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P. S. HUGHES *and* E. D. BAXTER

BEER: QUALITY, SAFETY AND NUTRITIONAL ASPECTS

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BEER: QUALITY, SAFETY AND NUTRITIONAL ASPECTS

E. DENISE BAXTER

*Brewing Research International,
Lyttel Hall, Nutfield, Redhill, Surrey RH1 4HY, UK*

PAUL S. HUGHES

*Heineken Technical Services,
Burgemeester Smeetsweg 1, 2382 PH Zoeterwoude,
The Netherlands*

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Preface

Beer has been a popular beverage for thousands of years and brewing is often described as the oldest biotechnological process. Over the years the brewmaster's art has been supplemented by vast increases in our knowledge of the chemistry and biochemistry both of the ingredients and of the changes taking place to those ingredients during brewing. Together these contribute to give the products we recognise today – a wide range of different but consistently high quality beer types.

This book aims to explain the scientific principles which underpin those aspects of beer which are of the great interest to the beer drinker – namely its taste, appearance and nutritional qualities. This book is very much a synthesis of the current thinking as many aspects of beer quality are still tantalisingly elusive, so the story cannot be completed at the moment. . . .

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Glossary

α -Acids: The major constituent of the resin (humulones) in hop cones: α -acids are converted to bittering substances (iso- α -acids) during wort boiling.

Adjunct: Any source of fermentable extract other than malted barley used in the mash tun or the copper. May be solid, *e.g.* cereal grits, or liquid *e.g.* sugar syrup.

Air rest: An interruption of the steeping process to allow the barley to absorb oxygen from the air and thus to overcome water sensitivity and to ensure even germination.

Ale: Originally an unhopped but fermented malt drink, the term ale nowadays refers to any beer produced at temperatures of between 16 and 21 °C (most frequently around 18 °C) using a top-fermenting yeast (*Saccharomyces cerevisiae*).

Aleurone: The thick layer of living cells which surrounds the starchy endosperm in mature barley kernels.

Amylopectin: The second major constituent of barley starch, amylopectin is a large, highly branched molecule consisting of glucose units linked by α -1,4 and α -1,6 bonds.

Amylose: One of the two main components of barley starch. Amylose consists of a linear chain of glucose molecules linked by α -1,4 bonds.

Attenuation: The reduction in density of wort which occurs during fermentation as sugars are converted to alcohol.

Beer: In the UK, the legal definition of beer is for Excise purposes, and defines beer as any liquor made or sold as beer. The clearest technical definition describes beer as a fermented liquor produced mainly from malted barley but including other carbohydrate sources and flavoured with hops.

Cask: A large container for draught beer, originally made of wood, but now may also be made of aluminium. Traditionally, beer casks came in seven sizes: butt (108 gallons), puncheon (72 gallons), hogshead (54 gallons), barrel (36 gallons), kilderkin (18 gallons), firkin (9 gallons) and pin (4.5 gallons). *NB* 1 gallon = 4.54 litres.

Cold break: The precipitate formed when wort is cooled to room temperatures, consisting mainly of protein.

Copper: The vessel in which wort is boiled with hops to obtain the characteristic bitter flavours. So-called because it traditionally was made of copper, now often made of stainless steel. Also known as the kettle.

Crystal malt: Malt whose endosperm has been converted to a sugary crystalline mass during kilning. A proportion of crystal malt is added to the grist to provide colour and flavour to certain beers, particularly British ales.

Cylindroconical vessel: A cylindrical vertical tank with a conical base in which the yeast sediments after fermentation. Temperature is controlled by cooling-coils around the walls. Capacity ranges from 200 to 6000 hectolitres.

Embryo: The part of the barley kernel which gives rise to the new plant.

Endosperm: The part of the barley kernel other than the embryo. The endosperm consists essentially of a store of food for the new barley plant.

Finings: Charged colloidal substances, prepared from isinglass (collagen) from the swim bladders of certain tropical fish.

Flocculation: The clumping together of yeast cells at the end of fermentation. Also used to describe the clumping together of protein precipitated during wort boiling.

Germination: The sprouting of the resting barley seed to form new roots and shoots. The first visible sign is the cream-coloured 'chit' or first root emerging from the embryo end of the barley kernel.

Gibberellins: Natural plant hormones (phytohormones) produced by the barley embryo in response to steeping in water. Gibberellins stimulate the production of enzymes in the endosperm which hydrolyse the stored food reserves in the embryo and make them available to the growing plant.

Green beer: Freshly produced beer immediately after the end of primary fermentation and before conditioning (maturation).

Green malt: Barley germinated for between one and five days, before kilning, with a moisture content of at least 40%.

Grist: The term given to the mixture of coarsely ground malted barley, together with milled raw cereals and speciality malts (and barley) such as crystal malt or roast barley. Includes liquid adjuncts such as syrups. May also be applied to the mixture of hops and hop pellets added to the copper.

Hops: A perennial climbing vine, *Humulus lupulus*, a member of the family of *Cannabinaeae*. First recorded use to flavour beer was in Egypt, 600 years BC. The part traditionally used in brewing is the hop cone, which is the female ripened flower. In modern brewing, the hop cones are either extracted or finely powdered and compressed to form hop pellets which keep better and are easier to transport.

Hordein: The main component of barley protein. Closely related to similar proteins in wheat (gliadins), rye (secalins) and maize (zeins).

Hot break: Term given to the precipitate of protein which forms in boiled wort when it is cooled. Also called trub.

Husk: The outer, protective layers of the barley kernel, formed from the fruit and seed coats.

Isinglass: Collagen from the swim bladders of certain tropical fish, used as finings (*qv*) in beer to assist clarification.

Kettle: Another term, originally American, for the vessel in which wort is boiled. See also 'copper'.

Kilning: The final stage of malting in which the green malt is dried and cured by heating in a draught of warm air. The final temperature depends upon the type of malt being made.

Lager: A pale straw coloured beer produced from a lightly kilned malt and fermented by bottom-fermenting yeast (*Saccharomyces carlsbergensis*) at a low temperature (7–13 °C) and matured for several weeks.

Lautering: The process by which the sweet wort is separated from the spent grains, by drawing it off through the bed of spent grains.

Lauter tun: Vessel in which wort is separated from the spent grains by filtration through the spent grain bed. Generally a wide shallow vessel fitted with rakes to break up the bed.

Mashing: Process in which milled malt is mixed with hot water to extract cereal components, mainly starch. This starch is then converted to fermentable sugars by enzyme action.

Mash tun: The vessel in which mashing occurs. May also be called the 'conversion' vessel. In traditional ale brewing, the wort is also separated from the spent grains in the mash tun. However, in modern practice, it is more common to transfer the mash to a specific filtration vessel, the lauter tun (*qv*).

Original gravity (OG): This is the gravity of the wort prior to fermentation. In general, the higher the gravity, the more alcohol is produced, but there is no absolute correlation since worts may contain varying proportions of unfermentable material (such as protein). In addition, some types of beers retain some sugars that are potentially fermentable. The OG has often been the basis for calculating the excise duty payable, but nowadays the final alcohol content is more generally used.

Paraflo: A plate heat exchanger for cooling wort after boiling. Also used to cool beer before packaging.

Primings: Sugar added after the primary fermentation, particularly to traditional mild ales and sweet stouts, to add some sweetness. May also be added to cask ales to provide additional fermentable extract for secondary fermentation in the cask.