Fermentation, Productivity, and Society:

Beer and Kombucha in a Modern, Global, and Sterile World

Hart Nadav Feuer

The Arava Institute for Environmental Studies
מכון הערבה ללימודי הסביבה
معهد وادي عربة للدراسات البيئية

Advisor: Dr. Elaine Solowey
February 2, 2006

"Beer is proof that God loves us and wants us to be happy."
- Benjamin Franklin

The manufacturing process is characterized by its ability to produce and reproduce exactly the same product and to aim for industrial economies of scale. And while a modern, high-capacity brewery producing millions of hectoliters per year in Germany might itself seem like the epitome of productivity, the real workers inside that factory, the microorganisms, are likely the least appreciated. A combination of yeasty enzymes, sugars, flavonoids, and countless other chemicals are swirling together to actually make your beer. While the industrial process aiming for identical output has reduced the activity of many cheese enzymes, beer yeasts, and other microorganisms to the level of monotonous slavery, there is wide agreement that the best products are not made in this way. The very nature of fermentation is that it is a dynamic and often unpredictable process, which, by its own virtue is also a natural, and generally health process. I argue that it is the variability and uncertainty in the fermentation process that encourages a level of innovation and social progress not seen in many other industrialized processes. The current embededness of beer into culture requires that it maintain abreast of cultural demands, recently including environmental protection and organic inputs. Kombucha drink is an example of a fermented beverage with huge nutritional potential that has been slowly growing in popularity and has recently broken into the "market" in many western countries.

In a modern world intent on anti-microbial products, homogenization, pasteurization, sterility, and preservatives, the age-old culture of fermentation and beneficial organisms has lost ground. Enzymes and other microbial cultures are part of a complex system that aids us in digestion, disease resistance, and healthy body systems. Enzymes are also highly productive members of our society, contributing in so many ways to the good taste, diversity, and health of our collective diet. By limiting our exposure to fermented products or by obliterating microorganisms through sterilization, how and to what extent are we endangering our own body systems, and further, at what cost, in terms of energy and artificial chemicals, are we doing so?

Fermentation has always been a staple procedure for humans. Sauerkraut and its high Vitamin C helped James Cooke sustain long voyages across the oceans. Soy sauce, fish sauce, miso, kimchi, sake, and vinegar have been basic ingredients in Asian cuisine as far as is documented. Yoghurts, ripe cheeses, whiskey, wine, beer, and sourdough bread have been and

continue to be some of the most fundamental parts of the European diet. Pickles, olives, labaneh, ripened goat and sheep cheeses have maintained their role in Mediterranean diet for ages. Not every culture agrees on the best fermented products to make, but the basic structure of introducing microbial activity to a set of raw ingredients is common to many cultures. The Westerners struggling to understand how the Japanese appreciate fermented and wormy tofu and the foot-odor sorghum beer of Ethiopia should rightly understand that these cultures might feel the same way about a brightly-colored and odorous piece of Roquefort.

Many of the anecdotal benefits of fermented products reported for generations are now increasingly becoming scientifically based. The following will assess the entire product system and culture associated with a very well known product, namely beer, and evaluate the potential for the introduction of a poorly known product, namely kombucha.

BEER: THE ENTRY OF A CULTURAL ITEM INTO THE MODERN MARKETPLACE

Outside of the glitzy realm of Budweiser, Miller, Coors, and even Heineken, Amstel, and Carlsberg, there exists a community of beer drinkers who, by their preference for a quality product, support a movement loosely called the "Real Beer Movement." The difference between this minority and other similar progressive minorities, like organic consumers, is that "real beer" can be made at home (even in a small apartment) as easily as a microwaveable dinner and it is almost guaranteed to cost less.[1] The recipe is as simple as the one for pancakes and the ingredients only slightly more difficult to source. This comes as no surprise, given that beer and other similar tonic beverages have been brewed for hundreds of years by people with far inferior equipment than is available today.

