Examination of the Filtering Process of Homemade Ginger Liqueur to Reduce the Appearance of Particulates in the Final Product

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Sample Report

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Introduction

Homemade liqueurs can look and taste just as good or better than those commercially produced; however, one issue frequently encountered by this home-producer is the appearance of particulate matter upon refrigeration even after passing the final product through a coffee filter.

The particulate matter either settles on the bottom of the jar or forms what looks like a faint cloud that usually disappears when brought to room temperature. The particulates are thought to be either fine sediment from organic matter used during infusion or a protein. Mold has been ruled out in all but one case, when mold growth was strikingly obvious (visually and aromatically).

The process to make the liqueurs involves two main steps: infusion and sweetening. First, the selected fruit, herb, or spice is left to infuse a quantity of alcohol. The alcohol could be any spirit, but this home-producer typically uses vodka or grain alcohol. After days or weeks, the infusion is filtered through a mesh strainer and/or cheesecloth. Lastly, simple syrup is added to the desired sweetness.

The liqueurs are sometimes filtered once or twice at different steps using coffee filters. Even with this filtration, particulates appear most often when the liqueur is refrigerated. This report details a screening design of experiments, which was performed as a first step to optimize the filtering process and reduce particulates seen in the final product.

Purpose of Experiments

This experiment was performed to determine how the filtering process of homemade liqueur affects the removal of impurities.

Materials and Equipment

Everclear grain alcohol, 190 proof
Fresh ginger
Granulated sugar
Water
Brand 1 coffee filters
Brand 2 coffee filters
Scale
Mason jars
Funnels

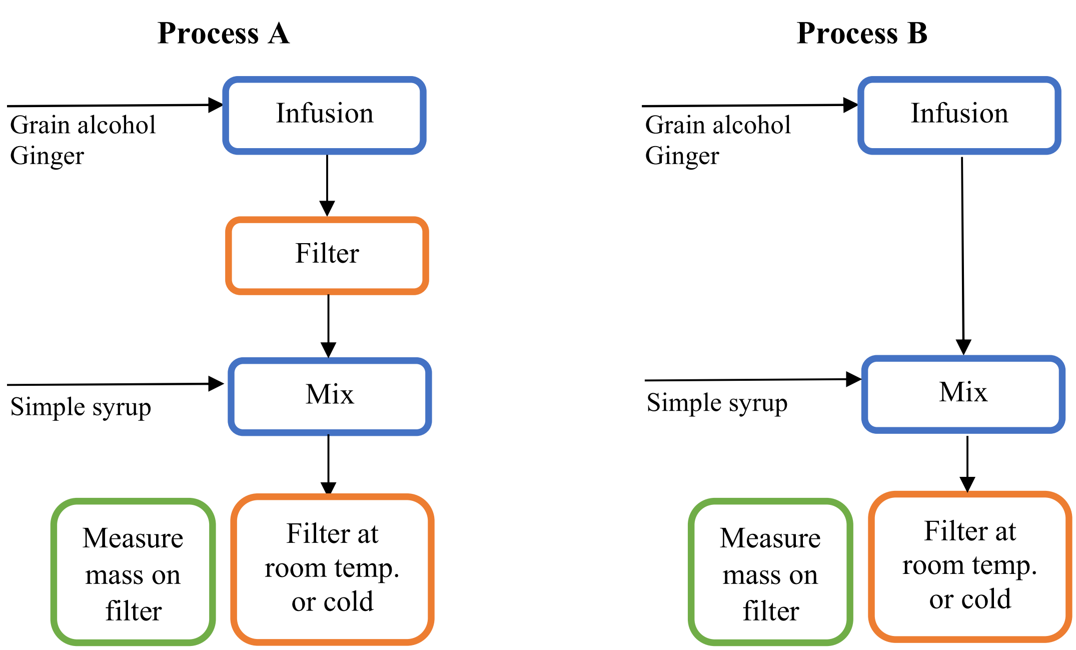
Methods

Preparation of the ginger liqueur followed the method described on Everclear's website. 60 g of peeled and chopped ginger was added to 2 cups of grain alcohol in a mason jar and covered with a screw-top lid. The mixture was inverted several times once a day for 10 days.

To prepare the simple syrup, equal parts granulated sugar and water were heated until the sugar dissolved. The solution was cooled to room temperature before use.

