q_{t\,w(av)}$	Average absorbed microwave energy by white pepper sample
$Q_{t\,b(av)}$	Average absorbed microwave energy by black pepper sample
a	Values are means ±SD of triplicate runs

LIST OF ABBREVIATIONS

ANOM	Analysis of Mean
ARP	Antiradical Power
BPOE	Black Pepper Oleoresin Extracts
HRE	Heat Reflux Extraction
MRE	Microwave Reflux Extraction
PI	Performance Index
REI	Relative Extraction Index
SFE	Single Factor Experiment
SNR	Signal to noise ratio
TODOE	Taguchi orthogonal design of experiment
WPOE	White Pepper Oleoresin Extracts