

Impact case study (REF3)

Institution: Heriot-Watt University		
Unit of Assessment: UoA8 Chemistry		
Title of case study: Library of Botanicals to Boost Worldwide Sales of Scottish Gin		
Period when the underpinning research was undertaken: 2013 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Annie Hill Matthew Pauley	Associate Professor Assistant Professor	Jan 2001 – present Feb 2015 – present
Period when the claimed impact occurred: 2014 – 2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact		
<p>The gin industry is booming, with Scotland leading the way in terms of innovative products. In 2019, UK exports of gin accounted for GBP672,000,000 taking total gin sales (UK and overseas) to over GBP3,200,000,000. Underpinning over a third of the 90 Scottish gin distilleries, is fundamental research on botanicals and distillation processes carried out at Heriot-Watt University's world-renowned International Centre for Brewing and Distilling (ICBD). Identification of commercially available botanicals that provide desired attributes in terms of flavour, mouthfeel and terroir has enabled distillers such as Edinburgh Gin and Highland Boundary to reduce product development time, find new marketing and export avenues and improve processes. This has led to significant reduction in costs in terms of staff time, raw materials sourcing and in process design, all of which has also helped reduce incidence of costly retro-fitting of equipment, product recall or reduction in sales potential.</p>		
2. Underpinning research		
<p>Fundamental research surrounding botanical behaviour during distillation, sensory impact and impact of scale-up from lab/bench top to commercial gin production began in earnest in 2010. This foundational research was prompted by a desire to assist and meet an industry need with robust methods to convert small-scale trials to full-scale production and to determine optimal production parameters for extraction of volatiles during distillation.</p> <p>Expanding on this base, and an understanding of the impact of botanical choice on the sensory characteristics of gin, a new phase of research into a Scottish Botanical Library began in 2014. This was enabled by the strategic appointment at HWU of Matthew Pauley in 2015 in addition to support by the Scottish Distillers Association with funding obtained via Interface (https://interface-online.org.uk/). This ongoing research involves single botanical distillation of plants to understand their behaviour during distillation, impact of distillation regimes, chemical and sensory footprint, and toxicity. This also includes research surrounding medicinal uses and a focus on plants native to Scotland to highlight the significance of raw materials available locally to Scottish distillers.</p>		

The funding from Interface facilitated close links with The Three Stills Distillery and enabled the publication of fundamental work on gin scale-up, the comparison of production processes, and on key gin botanicals (2017-2020). This work identified patterns in botanical extraction during vacuum distillation and in standard methods of vapour and steep infusion. The results have been used to develop a model that may be applied to predict extraction of specific flavour compounds from botanicals during gin production.

Further funding from The Gin Guild has also enabled fundamental research into the predominance of juniper in gin. Within current regulations, gin is defined as being “juniper predominant”. Our research in this area covers identification of marker compounds for juniper that may be used to define more specifically products that are perceived organoleptically as juniper predominant. This research will also enable authentication of gin products and has wider application within quality control of other distilled spirits.

3. References to the research

[3.1] Hodel, J, Burke, M & Hill, AE 2020, 'Influence of distillation parameters on the extraction of *Juniperus communis* L. in vapour infused gin', *Journal of the Institute of Brewing*, vol. 126, no. 2, pp. 184-193. <https://doi.org/10.1002/jib.607>

[3.2] Hodel, J, Pauley, M, Gorseling, MCJK & Hill, AE 2019, 'Quantitative Comparison of Volatiles in Vapor Infused Gin versus Steep Infused Gin Distillates', *Journal of the American Society of Brewing Chemists*, vol. 77, no. 3, pp. 149-156. <https://doi.org/10.1080/03610470.2019.1629263>

[3.3] Watson, DC & Hill, AE 2017, Spirits. in *Ullmann's Encyclopedia of Industrial Chemistry*. Wiley-VCH Verlag, pp. 1-17. https://doi.org/10.1002/14356007.a24_551.pub2

[3.4] Wilkinson, D, Huismann, M, Quinn, C, Postlethwaite, E, Macasso, E, Gowrie, D, Edmond, D, Sime, H, Hornbeck, D & Hill, AE 2018, 'Designing Gin: Conception to Commercial Production', *Proceedings of the 6th Worldwide Distilled Spirits Conference*, Glasgow, United Kingdom, pp. 137-140.

[3.5] Huisman, M, Quinn, C, Postlethwaite, E, Macasso, E, Wilkinson, D & Hill, AE 2018, 'Building a University Brand: creating new trends in distilling by University-industry collaboration', *Proceedings of the 6th Worldwide Distilled Spirits Conference*, Glasgow, United Kingdom, pp. 363-370.

[3.6] Pauley, M & Hill, AE 2018, 'Novel botanicals: an approach to building a botanical library', *Proceedings of the 6th Worldwide Distilled Spirits Conference*, Glasgow, United Kingdom, pp. 245-248.

[3.7] Pauley, M & Maskell, DL 2017, 'Mini-review: The role of *Saccharomyces cerevisiae* in the production of gin and vodka', *Beverages*, vol. 3, no. 1, 13. <https://doi.org/10.3390/beverages3010013>

4. Details of the impact

There are over 110 Scottish gins and over 90 distilleries currently producing gin within Scotland. The rise of gin has been rapid, with UK sales in 2010 around half those of Scotch Whisky. By 2018 both were worth about GBP1,200,000,000. In 2019, UK exports of gin accounted for GBP672,000,000 taking total gin sales (UK and overseas) to over GBP3,200,000,000.

