

# TO OIL OR NOT TO OIL: AN INVESTIGATION INTO AGRABATHI AND OLD WIFE'S TALES

STA2005S

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Abstract

A quatitative analysis of the burn time of Agrabathi when covered in various common oils found in Indian households.

## Table of contents

1	Introduction	3
2	Motivation	3
3	Objectives	3
4	Design and Procedure	3
5	Pilot study	4
6	Model and outline of analysis	4
7	Randomisation	5
8	The actual experiment and data	5
9	ANOVA	5
10	Contrasts	5
11	Interpretation	5
12	Conclusion	5
13	Appendix	5

# 1 Introduction

This assignment explores the influence of different oil treatments on the burn time of incense sticks through the application of a randomized block design (RBD). This study is structured around 3 distinct treatment types (..) randomly applied across 18 experimental units, with the incense brand serving as a blocking factor. By acknowledging the differences that might arise due to manufacturing or material quality, blocking for brands serves as a crucial step in isolating the true effects of the oil treatments. By structuring the experiment in this way, we aim to minimize the impact of confounding variables, allowing us to attribute any variations in burn time more confidently to the treatments themselves rather than to the intrinsic characteristics of the incense sticks.

## 2 Motivation

There is an old wives tale which hails from the ancient Indian subcontinent and has been told for generations; applying oil to an incense stick will cause it to burn faster. This quick burn time ensured that the smoke created a sacred atmosphere, a well scented home and most importantly, carried your family's prayers to the almighty deities above. While there can be no doubt about the role of incense sticks (or Agrabathi) in the cultural and spiritual settings of an Indian home, doubt remained about the effectiveness of dipping these sticks into the rich, often fragranced, oils. This study seeks to unravel the truth behind this age-old belief, offering modern families the wisdom to discern whether investing in extra oils for incense sticks truly enhances both their connection to the divine and the speed in which the fragrance emanates throughout their homes. By providing this knowledge, we aim to empower families to make informed decisions and potentially save them from unnecessary expenses if these treatments are found not to significantly extend the burn time of incense sticks.

## 3 Objectives

Our objective is to determine which treatment produces the shortest burn time by testing three options: a control, sandalwood oil, and coconut oil, and assessing their effects on burn time. We will examine whether these commonly used oils differ from each other (comparison of the sandalwood and coconut oil) and whether there is a difference with the oils from the control (comparing each oil individually to the control). By blocking for the different brands of incense sticks, we can more confidently deduce the differences between treatments, as the blocks contain homogeneous units. Once the incense sticks are lit and the smoke clears, the last burning stick will reveal whether oils truly influence burn time. By repeating this experiment three times, we ensure that our findings are as robust as the scent that lingers in the air.

Formally this study will test the following hypothesis:

- i**  $H_0$ : The application of different oils has no effect on the burn time of Agrabathi
- $H_A$ : The application of at least one of the oils has an effect on the burn time of Agrabathi

Additionally the following two comparisons of means will be conducted:

- i**  $L_1$ : Effect of sandalwood oil is equal to the effect of coconut oil.
- $L_2$ : The effect of no oil is equal to the average effect of applying the oils

## 4 Design and Procedure

This experiment will employ a randomised block design with a single factor - application of oil - of three levels, viz., control (no oil), coconut oil, and castor oil. The experiment will block for heterogeneity of experimental units arising from the use of different brands of Agrabathi viz., Hem, Malarani and Tulasi. The factor levels have been selected as they are oils commonly used in Indian households across the world and are the de facto choices during day to day use. The brands of Agrabathi from which the experimental units are drawn from represent easily found and widely exported brands.

A pilot study will be conducted to assess the viability of the experimental procedure which is outlined below:

1. Select experimental units from each brand of Agrabathi
2. Randomly assign treatments to the units within each block
3. Apply the relevant treatment in the form of coating the sticks of Agrabathi in the appropriate oil ensuring that there is even and consistent covering
4. Light the Agrabathi sticks at their tip and place them in a sheltered area to burn
5. Record the time taken of the Agrabathi to completely burn

Precise details about the randomisation procedure will be discussed in [Link to the relevant section](#).

To reduce variance in the experiment due to external factors several steps will be taken to ensure that the experimental conditions will be kept consistent:

1. The Agrabathi will be burnt in the same area to prevent confounding due to location
2. The Agrabathi will be sheltered from wind and sunlight to prevent confounding due to increased airflow over the flaming tip and increased energy due to the sunlight
3. The blocks will be burnt at 10 minute intervals from each other to reduce confounding due to time. The interval is given to allow for the experimenters to set up and light the Agrabathi. This also allows for the majority of the Agrabathi in each group to burn concurrently to further reduce confounding due to time as well as increase the efficiency of the experiment

The response variable is the time taken for the Agrabathi to burn given in seconds. The measurement of this was achieved via online stopwatch websites and the data was then manually transcribed.

## 5 Pilot study

The pilot study was run with 18 experimental units and blocks were replicated twice.

Several difficulties were experienced while conducting the pilot study. Due to the large volume of smoke produced by the Agrabathi as it burnt, the experiment had to be conducted outdoors. This made it difficult to control for environmental factors such as wind, humidity, and sunlight. Additionally it was difficult to determine exactly when the Agrabathi stopped burning and thus there are slight non-systematic errors in the measurements of the burn times due to experimental error.

The original data is provided in the appendix. A basic descriptive analysis was conducted to analyse the data:

Table 1: Basic descriptive statistics

	Median	Mean	SD
Control	2243.44	1951.10	549.10
Coconut Oil	2780.95	2642.46	390.76
Castor Oil	2835.09	2712.11	321.78

The grand mean is 2435.23 and grand sample standard deviation is 537.57. From Table 1, one notes some differences in the means across the three treatments. The control group shows the lowest mean burn time but displays the highest standard deviation out of all the treatments. This may be due to the heterogeneity of experimental units. The oil treatments show smaller standard deviations which may be indicative of a treatment effect. Additionally all three treatments display a positive skew. [Check the skew dir](#) These insights suggest a need for more data to test for significant effects.

## 6 Model and outline of analysis

This study will employ the following model for the data:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$$

Where  $\varepsilon \sim N(0, \sigma^2)$  is the error term,  $1 \leq i \leq 3$  indexes the treatments,  $1 \leq j \leq 3$  indexes the blocks. Additionally we employ the corner point constraint such that  $\alpha_1 = 0$ .

## 7 Randomisation

Randomisation took place within each block of 3 experimental units (EUs). The procedure was as follows:

1. Label the EUs 1-3
2. Generate three random numbers between 1 and 1000 and iteratively assign them to the EUs (first generated number to EU 1, etc.)
3. Sort the random numbers in ascending order
4. Assign the treatments to the EUs using this ordered list, i.e., the EU corresponding to the lowest random number will be assigned the control treatment of no oil, the second number will get the coconut oil treatment and the largest number will get the castor oil treatment
5. Repeat 1-4 for all three blocks
6. Repeat 1-5 for every replication of the experiment

A sample randomisation for a singly replicated experiment is given below:

Table 2: Sample Randomisation

	1	2	3
Hem	B	C	A
Malarani	C	B	A
Tulasi	B	A	C

Where A,B, and C correspond to the treatment of no oil, coconut oil and castor oil respectively.

## 8 The actual experiment and data

see appendix clean and set up dfs

## 9 ANOVA

dhiya DO from here down on friday 12pm M202

## 10 Contrasts

bonferrini corrections keeran

## 11 Interpretation

both

## 12 Conclusion

both

## 13 Appendix