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Characterization of difference between the aroma profiles of beer brewed from sorghum and barley malt

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Introduction:

Coeliac disease is characterized by gluten-intolerance and affects about 1-2% of the general population in Western countries.[1] Providing safe foods for coeliac patients is one of the motivations behind the recent influx of gluten-free foodstuff variety and research. Sorghum–based beer is the most widely produced gluten-free alcoholic beverage, but the aroma profile of sorghum-based beer has yet to be fully studied. An initial analytical comparison was made between similar beers brewed from either barley malt or sorghum malt to identify the chemical differences between the aroma profiles of gluten free and gluten-containing beer. The analysis of the beer was based on the optimized conditions described by Saison *et al.* using solid phase microextraction (SPME) followed by gas chromatography with mass spectra detection (GCMS).[2] These initial comparisons can help identify a framework for the chemical differences in the two beverages. The identification of these differences will guide follow-up studies.

Brewing:

Maillard Malts® Sorghum Extract Syrup, Maillard Malts® Amber Malt Extract Syrup, and Safale US-05 Ale Dry Yeast were used.
The Malt Extract Syrup was added to approximately 3 gallons of water and boiled for an hour.
Wort was cooled, then diluted with DI water to a volume of 5 gallons.
Three 3 L aliquots were removed to serve as three aliquots of the original. These samples were sealed with an airlock
*S*afale US-05 Ale Dry Yeast was added to each of the aliquots.
Aliquots were maintained at room temperature during fermentation.
Samples of each aliquot were taken periodically and gravity measured.

Barley vs Sorghum Comparison

Table 1: Example compounds present in the aroma profiles of both sorghum-based and barley-based beer but at different amounts. The amount is represented relative to the internal standard.

Retention time (min)	Compound	Barley	Sorghum
2.8	1-Propanol, 2-methyl-	0.287	1.021
4.8	Propanoic acid, 2-methyl-, ethyl ester	0.108	0.015
4.876	Butanoic acid, ethyl ester	1.710	0.535
7.4	1-Butanol, 3-methyl-, acetate	3.038	1.38
7.732	Styrene	2.275	0.269
10.9	Hexanoic acid, ethyl ester	2.73	1.035
17.842	Octanoic acid, ethyl ester	25.189	3.127
19.884	Acetic acid, 2-phenylethyl ester	1.216	0.068
24.489	4-Decenoic acid, ethyl ester, (Z)-	2.704	0.039
24.784	Decanoic acid, ethyl ester	27.941	0.776
30.35	4-Decenoic acid, ethyl ester, (Z)-	2.740	0.000
31.149	Ethyl tridecanoate	5.935	0.084

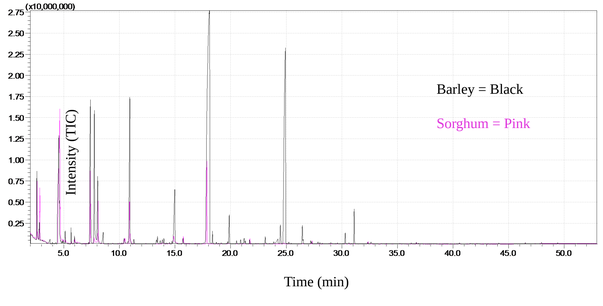

Figure 1: Total Ion Spectra of the aroma profile from barley (black) and Sorghum (pink) beer samples on Day 12.

Barley and Sorghum Differences

Table 2: Example compounds present in the aroma profiles of only the sorghum-based beer or only the barley-based beer.

Sorghum		Barley	
Retention time (min)	Compound Name	Retention time (min)	Compound Name
8.2	Phenol, 4-ethyl-		
		8.6	Oxime-, methoxy-phenyl-_
		11.3	Acetic acid, hexyl ester
		14.8	Phenylethyl Alcohol
		19.8	Acetic acid, 2-phenylethyl ester
		24.5	Ethyl 9-decenoate
		24.8	Decanoic acid, ethyl ester

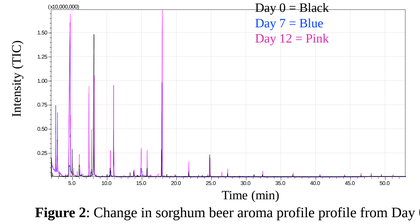

Figure 2: Change in sorghum beer aroma profile profile from Day 0 (black) to Day 7 (blue) to Day 12 (Pink).

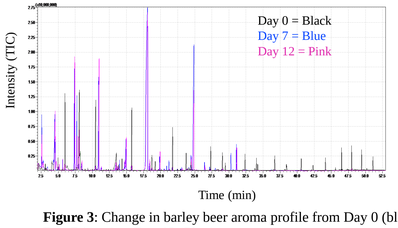

Figure 3: Change in barley beer aroma profile from Day 0 (black) to Day 7 (blue) to Day 12 (Pink).

Beer Analysis

From each aliquot, a 10 mL of beer was taken and placed into a 20 mL headspace sample vial.
To this sample 3 g NaCl and 50 µL internal standard (200 mg/L 2-heptanol) were added
The sample was thermally conditioned at 35 ˚C for 10 minutes then a 50/30 DVB/CAR/PDMS Stableflex fiber was exposed to the headspace for 30 minutes with agitation at 250 RPM.
Fibers were thermally desorbed into in a Shimadzu QP 2010 SE GCMS. Analysis conditions are described in Table 1.
Samples were taken and analyzed periodically over a two-week span.

Table 1: General operating conditions for the GCMS analysis of beer samples. Conditions are based on optimized conditions described by Saison *et al.*[2]

Initial Column Temperature (˚C):	25	Flow Rate (L/min)	1.5
Final Column Temperature (˚C):	300	Column Type	Rtx-5MS
Injector Temperature (˚C):	250	Column Length (m):	30
Injection Mode	Splitless	Column Thickness (µm)	0.25
Detector Range (*m/z*)	25 - 280	Column Diameter (mm)	0.25

Disscussion

The chemical profiles of both the sorghum-based and barley-based beer changed over time.
There are distinct differences between aroma profiles of sorghum and barley aroma profiles after fermentation.
There are distinct differences in both the concentration and actual identity of aroma profile components

References:
1.Hager, A., Taylor, J.P., Waters, D.M., and Arendt, E.K. Gluten free beer – A review. *Trends in Food Science and Technology*. 2014, 36, 44-54.
2.Saison, D., De Schutter, D. P., Delvaux, F., and Delvaux, F. R. Optimisation of a complete method for the analysis of volatiles involved in the flavor stability of beer by solid-phase microextraction in combination with gas chromatography and mass spectrometry. *Journal of Chromatography A*. 2008, 1190, 342-349.