

PRODUCTION OF WHISKY USING SPECIALTY MALTS: APPLYING METHOD TO INDUSTRIAL SCALE DISTILLATION AND AGEING

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BACKGROUND

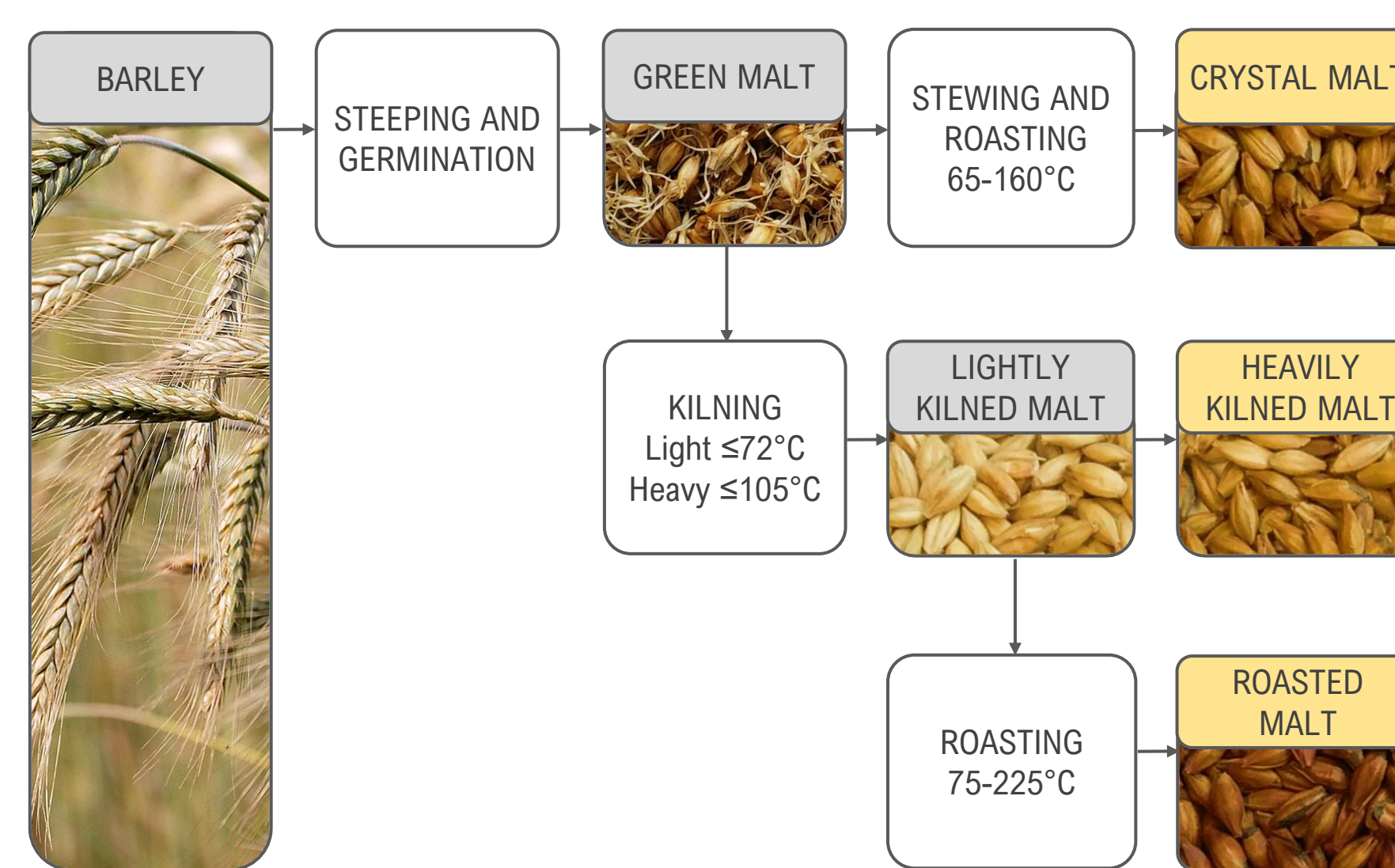
- Scotch whisky is an important sector of the Scottish economy. It adds £5.5bn/year gross value, supports >42 000 jobs in UK and accounts for 77% of all Scottish food and drink exports¹.
- There is a demand for Scotch whisky variety and flavour innovation. Recent studies have suggested that new aromas can be introduced to whisky spirit by using specialty malts².

OBJECTIVES

- Our aim was to investigate the distillation parameters and maturation characteristics of specialty malt derived spirits in a commercial distillery scale production.