What is currently referred to as beer in modern dialogue is basically a mixture of cooked cereals, flavored by hops, and fermented with brewing yeast. But the history of beer, ale, and other similar fermented beverages, which goes back to the Babylonians and ancient Egyptians, is not as straightforward as the modern recipe may represent. Hops, the most recent permanent addition to the beer recipe, only replaced ash leaves, yarrow, rosemary, coriander, bog myrtle,

[1] Based on my experience, an average batch of homebrew beer (18 liters, yielding fifty-four 350ml bottles) requires approximately four hours, or 4.2 minutes per bottle. Brewing a double batch requires almost no extra time and therefore almost halves the per-bottle preparation time. The production cost varies country-by-country, but even in a beer-wasteland such as Israel, where research was conducted, homebrewed beer averaged 15% less. In the Pacific Northwest of the United States, one can easily reach a savings of half.

and other herbs during the Medieval Age. The movement towards hops as the exclusive beer-bittering ingredient climaxed in 1516 with the promulgation of the Bavarian Purity Law *(Die Bayerische Reinheitsgebot*), which decreed that *only hops* could be used for bittering. Prior to this time, the variability of beer recipes was very large, although some of the most famous recipes were controlled tightly by monks throughout northern Europe (Moir 2000). The drawback of the shift to hops (a product that was essentially only utilized in beer) was that the fate of the beer industry rested on the ability of hop growers to produce a solid crop.

While hops have a fairly large tolerance for temperature and manage well in variable climatic conditions, hop yields are regularly threatened by pests and certain diseased fungi. In fact, there are no commercial varieties of hops that are resistant to pests—and certain types of aphids (such as the damson) regularly invade over 90% of the world hop area (Moir 2000). In addition to increased pesticide use due to aphids, abandonment of deep ploughing, which causes erosion but kills weeds, and stubble burning, which effectively kills fungi remaining on the stubble, have caused the industry to become more dependent upon herbicides and fungicides (Kendall 1994). However, hop growers are quickly adapting to these conditions. A Japanese wild hop with aphid resistance is being bred in England, and biological controls, such as the predatory mite *Phytoseiulus persimilis,* are quickly gaining prominence. The hop industry is diversifying as well as adapting, as can be seen in the recent attempts to integrate the plant *Garcinia kola* for bittering, and *Vernonia amygdalina* as a hop substitute. The latter has actually shown to increase alcohol yield compared to hops (Moir 2000). Barley, on the other hand, is grown more widely in the world, but it also falls prey to barley yellow dwarf virus (BYDV) and fusarium head blight (FHB), which can decimate a crop (Muehlbauer et al. 2001). The other main cereals for beer, rice and corn, are available in such abundance that a description of their agricultural circumstances is not warranted.

The fundamental dependence on mass-produced cereals and hops for beer production has raised some issues about toxicity and fitness of certain genetically modified inputs. With the bombardment of pesticides, herbicides, and fungicides on hops and similar measures for cereal inputs, the issue of chemical residues has been a primary concern for beer producers. Research conducted in Japan by Miyake et al. (1999) has ascertained that the rugged process of brewing, which includes grain mashing, boiling, and fermentation, effectively eliminates most agrochemicals, but is not able to reduce pervasive residues from *fenobucarb*, *glyphosate*, and *pirimicarb* families of chemicals. More specifically, pesticides with a *log* P_{ow} value (value of chemical stability) higher than 2 are eliminated. Some prominent examples of these are given in **Table 1** and illustrated in **Chart 1**. Due to the variability in barley sources and hop pesticide utilization in a given year, it is

TABLE 1 – Pesticide Stability in Brewing

Chemicals with log P_{ow} value > 2 are eliminated in brewing

Pesticides	Log P_{ow} value
NMC	
Oxamyl	0.44
Fenobucarb	2.79
Organophosphorus	
Glyphosate	–3.4
Dichlorvos	1.9
Malathion	2.75
Parathion-methyl	3
Pirimiphos-methyl	4.2
Chlorpyrifos	4.7
Carbamate	
Pirimicarb	1.7
Organochlorine	
Dichlofluanid	3.7
a-BHC	4.02
Captafol	3.8
Dicofol	4.3
Pyrethroid	
Fenvalerate	5.01
Deltamethrin	4.6
Permethrin	6.1
Flucythrinate	6.2

Source: Thomas (1987) and Tomlin (1997)

