The origins of pure yeast culture

Production of beer using a single strain of yeast, as opposed to a mixed population, was first performed at the Gamle (Old) Carlsberg brewery in Copenhagen in November 1883. The instigator of this radical departure from custom and practice was Emil Christian Hansen (Figure 1), head of the Physiological Department at the Carlsberg Laboratory. Hansen’s original conception of the idea of pure yeast was that such cultures should be free from “disease yeast species”. It soon became apparent to him, however, that there were different strains of “good brewery yeast”, with different flocculating and attenuating characteristics, which gave beers of different character. The use of only one of these good yeasts i.e. “that best suited to the brewery in question” was the sense in which the term “pure” became adopted.

Hansen’s technique was to isolate a single yeast by serial dilution of liquid medium and grow up a culture from this. In November 1885 the first purpose built pure yeast culture plant designed by Hansen and Søren Anton van der Aa Kühle, technical manager of Gamle Carlsberg, was commissioned. Within a few years pure yeast cultures were being employed in breweries across the world. In his book Practical Studies in Fermentation published in English in 1896, Hansen lists 173 breweries in 23 countries which had installed the pure yeast culture apparatus (Figure 2). The majority of these breweries employed bottom fermentation, but installations were also recorded in nineteen top fermentation breweries in six countries, with a single use reported from England.

In addition to these plants, Alfred Jörgensen was by then supplying 66 other breweries with pure yeast from his laboratory in Copenhagen (Figure 3), the experimental station in Nuremberg was sending out more than 100 samples of pure yeast annually to small Bavarian breweries and the Wahl-Henius was providing a similar service to more than 60 North American breweries. Thus pure culture yeast met with widening application in both bottom and top fermentation breweries. Only in Britain did the system stumble and meet with mixed fortune. For two decades following Hansen’s innovation an at times heated public debate ensued at meetings of the Laboratory Club and its successors over the applicability of the principle of pure yeast to the production of top fermentation beers.

A stall in progress

Hansen himself spoke in London in May 1889 on his system and a number of papers generally favourable to the technique were given at meetings over the next few years. Brewers from Combe’s brewery in London (the single English example Hansen had given for use of his culture plant) and Chester’s brewery in Manchester were particularly enthusiastic. In the former case two strains of pure yeast were used; one for porter and stout brewing the other for pale ale. Of their nature negative results seldom get published, there is however evidence of dissent amongst the audience in the discussions of these papers. Some brewers complained of difficulty in obtaining condition in their beers with a single yeast and also of lack of flavour.

It was in order to overcome these objections that in 1894 Henri Van Laer of the Ghent brewing school promoted the use of ‘pure mixed culture’ or ‘composite culture’ as it was variously termed, i.e. a culture containing a defined mixture of two different strains of Saccharomyces cerevisiae – one for the primary and another for the secondary fermentation. Soon afterwards The British Pure Yeast Company was established in Burton-on-Trent, with van Laer as technical director, in order to supply suitable cultures. This move met with opposition from Hansen, who had already rejected the idea on both
philosophical and practical grounds, and outright hostility from Alfred Jørgensen, Hansen’s principle acolyte.

As both Jørgensen and Van Laer were in the business of supplying yeast to breweries their disagreement over matters of science may also have been tempered by commercial considerations. In a paper published in 1894, Jørgensen did however make the valid point that Van Laer’s system: “... is not able to preserve the constancy of ratio between the species of which it is composed, but has to be renewed continually if wanted to keep unaltered”.

Jørgensen returned to the attack in another paper given in March 1899, in which he lamented the “still in progress” in the application of pure yeast in Great Britain and attributed it to what he stated to be the mistaken belief that English beers required a “... particular species of yeast ... to carry through fermentation”. He asserted that he had long ago shown that this was not the case and that all that was required was to select the correct primary yeast to achieve good results.

The clear inference from his paper is that British brewers were just incompetent. Obviously stung by this, George Harris Morris, who as we shall see presently had devoted considerable effort in trying to make pure culture work, spoke critically of Jørgensen’s paper during the discussion, noting that pure culture had received “a great check” and was no longer making progress in England. In April 1899, in an attempt to cool the situation, Albert John Murphy, proprietor of a firm specialising in the supply of brewery processing aids (then known as the Vanguard Chemical Company and still extant as Murphy & Son Ltd) delivered a paper in Leeds entitled: “Some aspects of the pure yeast question”. He noted the pure yeast “storm” and how the technique had been “severely assailed by most English scientists of brewing”. He went on to observe that “... both sides claim to have established their views by the results of very numerous and varied experiments on a practical and commercial scale as well as in the laboratory”. Whilst dismissing Van Laer’s dual yeast system as impractical, he refers to secondary fermentation as a “vexed and complex question”.

His own results led him to believe that a single yeast could give sufficient attenuation and condition, but that sometimes there was failure for no accountable reason. He seemed to tend towards the view that these failures were due to some deficiency in the condition or nutrition of the yeast rather than the absence of the correct yeast culture. To support this he reported that failures seemed mainly to be associated with Burton, whereas success had been achieved in London, Manchester and Bradford. He tentatively suggested that this was due to a lack of potassium and/or phosphorus in Burton yeast. He concluded that “... this paper ... may be taken as a plea for further investigation into the influence which inorganic elements may have upon the form and action of enzymes, and particularly the influence of phosphorus when organically combined”.

It is clear that Murphy was seeking a biochemical rather than a microbiological explanation for the conflicting evidence so far presented on the efficacy or otherwise of pure yeast.