Two filtering processes were studied. Process A has a filtering step before the addition of simple syrup that occurs at room temperature. A second filtering step is performed either at room temperature or after the solution has chilled in the refrigerator. Process B does not include a filtering step before the addition of simple syrup, but the final filtering step is performed as in Process A.

Figure 1 Processes Studied in Experiment



Filters were weighed before use and after drying to determine the mass of solids collected. Yield was calculated based on the theoretical yield of the process.

Experimental Design

A 2^3 randomized full factorial design was created using JMP® 15. Table 1 summarizes the three factors, Table 2 summarizes the response variables, and Table 3 describes the full design including the replicate runs.

Table 1 **Description of Factors**

Factor	Description	Code
Process (A)	**Process A** Filter step included before addition of simple syrup	-
	Process B No filter step before addition of simple syrup	+
Type of filter (B)	**Brand 1** coffee filter (white)	-
	Brand 2 coffee filter (brown)	+
Filtering temperature (C)	Final filtration of **refrigerated** liqueur (~40°F)	-
	Final filtration of **room temperature** liqueur (~68°F)	+

Table 2 **Description of Response Variables**

Response	Description
Mass on filter	Record the mass gain on the dried filter
Yield	Calculate the % yield at the end of the process

Table 3 **2^3 Design with One Replicate**

Run	Label	A	B	C
1	*a*	+	-	-
2	*bc*	-	+	+
3	*(1)*	-	-	-
4	*abc*	+	+	+
5	*ab*	+	+	-
6	*c*	-	-	+
7	*(1)*	-	-	-
8	*ac*	+	-	+
9	*b*	-	+	-
10	*c*	-	-	+
11	*ab*	+	+	-
12	*bc*	-	+	+
13	*a*	+	-	-
14	*abc*	+	+	+
15	*ac*	+	-	+
16	*b*	-	+	-

Results

Table 4 summarizes the mass on filter and yield results obtained for each run.

Table 4 Results of Experiment

Run	Label	A	B	C	Mass on Filter (mg)	Yield (%)
1	*a*	+	-	-	0.63	94.3
2	*bc*	-	+	+	1.06	94.2
3	*(1)*	-	-	-	0.63	96.0
4	*abc*	+	+	+	0.87	97.5
5	*ab*	+	+	-	1.41	95.2
6	*c*	-	-	+	0.48	96.8
7	*(1)*	-	-	-	0.40	96.7
8	*ac*	+	-	+	0.51	98.3
9	*b*	-	+	-	1.54	92.8
10	*c*	-	-	+	0.30	95.8
11	*ab*	+	+	-	1.31	94.3
12	*bc*	-	+	+	1.40	95.1
13	*a*	+	-	-	0.42	95.2
14	*abc*	+	+	+	0.68	99.1
15	*ac*	+	-	+	0.80	97.5
16	*b*	-	+	-	1.20	91.7

Analysis of Mass on Filter

ANOVA

A statistical analysis was performed in JMP using a standard least squares analysis, and p-values are given in Table 5.

Table 5 Effect Summary for Mass on Filter Response

Response	p-value
Temperature	**0.0085**
Filter type	**< 0.0001**
Process	0.5823
Temp. * Filter type	**0.0299**
Temp. * Process	0.4711
Filter type * Process	0.2276
Temp. * Filter type * Process	0.4711
Model	**0.0001**

The p-values for temperature, filter type, and the interaction between temperature and filter type are < 0.05 and considered significant. The p-value for the entire analysis is 0.0001 and suggests significance of the model.

Analysis of Yield

ANOVA

A statistical analysis was performed in JMP using a standard least squares analysis, and p-values are given in Table 6.

Table 6 Effect Summary for Yield Response

Source of Variation	p-value
Temperature	**0.0002**
Filter type	**0.006**
Process	**0.0028**
Temp. * Filter type	0.0837
Temp. * Process	**0.0167**
Filter type * Process	**0.0028**
Temp. * Filter type * Process	0.1932
Model	**0.0005**

The p-values for temperature, filter type, process, and the interactions between temperature and process and filter and process are < 0.05 and considered significant. The p-value for the entire analysis is 0.0005 and suggests significance of the model.