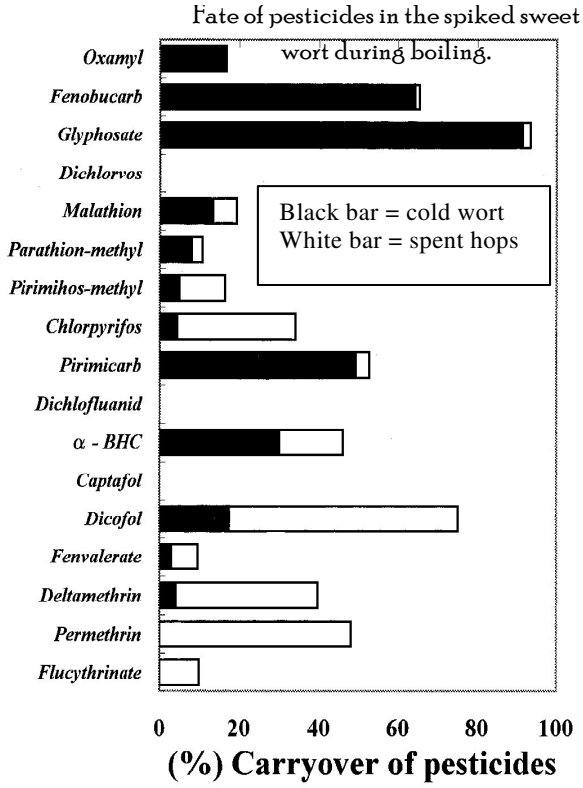


Chart 1

hard to measure the extent of agrochemical contamination in beer. In the United States, the same difficulty arises with tracking the entry of genetically modified cereal ingredients into beer. Genetically modified barley is not commercially available, so one can be sure that all-barley beer is mostly free of genetically modified organisms (GMOs), and it looks to stay this way given the dismal performance of barley modifications thus far.[2] However, most of the mainstream beers in the U.S. are made of rice and corn, the majority of the latter coming from genetically modified varieties. An additional source of GMO contamination in beer is in the dextrose (corn) sugar used for priming the beer. This can affect even all-barley beers, although mechanical carbonation eliminates this step.

Perceptions on beer and beer purity are naturally a function of the country or culture analyzing the issue. In places where beer holds a dominant position in the tradition and culture of the people, such as Britain, Germany, and Belgium, and even more recently in Japan, one could say that the people "take their beer seriously." But functionally, has the German *Purity Law* of 1516, for example, managed to adapt to modern conditions and demands for "purity"? Concerns about recipe purity led this law to mandate only barley and only hops. But what of concerns of ingredient purity—chemical residues, and to an increasing extent, genetically engineered organisms. The Japanese, on the other hand, have a smaller history with beer and view it in a much different light. The Japanese, for example, now commonly drink beer after a very common purification ritual—the bath. In fact, some even bathe in beer itself![3] Kawasaki et al. (2005) reports that, in general, the Japanese consumers "look at beer from a nutritional point of view" and demand beer that is healthy as well as tasty.

The declining rates of per capita beer drinking in Germany, the United States, and the United Kingdom since the mid 1970's are most often blamed on health and diet reasons, or on a stagnant marketing image. In almost all countries, beer has suffered from the claims of various fad diets, and the beer industry has not been able to wage an effective informational campaign to dispel the problem. Most recently, beer sales tumbled due to the growing popularity of the various Atkins-related diets, which focused on reducing carbohydrate consumption. The beer industry responded by pumping the media with statistics proving that beer has volumetrically

[2] Muehlbauer et al. (2001) reports that genetically modified barley strains have been so poor (affected by dwarfism, semi-prostrate growth habit, lower yields, smaller seeds, and higher variability) that researchers have actually reconsidered their entire transformation approach.

[3] Kawasaki et al. (2005) report that beer has become a popular after-bath drink, and spas have even begun embracing beer as another bathing tonic.

less calories than wine. This campaign was not particularly successful given the fact is that beer has more calories per percentage of alcohol than wine (important for those aiming for inebriation) and more calories per *traditional serving* (a regular 350ml beer has more calories than a 175ml glass of wine).[4] Only milk has a higher caloric count than beer by the *traditional serving* definition. The industry by in large failed to even point out that beer does, in fact, have less *carbohydrates* than most drinks, with wine being the noteworthy exception (see **Tables 2 and 3**). Bamforth (2005) makes it very clear that "beer has suffered unfairly through erroneous claims made in connection with at least one of these diets and has been unfairly categorised as being 'high carb.'" Bamforth relates a story of how a dietician actually retracted his mistaken claims about beer and carbohydrates after being confronted by the industry.[5] In fact, there might even be evidence to support the claim that beer is a source of so-called "good

