

UNIVERSITI TEKNOLOGI MARA

**EFFECT OF RADIATION HEAT ON
THE PHYSICAL AND CHEMICAL
PROPERTIES OF BREAD
INCORPORATED WITH *GARCINIA
MANGOSTANA***

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Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy

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CONFIRMATION BY PANEL OF EXAMINERS

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I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledge as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

Radiation is considered as the main process of heat transfer occurred in the oven during baking process. The sources of radiation energy are generated from heating elements as well as the oven surfaces. In this study, the effect of heat distribution due to the radiation energy inside the baking oven was analysed using network representation model. This model is developed by considering the configuration and the area of oven wall surfaces. Two types of oven were used (high and low emissivity) to evaluate the performance on radiation effect. The best oven performance condition was selected to be used in functional bread baking. In this work, *Garcinia mangostana* pericarp powder has been chosen to be incorporated in the bread due to the large amount of xanthonenes content in its pericarp. Xanthonenes has the ability as an antioxidant, antibacterial, anti-inflammatory and anticancer. The functional bread characteristics that being investigated were antioxidant activity, total phenolic content, surface colour and moisture content. The baking conditions were set at baking temperatures of 180°C, 200°C and 220°C while baking time was varied from 15 to 30 minutes and concentration of *Garcinia mangostana* pericarp powder varies from 0.5 wt% to 2 wt%. The experimental operating conditions were carried out systematically generated by Design Expert version 6.0. The colour development of bread crust and crumb was measured and expressed as L* (lightness), a* (redness) and b* (yellowness) values. The antioxidant activity and total phenolic content of bread samples were measured using DPPH (2,2-diphenyl-1-picrylhydrazyl) and Folin-Ciocalteu assays, respectively. The network model was successfully developed and was used to determine the radiation heat in baking oven. The results showed that high emissivity oven (black surface) provides more radiation heat compared to low emissivity oven (shiny surface). Therefore, high emissivity oven was used for baking bread incorporated with *Garcinia mangostana* pericarp powder. It was found that, incorporation of 0.5 wt% to 2 wt% of *Garcinia mangostana* pericarp powder in bread increased the antioxidant activity up to 90% of radical scavenging activity and total phenolic content up to 30 mg GAE/g. The surface colour and moisture content of the incorporated bread are also similar to the control sample. For optimisation process, it was found that baking temperature, baking time and concentration of pericarp powder give significant effect on total phenolic content, antioxidant activity, bread crust and crumb surface colour and moisture content. The optimum level of baking condition was found to be at baking temperature of 213°C, baking time of 23 minutes and *Garcinia mangostana* pericarp powder concentration of 0.87wt%.

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