Discussion of Effects

Figure 2 shows the interaction plots for the mass on filter response. The effect of temperature trends the same for each filter: the colder temperature leads to more mass on the filter for each filter type. The brown filter collected more mass at each temperature. The brown filter performed better but was more affected by temperature.

Figure 2 Interaction Plots for Mass on Filter

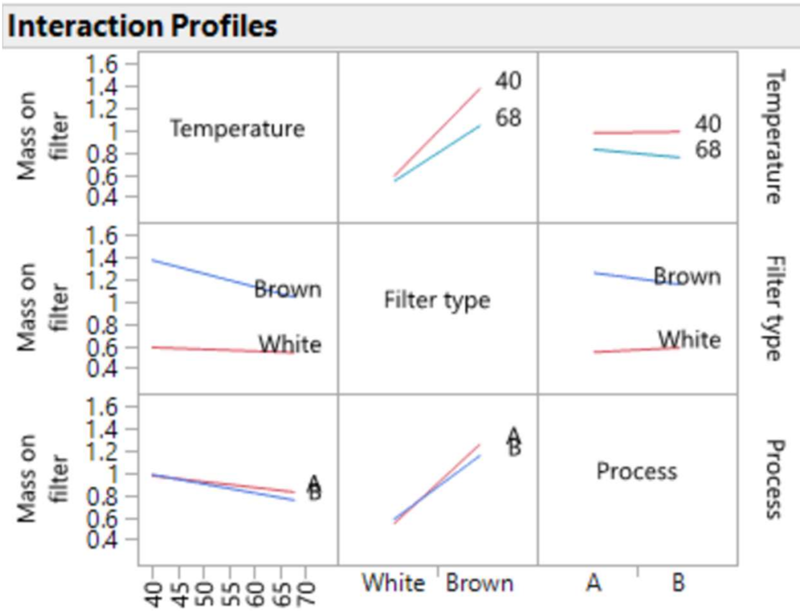
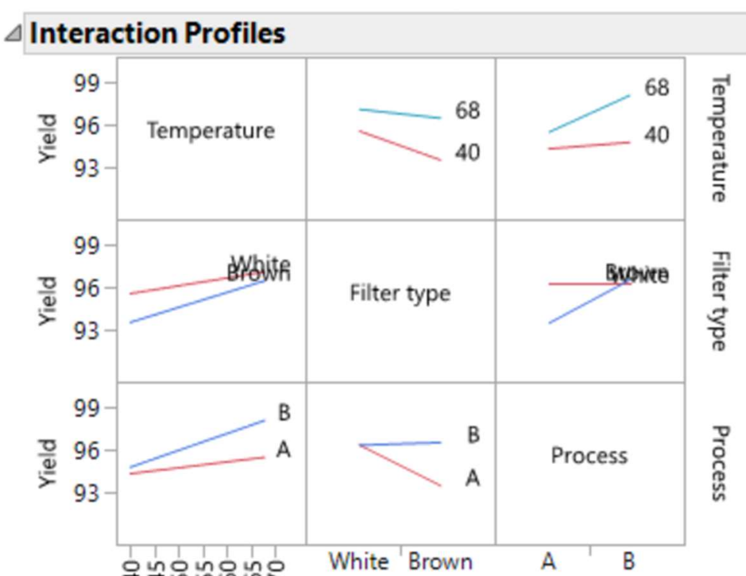


Figure 3 shows the interaction plots for the yield response. Each factor was found to have a significant effect on this response. Yield was higher at the higher temperature, which is expected because yield is calculated based on mass. More mass was collected on the filters at the cold temperature, leading to a lower yield. Though a higher yield seems preferable, part of the mass may include impurities that were in solution at a higher temperature. Similarly, yield was typically higher using the white filter, which may collect fewer impurities. Process B was favorable to a higher yield probably because there was one less filtration step than Process A.

Figure 3 Interaction Plots for Yield



Conclusions

Visible particulates were only observed in Run 6 after one day of refrigerated storage. Particulates have been known to appear even after one day, so more observations are required. The results of the statistical analysis support the use of brown filters and filtering at cold temperatures to increase the amount of solids collected from the liqueur. To increase yield, white filters, room temperature filtering, and Process B are preferred. The identity of the mass collected on the filter was not determined, though it was assumed to be impurities. Future studies should include the identification of the substances collected on the filter and an impurity profile of the final liqueur to truly determine the ideal processing conditions.