TABLE 2. Total Carbohydrates

Food	Carbohyd-rate (g) per serving
Coffee (brewed)	0.8
Cappuccino	23
Coffee liqueur	24
Tea (brewed)	0
Tea (iced, flavored)	25
Pina colada	32
Dessert wine	14
Red wine	2
White wine	1
Sherry	5
Apple juice	29
Cola	40
Ginger ale	32
Grape soda	42
Tomato juice	10
Tonic water	30
Beer	10–20
Light and low carb beer	2.5–10
Source: Bamforth (2005)	

TABLE 3. Carbohydrate, alcohol and calorie content of different beer styles.

Beer style	Alcohol (% vol /vol)	Carbohydrate (g/12 fl oz)	Calories (per 12 fl oz)
Lager	5	10.6	143
Pale ale	5.6	12.3	200
Wheat beer	5.4	12.9	171
Light lager	4.2	6.6	110
Ice beer	5.5	8.9	148
Barley wine	9.6	24.6	285
Low alcohol beer	0.4	5.8	96
Stout	4	10	125
Low carb lager	4.2	2.6	95
Source: Bamforth (2005)			

[4] Beer (4.6% alcohol): 8.9 calories per percentage of alcohol; 143.5 calories per 350ml beer
Wine (12% alcohol): 6.4 calories per percentage of alcohol; 134.8 calories per 175ml glass of wine (Source BBC, Author's calculations)

[5] To understand the dynamic of these diets, it might be helpful to quote the exact words of the dietician, Dr. Agatson, who lambasted carbohydrates: "This diet is constantly changing based on new research so some of the info in the book is out of date. One of those items, you will be happy to know, is the ban on beer."

carbs." Although it is not apparent that this media campaign backfired on the beer industry, it is clear that significant marketing resources were wasted in the process.

The health issues relating to the decline in beer consumption can be deconstructed into two parts: perception and reality. The reality is that beer has overall become less healthy, thanks to increased agrochemical usage, pasteurization, filtration, and conservatives. To the industry's defense, we can track all of these problems to competing demands of stricter food laws, increased agricultural pest and disease problems, and the demand for shelf life. But simultaneously we can, in the German context, point to the success of the organic or *Bio-Bier* movement, which has not capitulated to these problems and has even navigated around many of them. *Bio-Bier* utilizes organic agricultural inputs, avoids pasteurization and conservatives, but may be filtered. Its recommended shelf life is almost identical to conventional beers. On the issue of health benefits, one might say that the Germans have begun to wizen up to the misleading implications of the so-called Purity Law of 1516. The beer industry, on the other hand, is clearly so obsessed with this outmoded law that they still devote significant advertising space (both on the bottle and in television) to the promotion of their *Reinheitsgebot*.[6]

Navigating the perception of beer is an area where beer producers could use a little more practice. Making the right claims about what beer is and is not is an important step toward regaining the trust and respect of the broader public. Besides playing the defensive, as in the case of the Atkins' diet carbohydrate claims, the beer industry needs to be more forward-thinking in the propagation of new research findings and marketing schemes. Besides the already mentioned role of beer as a source of "good carbs," there is also significant scientific research showing beer as a source of soluble fiber and prebiotic molecules (Bode 2004; Bamforth 2005; Gromes 2000).[7] Recent media booklets, suggesting a move in the right direction by the beer industry, highlight the benefits of drinking in moderation: decreased risk of cardiovascular events, benefits for diabetics, reduced risk for gallstones, osteoporosis, and ulcers, as well as beneficial psychological outlook. Naturally, the issue of vitamins and minerals also deserves focus: high potassium, low sodium, and significant sources of B12, B2, B6, B9 folate, biotin, niacin, and pantothenic acid (CBMC 2002). And more recently, the role of the antioxidant

[6] Stephan Dahl (2000) reports that 3 out of 4 commercials aimed at praising the quality and cultural/traditional value of beer make reference to the *Reinheitsgebot*.

