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Primary gushing of over-carbonated beverages such as Belgian specialty beers

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Problem Statement

Gushing is a spontaneous and sudden over-pressure phenomenon occurring at the opening without any delay. While secondary gushing is due to technical and technological problems (crystals of calcium carbonate, filter aids...), primary gushing occurs when the weather conditions (high humidity and temperature) are favorable for fungal contamination.

It is assumed that primary gushing is provoked by fungal proteins called hydrophobins[5,6]. These are small amphiphilic and surface-active proteins that are able to adsorb at the hydrophilic-hydrophobic interface such as the air-water interface. From malt to finished beer the concentration of hydrophobins is 10⁴-fold reduced[5,6].

Production of hydrophobin HFBI (Trichoderma reesei) at MBS-KUL

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Theory of the primary gushing (Deckers et al., 2010; MBS-KUL) (Ref. 6) *

The carbon dioxide molecules at the interface will change their solubility. For a gas to be present, there is a critical diameter above which the gas bubbles will grow until they explode at the surface and under which they will shrink in size until their complete dissolution except in presence of a stabilizer.

Property of carbon dioxide

Carbon dioxide is a hydrophilic gas. For a gas, there is a critical diameter above which the gas bubbles will grow until they explode at the surface and under which they will shrink in size until their complete dissolution except in presence of a stabilizer.

Property of hydrophobic

Hydrophobins are surface-active and can self-assemble at the hydrophilic-hydrophobic interface[5,6]. While the self-assembly of Class I hydrophobins is insoluble (except in strong acid), the self-assembly of Class II hydrophobins are more easily soluble (60% ethanol, 2% SDS)[5,6]..

Model of the primary gushing

The carbon dioxide molecules at the interface will change their solubility. For a gas to be present, there is a critical diameter above which the gas bubbles will grow until they explode at the surface and under which they will shrink in size until their complete dissolution except in presence of a stabilizer.

Detection method

As suggested by Niner and Barme[7,8], particle-size measurement can be used to do a comparison between a gushing and a non-gushing beer. DLS is a technique used to determine the size of particles (hydrodynamic diameter). It measures the Brownian motion (random movement due to collisions with solvent molecules) and relates this to the size of particles. The larger (smaller) the particle, the slower (faster) the Brownian motion will be. The speed at which the particles are diffusing is determined by measuring the rate at which the intensity of the scattered light fluctuates when detected using a suitable optical arrangement. The small particles cause the intensity to fluctuate more rapidly than the large ones. A correlation is measured to design the degree of similarity between two signals, or one signal with itself at varying time intervals. If the particles are large the signal will be changing slowly and the correlation will persist for a long time. If the particles are small and moving quickly then correlation will return more quickly.

Opening of the bottle

As the opening the small hydrophobic molecules are at nanobombs. Due to the drop of pressure, the volume of nanobombs increases (Gay-Lussac’s Law), the hydrophobins film is destroyed and nucleation sites are formed causing gushing. After natural degassing at atmospheric pressure, carbon dioxide molecules contained by hydrophobins arrange together to form bubbles with critical diameter.

References


Acknowledgements

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Ligand

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Magnetic field

Preventive method

Curtative method

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