

---

# Design of Experiments

## Beer tasting

---

**Lund University**

Hansson Reuter, Malin  
Wiskman, Malin

May 24, 2016

FMS072

# Contents

<b>1</b>	<b>Introduction</b>	<b>2</b>
<b>2</b>	<b>Method</b>	<b>2</b>
2.1	Hypothesis and assumptions . . . . .	2
2.2	Design of experiment . . . . .	2
2.3	Calculations . . . . .	2
<b>3</b>	<b>Results</b>	<b>3</b>
<b>4</b>	<b>Discussion</b>	<b>3</b>
<b>5</b>	<b>Conclusion</b>	<b>4</b>
<b>6</b>	<b>Appendix</b>	<b>4</b>

# 1 Introduction

Good taste and quality is thoroughly believed to be connected when it comes to many different areas in our everyday life. Not the least when it comes to food and beverages, where there are many recommendations for under what circumstances the best experience is achieved. In student life the concept of quality is sometimes overseen because of a somewhat tight budget and maybe a nonchalant approach. However, is this actually a problem? Could it be that a more expensive, and thus higher quality beverage is perceived more tasty than a less expensive one? During this project an experiment was designed to be able to say if a more expensive, cold beverage is perceived better than an inexpensive beverage served at room temperature.

## 2 Method

The data was treated in R Studio for the factorial design and in MatLab for the t-test.

### 2.1 Hypothesis and assumptions

The aim of the study was to test the hypothesis: "The most expensive, cold beer is perceived the as the best one". To be able to answer this hypothesis a factorial ANOVA was used, as well as a t-test for each pair brand-temperature.

For the factorial ANOVA two levels and three factors were examined; warm/cold (temperature) and three different brands of beer. The factorial ANOVA works with three null hypothesis

- $H_{01}$ : Main effect "brand" is not significant
- $H_{02}$ : Main effect "temperature" is not significant
- $H_{03}$ : interaction effect is not present

The theory is based on the assumptions of normality, independence and equality of variance.

### 2.2 Design of experiment

The experiment was designed in the settings of a beer tasting. Three different beers were tasted; Mariestads Export, Pistonhead Lager and Nils Oscar India Pale Ale. Each beer was also tasted at two temperatures; fridge cold (5°C) and room temperature (21°C). The test group was made up of 12 volunteers around 25 years old. Each person was given 6 cups marked with a letter ranging from A to F on each cup, where the different brands and temperatures had been randomized in MatLab.

The test group was asked to rank the 6 cups amongst themselves between 1 and 6, where 6 was perceived the best. This was done with respect to appearance, aroma, taste and overall opinion. They were also asked to state if they were male, female or no answer and if they would pay extra for a better beer. The test sheet can be found in the Appendix. The test sheet was knowingly designed to hold more data than might be needed, as the hypothesis was not fully formed at the time of the tasting.

### 2.3 Calculations

The factorial design theory was used to see if there was any significant difference between the overall opinion of the six sample beverages.

For the calculations the beers were labeled A to F accordingly and the averages were calculated in Excel. These can be seen in the Appendix.

Table 1: Denotations of the beverages used in the test.

A	B	C	D	E	F
Mariestads, warm	Mariestads, cold	Pistonhead, warm	Pistonhead, cold	Nils Oscar, warm	Nils Oscar, cold

### 3 Results

The result of the factorial design is presented in *Table 2*. It showed that there was no significant difference between the perceived overall opinions of the different beverages. This indicates that the variance in the results is more dependent on the subjective opinion of the test person, rather than on the variance between the overall opinions of the different beers.

Table 2: Summary of ANOVA-analysis of the overall opinion of the beers. The data was run as a two-way factorial design test, as described in *Method*.

	Degrees of freedom	Sum of squares	Mean square	F-dist. value	P-value
brand	2	1.08	0.542	0.178	0.837
temp	1	0.06	0.056	0.018	0.893
brand:temp	2	8.53	4.264	1.405	0.253
Residuals	66	200.33	3.035		

The result of the t-test is presented in *Table 3*. It shows that there was a perceived difference between the taste of the cold beverage and the warm beverage in the case of type A/B; Mariestads Lager, but not in the other cases. Type C/D; Pistonhead showed no significant difference and in the case of type E/F; Nils Oscar IPA the warm beverage was perceived tastier.

Table 3: Summary of results: t-test warm/cold

Type of beverage	Confidence interval, 5%
Mariestads Export, lager	[0.1684 1.6650]
Pistonhead, lager	[-1.5716 0.5716]
Nils Oscar, India Pale Ale	[-1.0998 -0.0669]

### 4 Discussion

The factorial ANOVA showed that neither of the null hypothesis could be rejected and thus nothing could really be said about the test. This could be because of many different factors apart from the fact that the temperature and brand actually did not prove to generate any difference in opinion. For example, many people in the test group thought it was hard to make out a difference between the samples. This could be due to that the temperature difference might not have been as remarkable as wished. The grading might also have been done wrong as some test persons were confused about this.

For further testing it would be good to maybe have a more controlled tasting. It would also be good to try a more expensive beer against a much less expensive beer of the same type (lager, ale ect.).

The t-test showed that the colder beer in the Mariestad case was perceived better, but as this was not the case for the other beers the conclusion could not be made that the beers in general is perceived better at a colder temperature.

## 5 Conclusion

The factorial design ANOVA showed that none of the null hypothesis could be rejected, thus it could no be concluded anything about if the brand or temperature had any influence of the taste. The interaction between the two factors could also not be concluded "not present". The t-test showed however that Mariestad was perceived better at a colder temperature.

## 6 Appendix

Table 4: Averages for taste and overall opinion

	A	B	C	D	E	F
Overall opinion, treatment average	2.92	3.83	3.92	3.42	3.75	3.17
Taste, treatment average	3.5	4.08	3.83	3.58	3.17	2.83
Grand average	3.5	3.5	3.5	3.5	3.5	3.5