**Factorial Experiment Design Exercise**

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Working in self-selected groups of four, you are to determine the main effects, and interaction effect, of air-flow rate and heater temperature on the quality of air-popped popcorn. You may use any appropriate measure of popcorn quality that you want. Examples could include counting the number of unpopped kernals, a subjective measure of quality, weight, etc.

In this experiment you will investigate a PRESTO hot air popcorn machine. A centrifugal fan driven by a DC motor blows ambient air across two heating coils. The heated air enters a metal canister which contains the unpopped kernels. Depending on the air temperature and the air flow rate, the kernels will take different lengths of time to pop.

To independently control the heating and air flow rate, the electrical circuit of the popcorn machine has been modified. The heating coil has been connected to a variable transformer. This provides control over the amount of heat added. A variable current DC power supply is connected to the fan motor. This provides control over the air flow rate.

Two effective performance indices for popcorn machines have been suggested by. The first is known as the "popping time". The popping time is calculated as follows,

Popping Time = 1/2 \* (time elapsed until first corn pops +

time elapsed until last corn pops)

Different air temperatures and air flow rates will result in different popping times.

The second performance index will be referred to as the “popcorn quality rating”. Your team will document your measure for quality, and collect data for quality.

|  |  |
| --- | --- |
| **Apparatus:**   1. Timer 2. Measuring Graduated Cylinder 3. Variable Transformer 4. Variable Current DC power supply 5. Bowl, 1 liter 6. PRESTO corn popper (Model#0482005) | **Material:**  Popcorn |

**Procedure:**

**Note: Always make sure the fan is running (DC Power Supply) before and after turning on the heating element (Variable Transformer).**

1. Connect the banana plug to the DC power supply, and the three‑pin plug to the variable transformer.
2. Turn the DC power supply on and set current to 0.9A.
3. Measure 20ml of kernels and pour into the corn popper.
4. Set the variable transformer at 100%.
5. Turn on the transformer and start the timer.
6. Record the time taken for the first pop and the last pop to occur. In addition, write down your observations.
7. Turn off the heater when the popping has stop or when the corns start to burn. Empty the popcorn from the popper immediately. Allow the blower to run to cool of the popper for at least 1 minute before starting the next experiment.
8. Save some popped corns for quality comparison at the end of all four experiments.

**Data Table for Popping Time**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Experiment* | *Heater Power (A)* | *Air Flow*  *Rate (B)* | *Rep*  *I* | *Rep*  *II* | *Rep*  *III* | *Rep*  *IV* |
| 1 | 115V | 0.9A |  |  |  |  |
| 2 | 75V | 0.9A |  |  |  |  |
| 3 | 115V | 0.75A |  |  |  |  |
| 4 | 75V | 0.75A |  |  |  |  |

**Describe your measure of popcorn quality:**

**Data Table for Quality**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Experiment* | *Heater Power (A)* | *Air Flow*  *Rate (B)* | *Rep*  *I* | *Rep*  *II* | *Rep*  *III* | *Rep*  *IV* |
| 1 | 115V | 0.9A |  |  |  |  |
| 2 | 75V | 0.9A |  |  |  |  |
| 3 | 115V | 0.75A |  |  |  |  |
| 4 | 75V | 0.75A |  |  |  |  |

**Analysis**

1. Compute mean effects A, B, and interaction effect AB.
2. Compute the averages.
3. Compute the mean square variances *MSA, MSB, MSE*, and *MSAB*.
4. Accept or reject the conclusion that *MSA/MSE, MSB/MSE,* and *MSAB/MSE* are due to statistical anomaly at a probability level of less than 5%.