RESULTS

Numerical Simulations and Experiments with

BACON PREPARATION IN A MICROWAVE

EiT - Matematikk Innen Anvendelser

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Abstract

Text in abstract

Preface

Text in foreword

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Chapter 1

Introduction

1.1 Problem formulation

The problem considered in this project is the preparation of bacon in a microwave oven. Bacon is defined as cured meat from side and back cuts of a pig. A microwave oven in this context is a household appliance typically delivering 750 W of microwave effect at a frequency of 2.1 GHz to a Faraday cage of volume 40 liters.

The motivation for the problem formulation was clear. As soon as modeling of food preparation was brought on the table, bacon seemed a prime choice. A microwave oven may seem an odd choice for bacon, but previous experiments have shown that optimal bacon can consistently be attained with this preparation method. Obvious advantages over traditional bacon preparation include less cleaning up to do afterwards and a shorter time-to-plate. The caveat is that microwave preparation is less suitable for feedback during the cooking process, as the bacon is obscured from view. To the traditional bacon chef, used to a touch-and-go approach, this is an obstacle to implementation, as overcooking bacon in a microwave oven yields inedible results. The purpose of this work, then, is to establish reliable numerical simulations that can serve as a basis for estimating cooking time for an arbitrary slice of bacon.

As the project considers the optimal preparation of bacon in a microwave oven, two natural questions were formulated:

- How is preparation of bacon in a microwave oven modelled numerically?
- How does water and fat content affect the preparation, and what preparation time is optimal?

1.2 Reasoning behind the problem formulation

The first question is obvious, as any attempt at predicting the preparation time necessitates a numerical model of bacon in a microwave oven; a simple glance at the relevant equations tells the experienced numerics person that no analytical solution exists. With a numerical solution of the heat and mass transport equations, the optimal preparation time can be predicted. But this presumes an understanding of what makes good bacon. So what does?

Work done by [?] and [?] suggest that two factors are important in determining good bacon. The first is a high enough temperature that the Maillard reaction can take place, which happens around 140^{circ}C. The second is that a significant proportion of the fat has melted and has been transported out of the bacon. Both of these factors are naturally affected by the composition of the bacon; especially water and fat content will play a major role.

Having identified these two factors as the important criteria for an optimal solution, experimental work is needed to determine the correlation between temperature and fat loss, and how finished bacon is. This is, of course, also a subjective question - different people prefer different grades of crispness.

Another experimental question is how much of the microwave effect that is absorbed by the bacon. The second law of thermodynamics dictates that some of the effect is lost in the microwave magnetron, the question is how much effect is dissipated in the bacon. This may include losses besides that of the magnetron, which has a typical efficiency of 65% [?]. It turns out that common household microwave ovens are rated to include this loss, with standardized calibration procedures published by the IEC's SC 59K, so a 750 W microwave oven will typically draw 1.1 kW of electrical power from the mains socket. This means using the rated power will be good enough for our purposes.

Finally, experiments are needed to verify the accuracy of the numerical results. As heat and mass transport is a Complicated Problem, this is not guaranteed a priori.