DISTILLING VS. SPECIALTY MALTS



- Distilling malt is lightly kilned (65-70°C) and provides only subtle aromas to whisky.
- Specialty malts are produced by treating malt at higher temperatures (75-230°C), and are commonly used to brew beers with increased colour, flavour and mouthfeel (e.g. red ale, brown ale, stout, porter).
- Main aroma compounds in specialty malts are created in Maillard and caramelisation reactions during steeping and roasting.
- Specialty malt use in distilling has been neglected in scientific literature.

WHISKY PRODUCTION AT HOLYROOD DISTILLERY

MALT	Moisture	Colour
LIGHTLY KILNED Pot Still Neutral malt flavour	4.5%	4 EBC
HEAVILY KILNED Dark Munich Toast, malty, sweet	3.3%	45 EBC
CRYSTAL (STEWED) M Crystal 240 Caramel, spiced coffee, dark fruits	3.0%	235 EBC
ROASTED Amber Malty, biscuit, toast	1.7%	55 EBC
Brown Milky coffee, sweet pastries	1.5%	100 EBC
Chocolate Espresso, toasted nuts, black pepper	0.7%	917 EBC

MASHING
Starch is extracted from the malt and hydrolysed to fermentable sugars, producing sugary liquid - wort. Specialty malts were included at 18% w/w to the Pot Still malt grist bill. Mash size was 1250 kg. All samples were processed in triplicates.

FERMENTING
Fermentable sugars are metabolised by yeast (in presence of essential nitrogenous materials) to yield ethanol, CO₂ and flavour congeners. Dried yeast (2.5 kg DY502 + 2.5 kg DY379) was added to 5000 L of wort and fermented for 50-117 hours without temperature control.

DISTILLING (wash)
Fermented wort (wash) is distilled to separate alcohol from insoluble or unfermentable malt material, dissolved gases, yeast cells and non-volatile metabolites. Wash (5000 L, 8-9% ABV) was distilled until the distillate was running at 1-8% ABV.

DISTILLING (spirit)
Low wines are re-distilled to further concentrate ethanol and separate desirable flavour congeners. Low wines (2000 L, 29% ABV), heads and tails from previous run were distilled, foreshots were cut at 75 L, feints at 57% ABV.

MATURATION
Middle cut is collected and filled to charred oak barrels to develop spirit flavour and colour. New make spirit (~70% ABV) was diluted to 60 / 63.5 / 67% ABV, filled into 54x 200 L ex-bourbon casks, racked in 3 levels in a warehouse near Edinburgh.

OUR FINDINGS

WORT AND WASH QUALITY

Wort made from specialty malts was higher in colour, lower in free amino nitrogen and fermentable sugars. There were no significant differences in wash alcohol yield.

AROMA VOLATILES IN DISTILLATION FRACTIONS

Aroma molecules were concentrated in different fractions according to their volatility: esters in heads (still temperature = 84-85°C), higher alcohols in hearts (85-92°C; grey shaded area), while furans, pyrazines and phenols concentrations increased in tails (92-99°C).

There were no significant differences in ester and higher alcohol levels in spirit made from different malts.

Significantly higher levels of furans were detected in roasted malts, pyrazines in dry roasted malts, phenols in Chocolate malt.

AROMA VOLATILES DURING SPIRIT AGEING

Concentrations of most aroma volatiles in spirits increased with maturation in oak casks. Increase in higher alcohols and short esters was most rapid in the first three months of maturation, long chain esters continued to build up in the following months. Level of roasted aroma volatiles (furans, pyrazines and phenols) remained stable even after one year of maturation.

FILLING STRENGTH

Higher cask fill ABV resulted in higher spirit colour and higher alcohol losses. No significant differences in aroma volatiles were observed between different fill strengths during 12 months of maturation.

SPIRIT SENSORY ANALYSIS

Trained sensory panel (8 members) analysed nose, palate and finish of whisky new make spirit (NMS) and spirit aged for 6 months (6mo) in oak casks, samples were diluted to 20% ABV. Spirits made from Brown malt were perceived as significantly less fruity and more chocolate-like, while spirits from Chocolate malt were significantly less fruity and more coffee-like.

IMPACT TO THE INDUSTRY

Addition of specialty malts to whisky production provides a tool for distillers, seeking greater control over product aroma volatile composition. By selecting specialty malts according to their production methodology, new aromas (chocolate, coffee, smoky) can be introduced to whisky spirit with minimal losses of alcohol yield.

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