Problems in Burton

Murphy’s diversion was not followed up and instead Hansen himself returned to the fray in support of the views expressed by Jørgensen. In a letter to the Journal of the Federated Institutes of Brewing published in January 1900, characteristically peppered with references to “my pure cultivation system” - Hansen was very possessive of his achievements – he rehearsed the arguments and evidence in favour of pure yeast from both continental and British sources. He blamed the lack of penetration of his system in British breweries to the “secretiveness” of the brewers and called for a more open publication of results rather than opinions. Stimulated by Hansen’s challenge George Harris Morris (Figure 4) immediately responded with a detailed paper read to the (London) Institute of Brewing in May 1900. At this time Morris was consulting chemist to the Country Brewers’ Society and lecturer in technical bacteriology in the Jenner (now Lister) Institute. But between 1883 and 1894 he had been Horace Brown’s assistant at Worthingtons in Burton-on-Trent. His paper recounted his experiences with pure yeast during that period. Morris had been sent by Brown to Copenhagen in 1885 to learn about pure yeast culture directly from Hansen. On his return to Burton he set about employing the new techniques with vigour using a Hansen-Kühle yeast culture apparatus installed at Worthingtons.

At the time both he and Horace Brown were convinced that the future lay in “Hansen’s beautiful system”. Morris describes in detail the extensive measures taken to guard against contamination during yeast propagation and in subsequent fermentations. Fermentations with the pure culture were carried out side by side with regular fermentations with the normal brewery yeast. The course of fermentation of both trials and controls were said to be “identical”. Differences came when the beers were run into cask (or bottle) for conditioning. The pure yeast beers did not condition, or when they did so were always found to be contaminated with wild yeast. Morris met with failure with both ‘stock ales’ which received prolonged (six months plus) conditioning and ‘running ales’ which were “brewed, racked and drunk all in the course of one month”. The beers tasted clean but remained thin and flat unless as Morris puts it “cold malt-extract or ordinary sugar priming” were added. In nine years of experimentation in which he brewed over 2000 barrels of beer using a variety of different isolates from the brewery culture, Morris could never obtain the same results with pure culture as he could with his ‘ordinary’ yeast.

Morris did not deny that pure culture worked well in bottom fermentation breweries and also in continental top
convinced that pure yeast was a dead letter in their countries, but the subject refused to lie down. In a paper given in Manchester in December 1900 to the North of England Institute of Brewing, entitled “The Development of Scientific Ideas, as Applied to Fermentation Industries” two academic scientists, Drs William A. Bore and H. C. Harold Carpenter, in applauding Hansen’s work and the transformation it had brought about in continental brewing practice noted how: “... the inherent conservatism of the English character has prevented the majority of brewing firms from following the good example of their more enlightened and progressive competitors”. This prompted a brewer from Chester’s Brewery in Manchester, Charles Frederick Hyde (Figure 6), to respond that his brewery had been using pure yeast successfully for seven years in which time they had introduced “147 new growths...from the same stock” and had sent over 700,000 barrels of ale and porter to trade. Hyde went on to criticise Morris’s recent paper and stated: “Had Dr Morris taken the trouble to send him a postcard asking if he was using pure yeast, he should have at once replied in the affirmative”. Ouch!

Meanwhile, Jørgensen remained active in promulgating the doctrine of pure yeast. In October 1901 an English brewer, Ralph Grey, fresh from a trip to Jørgensen’s laboratory in Copenhagen read a paper in Manchester in praise of the technique. In May 1903 Jørgensen himself, in a paper coupled with, and presented by, Walter Alfred Riley jnr. of Morgan’s Brewery Company in Norwich, again claimed success in British breweries, blaming the failures of others on poor yeast selection techniques. By now George Harris Morgan was unable to fight his corner having died of pneumonia at the age of 43 on New Year’s Eve 1901 at a time when his career was at a low ebb.

But other prominent English brewing scientists and brewers took up the cudgels pointing out that things were not as straightforward as Jørgensen had tried to tell them; that failures to give condition and flavour in stock ales were too widespread to be discounted easily. Levett Baker, newly appointed chemist to Watney, Combe, Reid, also spoke from experience of the problems of maintaining a pure culture in the typical English brewery of the time. Alfred Chaston Chapman, a rising consulting chemist, spoke particularly forcefully of the “unfavourable results which were obtained” in several English breweries he had attended in the course of his work. Chapman went on to question the apparent success of Jørgensen and Riley, raising a valid practical point which has resonance today, when he asked how the authors were so sure that they were still using a single strain of yeast after repeated repitchings rather than a mixture of several “closely allied” culture yeasts: “He certainly would be extremely sorry to be asked to detect the presence of 10 to 20% of a variety of one yeast in another...He could not help thinking that the results brought forward to-night did not carry them much further”.

Indeed the two sides in the by now stale argument where as far apart as ever, but even as they debated that May evening in 1903 in Brewers’ Hall, London, fresh discoveries were being made in Copenhagen which would lend decisive support to the doubting English brewers and show that in some cases two yeasts really were better than one.

To be continued.

Acknowledgements

Figure 1 is from “The Carlsberg Laboratory 1876/1976”, eds. H. Holter and K. Max Møller, the Carlsberg Foundation, Copenhagen, 1976. Figure 2 is from “Brewing Science and Practice”, volume II by H. Lloyd Hind, third Impression, Chapman & Hall, London, 1948. Figure 3 is from “Practical Management of Pure Yeast” by Alfred Jørgensen, 3rd edition, Charles Griffin & Co., 1936. Figure 4 is from Transactions of the Burton-on-Trent Archaeological Society, volume VI, 1911. Figure 6 is from “A History of the Institute of Brewing” by W. H. Bird, the Institute of Brewing, London, 1955.