Efficiency of Heating Containers Used in Microwave Ovens

Korede Adegboye, Mohamad Al-Sabbagh, Rehan Gotla

A: Efficiency of Heating Containers Used in Microwave Ovens General Objective

- To determine what properties of microwave containers result in the minimum amount of time for heating to a given temperature.

1. Determine some sort of overall objective – you will have to revise and specify this more clearly later.

- When you put the food in the oven, the microwaves penetrate inside the food.The vibrating molecules have heat and the molecules vibrate fast and this makes the food hot. Hence it takes less time to cook food in an oven.Therefore the overall objective of an oven is to cook food more efficiently with little energy consumption and time. We can know the efficiency of heating containers used in microwave ovens by measuring the frequency of the magnetron.

Null hypothesis : The average frequency of the magnetrons are the same

Alternative hypothesis : The average frequency of the magnetrons are different

2. Think what you could use as a response variable. Remember you will have to decide on some precise way of measuring it.

- Temperature, we need a temperature that heats the meal quickly but at the same time doesn't burn the meal. We measure the temperature using a thermometer and the results will be in Celsius, Fahrenheit, Kalvin, and Rankine.
- Time, we use microwaves to get the meal heated as soon as possible. The microwave which needs less time to heat the meal is considered as the best option. We measure the time by a timer found in the microwave .

3. Then decide which of all the factors listed are the ones that you want to use as the factors to be investigated.

The factors which would like to investigate:

- Time which is measured by the microwave timer
- Temperature which is measured by a thermometer

4. Everybody should at this point:

- **List ALL the variables you can possibly think of that might affect the response. Keep this list. Start thinking about which of these variables are controllable by some method. Eg some might reasonably be kept constant, and might be able to use blocking for some of them. Some you might decide would not contribute significantly to changes in the response**
    - Extraneous factors:
        - Size of container
        - Material of container
        - Electricity because if the the electricity in your country or home is strong the microwave will function better
- **You might even consider whether it would be a good idea to add them to your factors to be studied.**
    - Factors to be investigated and studied:
        - Temperature (Small, medium, large)
        - Time (30 sec 60 sec, 90 sec)
    - All the extraneous factors can be controlled because we can bring microwaves with the same size and material and electricity . The treatments are the combination of the levels of time and temperature .

5. Specify the study units.

Study unit is the frequency of the magnetron that transfers electrical electrical energy into an electromagnetic field.

6. Based on what you have done above decide what type of randomization to use. I.e. CRD, RCBD, Repeated Measures (next 3 "lectures"). Remember you can have 1, 2, 3, 4, ...factors in either an CRD or RCBD design, but with more than 4 may be very messy to analyze with these methods.

We would like to study the effect of time and temperature on the final results (quality of the meal or frequency of the magnetron). We will assume similar extraneous conditions in this experiment, that is similar power, similar size and material of container. We hope to reduce experimental error as much as possible in this experiment. The different meals we want to experiment are identical (cold but not frozen).

a) We will divide the experiment to 3 blocks , with each block having different times (30 seconds, 60 seconds, 90 seconds)
b) On the other hand the other factor is temperature where we have three different temperatures (low,medium,high), and each of the times will be assigned randomly to each of the temperatures within each block.

8. Specify the model for the design decided on.

$Y_{ijk} = \mu... + \tau_{ij} + P_k + E_{ijk}$ where

$E_{ijk} \sim NID(0, \sigma^2)$

$\tau_{ij} = \alpha_i + \beta_j + (\alpha\beta)_{ij}$ = effect of i-j-th treatment

P_k = effect of kth block

i=1,2,3 , j=1,2,3 , k=1,2,3

assuming no block treatment interaction

9. Outline the analysis to be used including hypotheses to be tested, checks on assumption violations, what remedial measures you might take IF there was an assumption violation, what comparisons you would want to carry out under the different possible situations.

Testing Procedure - Hypothesis':

H_0: $(\alpha\beta)_{ij} = 0 \ \forall i,j$ i, j vs H_A: not all $(\alpha\beta)_{ij}$ are zero $\forall i,j$

H_0: $\alpha_i = 0 \ \forall i$ vs H_A: not all α_i are zero $\forall i$

H_0: $\beta_j = 0 \ \forall j$ vs H_A: not all β_j are zero $\forall j$

If there is a significant interaction between time and temperature we will use tukey's procedure to compare the μ_{ij} . If time significantly affects the average frequency of magnetrons, then we will compare the $\mu_{i.}$. If temperature significantly affects the average frequency of magnetrons, then we will compare the $\mu_{.j}$. In regards to remedial measures, we will need to evaluate the seriousness of them. Depending on the possible outcomes, such as the Y_{ijk} not being independent. We will have to construct a new model. Further, variance stabilizing transformations can be candidates to eliminate non-normality and unequal variances.

10. Review your previous decisions if necessary and revise if necessary.

After our analysis with the Tukey procedure, we would investigate further, and check the relative efficiency of RCBD to CRD. Deciding then if the blocks were useful or not.