Variations in flavour stability in lager beers

Raymond K. Boccorh[1] and Alistair Paterson[2]

[1]School of Management Studies, University of Surrey, Guildford, Surrey, GU2 7XH, UK
[2]Centre for Food Quality, Department of Bioscience and Biotechnology, University of Strathclyde, 204 George Street, Glasgow, G1 1XW, Scotland UK

Introduction

Time related flavour changes in beer have received wide attention in brewing research in recent years, and various analytical strategies have identified several mechanisms and flavour components, that contribute to flavour stability. Stability in beer is, however, difficult to define since there are ongoing changes (Table 1) in levels of causative components. Such components will also vary depending on beer type, brand and staling levels.

A number of mechanisms have been proposed for formation of stale flavour, including Strecker degradation of amino acids; oxidation of alcohols to aldehydes; lipid oxidation; enzyme degradation of lipids and aldol condesantion of aldehydes. Lipid oxidation is widely accepted as the dominant mechanism, although others may contribute, to various extents, over the wide range of beer available styles.

Stale beer is mostly dominated by *cardboard* and *papery* notes, conferred by unsaturated long chain carbonyl compounds, most with flavour thresholds of less than 1.0 $\mu g\ L^{-1}$. Trans-2-nonenal (threshold: 0.1 $\mu g\ L^{-1}$), together with other related compounds contributes significantly to stale character. Other aldehydes: 2-furfuryl ethyl ether, nonadienal, decadienal, and undecadienal have been reported at above-threshold levels in stored beer, and may be implicated in staling.

Dimethyl sulphide (DMS) is another common component in lager beers. With a flavour threshold of 30 $\mu g\ L^{-1}$, and occurring in levels of up to 150 $\mu g\ L^{-1}$, changes in levels of this compound play a central role in flavour stability.

The aim of this study was to investigate variations in flavour stability in a range of commercially available lager beers.

Methodology

A range of lager beers were assessed for aroma and taste attributes (Table 2), by 21 trained panellists employing Quantitative Descriptive Analysis. Test samples were five lager beers obtained from the UK market. For each test lager, five samples were collected from 3 different locations to ensure randomisation. Ten reference beers, selected on the basis of large variations in sensory character, comprising: *Urquell Pilsner*; *Heineken*; *Hell Banska Stiavnica*; *Haake Beck*; *Amstel Bier*; *Holstein Pils*; *Asahi* (*Super Dry*); *Becks Bier*, *Stella Artois*; and *Budweiser*, were similarly sampled.

Test lager beers were assessed in three batches: 4 weeks prior to best-before date; on best-before date; 4 weeks after best-before date. Reference beers were purchased and assessed (well within best-before dates) alongside each batch of test beers.

Sample presentation was in a balanced incomplete block fashion; and lagers were assessed in duplicate under purple light to reduce order, and colour effects respectively. Data was logged using the PSA-System (Oliemans, Punter & Partners, Burgemeester Reigerstraat 89, 3508 SG Utrecht, The Netherlands), and subjected to principal components analysis and ANOVA.

Results and discussion

The most important source of variation in the data was differences in *DMS* on PC1 (58% variance), with test and most reference lagers being distinctly different. Reference lagers mostly differentiated included Hell Banska, Holstein Pils, Haake Beck, Urquell Pils and Becks Bier, perceived to have *DMS*, *malty*, *worty*, *grainy,* and *kettle-hop* character. Test lagers were perceived to be *estery*, *fruity*, *alcoholic* and *floral*; as well as *sulphury*, *sulphitic*, *spicy*, *oxidised /harsh* taste and *aldehydic* character. Heineken and Stella Artois and Amstel Bier were less differentiated from test lagers, and were describe as *estery*, *fruity*, *smooth*, *astringent* and *sweet*. ANOVA revealed variations in flavour characteristics between batches of individual reference beers were not significant ($p > 0.05$).

PC2 (31.4% variance) was important for variations in changes among test lagers with test lager B, in addition to Urquell Pils and Hell Banska differentiated from other samples.

Changes in test beers

Sensory characteristics of test lager A were comparatively constant during storage. Perceived changes in *DMS*, *cardboard*, *estery*, and *fruity* characters were not significant ($p > 0.05$).

Test beer B exhibited the largest drifts in flavour character with time. There were significant ($p < 0.05$) drifts towards increased *DMS*, and also increased *cardboard*, *aldehydic* and *sulphitic* character. Perceived increase in levels of *sweet*, *floral*, *light-struck* and reduction of *DMS* attributes from one sampling location was not significant ($p > 0.05$).

Significant ($p < 0.05$) changes were perceived on PC2, for test lager C, attributed to increases in levels of *fruity*, *floral*, *cardboard*, *aldehydic* and *sulphitic* attributes.

Test lagers D were initially perceived to be similar to Stella Artois and Amstel Bier (*estery*, *alcoholic*, *fruity*, *floral*, *sweet*). Storage changes were significant on PC1 due to perceived increases in *DMS*, and reductions in *fruity* and *floral* character on PC2 ($p < 0.05$).

Changes in test lager E beers indicated PC1 to be attributed to perceived decreases ($p < 0.05$) in *DMS* levels.

This study has revealed significant differences in flavour stability in lager beers. Variations during storage are often due to changes in perceived levels of staling attributes, *DMS* and other flavour active compounds.

Brewers often add sulphites to beer to slow staling aldehyde release, in efforts to control staling. Sulphites are also produced by yeast metabolism during fermentation. Such compounds are important in beer flavour stability because of the antioxidant properties of the resulting adjuncts formed from the combination of sulphites and carbonyl compounds. Differences in brewery practices, and levels of sulphites produced naturally by different strains of yeast, will thus be expected to contribute to variations in staling levels. Such variations will also be influenced by factors such as barley and hop varieties.

Similarly, levels of DMS are important in beer flavour, and has been reported to be formed at several stages of brewing. Levels of this compound will thus be expected to be influenced by brewing practices.

Table 1: Characteristics of stale beer.

Degree of staling.	Flavour characteristic**.**
Fresh	Clean flavour, dependent on beer style and brand characteristics.
Slightly stale beer.	Increased sweet, ribes and cardboard and papery notes; decreased bitterness; estery character.
Stale beer.	Increased bread-like character; decline in body.
Very stale beer.	Honey-like flavour.
Extremely stale beer.	Sherry-like.

Table 2: Flavour attributes assessed in lager beers.

Estery	Alcoholic	Burnt	Yeasty
Fruity	Spicy	Caramel-like	Soapy
Floral	Phenolic	Buttery (diacetyl)	Fatty
DMS	Kettle hop	Sour	Cardboard
Sweet	Grassy	Rancid	Oxidised
Bitter	Aldehydic	Sulphury	Light-struck
Smooth	Malty	Sulphitic	Metallic
Body	Grainy	Sulphidic	Astringent

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