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## P2\_5 Bun in the Oven

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### Abstract

This paper estimates the total monetary cost of making a cake sufficient to provide the extra calories a woman requires over the course of a standard pregnancy. The total extra calorie intake was determined to be 18600 kcal, the mass of the cake was calculated to be 6.4 kg and the total monetary cost was found to be £16.43.

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### Introduction

During pregnancy, a common phrase used is “eating for two”, however for the first two trimesters it is recommended that a woman consumes the same number of calories that they would if they were not pregnant, while during the third trimester it is recommended that they consume 200 kcal more per day than they would otherwise [1].

This paper aims to calculate the total cost of a home-baked cake that contains the same number of excess calories that a pregnant woman must consume above what they would eat if they were not pregnant.

### Method

First, the number of extra calories required during pregnancy is calculated by multiplying the number of extra calories required per days by the number of days in the third trimester (93 days). This value is used to determine the mass

of the cake using:

$$m = \frac{C}{\rho} \quad (1)$$

Where  $m$  is the mass of batter,  $\rho$  is the calorie density and  $C$  is the total number of calories. With the mass of the cake batter ascertained, the energy required to cook it can be calculated with the equation:

$$Q = mc_p\Delta T \quad (2)$$

Where  $Q$  is the total energy,  $m$  is the mass,  $c_p$  is the specific heat capacity and  $\Delta T$  is the change in temperature from precooked to cooked (79 K). The efficiency of the cooking appliance can then be used to calculate the total energy consumed in the baking process. The monetary cost of this amount of energy can be found by converting it to kWh and taking the average price per kWh in the UK [2]. The price of the consumed energy can be summed with the cost of the ingredients to give a total cost of creating the cake.

### Results

The specific heat capacity of the cake batter can be assumed to be constant with an estimated

value of  $2587 \text{ J kg}^{-1} \text{ K}^{-1}$  [3].

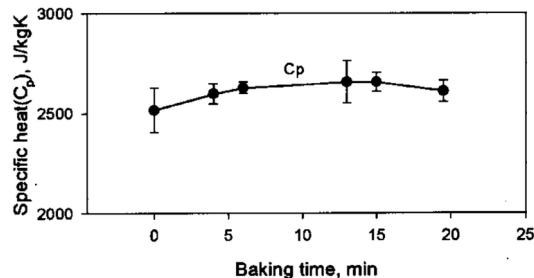


Figure 1: Thermal properties of cake batter during baking [3].

The total extra calories required for a woman over the course of their pregnancy was calculated to be 18600 kcal, whereupon using a value for the calorie density of chocolate cake batter of  $2910 \text{ kcal kg}^{-1}$  [4] leads to the total mass of the cake to be 6.4 kg. The initial temperature of the cake was taken to be 293.15 K with a final cooked temperature of 372.15 K [5]. The energy calculated using Eq. 1 was 1.3 MJ. The efficiency of an electric oven is around 12.5% [6], leading to a total energy required to bake the cake to be 10.4 MJ. Converting this to kWh gives around 3, using the average value of electrical energy in the UK of  $17.2 \text{ p kWh}^{-1}$  [2] gives a financial cost of 51p to bake the cake. The total cost of the ingredients required to bake a 6.4 kg cake was found to be £15.92 when scaling the ingredients used in an online recipe [7] and compared to a supermarket's prices [8]. Summing these gives a total cost of £16.43 to consume the extra calories associated with pregnancy by baking a single cake.

## Discussion

This paper assumes that the diet of the pregnant women is suitably balanced to provide all of the necessary nutrients for the baby, allowing for the extra calories to be made up in the form of a cake. If this were not the case, then the extra calories from this would not be useful.

## References

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