Within Heriot-Watt's International Centre for Brewing and Distilling (ICBD), distilling research has been ongoing for over 30 years, with gin-specific projects increasing in number and scale. Since 2010 we have worked with over 20 Scottish distilleries on specific gin/botanical spirit product development. This includes Edinburgh Gin (formerly Spencerfield Spirits), The Three Stills Distillery, Isle of Harris Distillery, Lindores Abbey Distillery, Raasay Distillery, Pickering's Gin and Highland Boundary. Projects have also been completed with distilleries further afield including Durham Gin (England), Shortcross Gin (Northern Ireland) and Transylvanian Gin (Romania). The combined sales of the top seven companies we have worked with was over GBP120,000,000 in 2018-19.

ICBD research led to the creation of the Scottish Botanical Library (2014), a library of over 70 botanicals developed with funding through Interface and partner distilleries [5.1]. The use of local or novel botanicals has become a popular method to create gins with a unique selling point and several members of the Scottish Distillers Association, (SDA - previously called the Scottish Craft Distillers Association), have worked with the ICBD on new product development, experimenting with botanicals that may be sourced close to their distilling operations.

The recipe development process can be very complex, particularly when working with novel or large numbers of botanicals. To simplify the process, it is useful to distil individual botanicals to determine their flavour and aroma attributes to predict their contribution in the final recipe. The Scottish Botanicals Library was created to address this challenge and reduce the time and cost of recipe development and widening the possible options for botanical choice [5.2]. The library consists of plants that may be grown in Scotland and can be sourced in dried form in amounts suitable for large-scale commercial production of either gin or botanical spirits. Each botanical has been distilled individually, providing a collection of distillates for sensory analysis. The library has already been a valuable resource for projects with both new start companies and developing businesses, vastly reducing the time and cost of recipe development and widening the possible options for botanical choice and helping create new products.

A collaboration, supported by a Knowledge Transfer Partnership (KTP) in 2014, with Edinburgh Gin, initially enabled the company to produce the original premium Edinburgh Gin product in house in an artisanal distillery whilst transferring Heriot-Watt's knowledge of gin-making to the company. In addition, it facilitated the creation of new products and techniques, exploring new botanical ingredients and distillation methods. The KTP led to investment in a third still to meet increasing demand and an increase in annual sales turnover of [text removed for publication] [5.3], Edinburgh Gin's Head Distiller, said;

"Seaside Gin was the first of our collaborations in partnership with Heriot-Watt University's International Centre for Brewing and Distilling. Such has been the success and popularity of Seaside Gin, we have had to transfer production from the small 150 litre still to our larger 1000 litre still at our second site. We will now be producing 1300 bottles per distillation, with at least 4 distillations per month. Testament to the success of developing and using a fantastic botanicals library resource for the benefit of the industry in Scotland." [5.4]

ICBD also collaborated with Highland Boundary, a craft distillery who identified a gap in the market for Scandinavian-inspired spirits with the botanicals sourced from local woodlands. By combining botanicals from the Highlands with grain spirit from the South of Scotland the company crafted a new generation of Scottish spirits firmly rooted in the Scottish Landscape. The Director of Highland Boundary, said:

"By accessing the expertise at Heriot-Watt University we were able to try out different botanicals to produce new flavours of spirit with distinct Scottish flavours reflecting Perthshire's 'big tree country'. Now that we have launched our first product, Birch and Elderflower Wild Scottish Spirit, we want to build the company and create employment in an area where manufacturing jobs are few and far between." [5.5, 5.6]

Following on from the initial development of the Scottish Botanical Library ICBD researchers looked more closely at each botanical, firstly determining whether each is listed within the USA GRAS (Generally Recognised as Safe) list and also to identify any potentially toxic compounds that could be extracted by distillation with ethanol. The latter is necessary to ensure consumer safety and the former has been used to advise companies on botanical choice for products intended for export. The collaborative work with the Scottish botanical library led to the award for "Multiparty Collaboration" at the Scottish Knowledge Exchange Awards (SKEA) 2019 [5.7]. Dr Annie Hill was also runner up in the 2018 SKEA for 'Outstanding Contribution to Knowledge Exchange' based on gin research.

Expertise from ICBD led to Dr Annie Hill co-founding the Scottish Distillers Association in 2014 in collaboration with industry (Strathearn Distillery) and Interface Food & Drink. The association currently has over 30 distillery members and serves to assist in business development and networking. The association has been involved in co-funding research within Heriot-Watt for the benefit of its members. Benefits include reduced R&D time through use of the botanicals library and access to expertise within Heriot-Watt. In addition, Dr Hill is a member of the Scottish Cross-Party Group on Scotch Whisky which covers all distilling activities within Scotland. Representation on behalf of the gin industry is made within this group and subsequent government publications including the [Brewing and Distilling Scottish Government Report 2018](#).

5. Sources to corroborate the impact

[5.1] inews article, 'The science of gin: Scottish researchers create library of botanicals', 2018. <https://inews.co.uk/news/scotland/the-science-of-gin-scottish-researchers-create-library-of-botanicals-202069>

[5.2] BBC Scotland News, 'Botanical library to aid Scottish gin producers', September 2018 <https://www.facebook.com/watch/?v=671152623257471>

[5.3] Edinburgh Gin (formerly KTP Spencerfield Spirit), final KTP report – confidential.

[5.4] Head Distiller, Edinburgh Gin, can be contacted to confirm the development of new products and associated impacts.

[5.5] Director, Highland Boundary, can be contacted to confirm the impacts stated.

[5.6] Highlandboundary article '*Collaboration Key - Knowledge Exchange Awards*', 2019.
<https://www.highlandboundary.com/news/collaboration-key---knowledge-exchange-awards>

[5.7] Scottish botanical library led to the award for "Multiparty Collaboration" at the Scottish Knowledge Exchange Awards 2019, <https://interface-online.org.uk/news/winners-4th-scottish-knowledge-exchange-awards-announced>.