UNIVERSITI TEKNOLOGI MARA

TECHNICAL REPORT

NUMERICAL ESTIMATION OF ENLIGHTENMENT PHASE OF CRACKER DURING BAKING

NUR FATIHAH BINTI SHAHMAN
2013207202   K15/12
NURUL NAJWA BINTI MOKHTAR
2013675776   K15/12
SITI NUR AINSYAH BINTI GHANI
2013409784   K15/12

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Faculty of Computer and Mathematical Sciences

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ABSTRACT

The topic of this project covers the study of the enlightenment phase of cracker during baking. Most of the researchers focused on solving the problem by experimental, while we decide to solve by mathematically. Baking air temperature, T_a (°C), cracker temperature, T_b (°C) baking time, t (minutes), ideal gas temperature, R ($J/mol/K$), energy of activation, Ea (kJ/mol) and kinetic constant of enlightenment reaction, k_0 are involved in the enlightenment phase of cracker during baking. The suitable baking air temperature of the experiment is 180°C and 210°C. The kinetic approach is used to describe color formation during baking. Kinetics parameter estimated from the experiment which closed to actual baking condition. The resulting equations were solved using analytical solution and appropriate numerical methods which are Explicit Euler's method and Fourth-Order Runge-Kutta (RK4) method. Then the validated approximated solution, analytical solution and experimental data were obtained in order to compare the relative errors. The error accuracy of the RK4 method is higher compared to Explicit Euler's method. This project identifies the effect Ea and k_0 parameter on the lightness, L^* variation of the cracker surface. This parametric study shows that by increasing the value of the Ea, the lightness increase slowly. While, the lightness increase rapidly as the value of k_0 parameter is increased.

1 INTRODUCTION

The baking of bakery products can be defined as the process which transform dough, basically made of flour and water (other ingredients such as sugar, fat, egg, leavening agent, and other additives will depend on each specific product), in a food with unique sensorial features. One of the major sensorial features is the texture of the baked products. The processes which determine that texture are the important issues for manufacturer such products. Respect to bakery product, the surface color together with its texture and flavor are the main features considering preference of consumers. Thus, it can be used to judge the completion baking. For clear understanding of baking, a few experimental and mathematical models are conducted.

According to Chevallier (2000), surface color of cracker devises from non-enzymatic browning (Maillard reaction) between reducing sugars and amino acids during the baking process and as well as starch dextrinisation and sugar caramelization. Baisier (1992) stated that it is generally agreed that an excess of reducing sugar over amino compound promotes the rate of Maillard browning. Damage of starch leads to decrease in reducing sugar concentration that causes color development due to Maillard reaction or sugar caramelization Broyart (1998).

During the baking process, two stages can be distinguished in the variation of product lightness. The first stage is characterized by a lightening of the surface and correspond to the first minutes of baking. Probably, this first stage of lightening is due to physical changes occurring at the product surface at the beginning of the process. This change in surface texture may be the reason for the observed initial lightning. Therefore, this first stage is only related to the method used for measuring lightness, which is defined as value or tone of the cracker itself. It also describes the representation of variation in the perception of a color or color space's brightness of the cracker.

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