[7] Prebiotic molecules are those derived from the ß-linked glucans and arabinoxylans that derive from the cereal cell walls. They provide nourishment and a palette for beneficial organisms located in the gut. Gromes et al. (2000) relates that beers average around 2 g/L of soluble fiber, although some contain three-fold or more than this!

xanthohumol in cancer prevention has come to light. Although this antioxidant is found in all beers, it is in much higher density in microbrews and other craft beers. Xanthohumol has now conclusively been linked to the prevention of ovarian, prostate, and colon cancer, as well as noted for hormone replacement therapy during menopause (Stevens 2004 cited in *Northwest Brewing News*). Although the Germans are quickly developing a "health beer" with higher levels of xanthohumol, there is clearly a media opportunity for current beer.

In particular, American craft brewers have come to understand the competition coming from the more dynamic wine industry, and books like Discovering the Pleasures of Real Beer with Real Food (Garrett 2003). Beer is effectively depicted as a replacement for wine when eating cheese and other wine-dominant foods, and shown as superior when dealing with foods problematic for wine, such as eggs, most Asian cuisines, and barbeque. Such books have begun appearing on household shelves next to their wine counterparts. Beer labeled as kosher is even on the rise, due in large part to the latent realization that beer is naturally kosher (Blech 2000). Craft brewers also instinctively know that their product is not only tastier, but significantly more healthy on all levels. Craft brews have more xanthohumol, prebiotic molecules, fiber, vitamins and minerals, and are usually characterized by less pasteurization and filtration than mainstream beers. Even roasted (specialty) barley, used primarily in craft brewing, has more antioxidants than kilned (standard) barley (Samaras 2005).

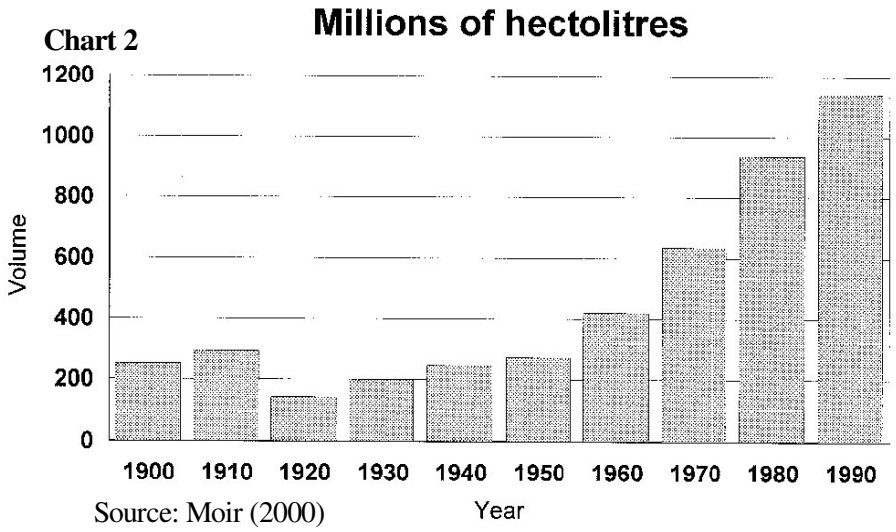
Increasingly, both craft and mainstream breweries are realizing that, due to the traditional, even nostalgic nature of their product, and the characteristics of their consumer base, that real ecological improvements to their products and process can garner them increased fame, new consumers, while simultaneously bolstering their claims about their products' quality and benefit.

ENVIRONMENTAL BEER TECHNOLOGY

Worldwide the economic, social, and environmental impact of beer is growing. Although per capita beer drinking is down in some of beer strongholds of the world, it remains high, and there is enormous growth in beer consumption in other parts of the world (see **Chart 2**). And yet beer has, in many ways, actually entered a post-industrial phase. Beer brewing has experienced numerous phases of boom and bust and, in many countries, has found itself a comfortable place

in the culture. Having reached some sort of cultural and technological equilibrium, brewing is grappling for a new identity, a new purpose, and a new way to continue growth. Many breweries produce and bottle non-alcoholic drinks to maximize their capital usage, and others have dabbled in beer derivatives (honey beer, pink strawberry beer, etc.) that go beyond slight flavor enhancements. Others have harkened back to old ages of herbal beer flavorings in the pre-*Reinheitsgebot* era. But all of the promulgation of these products does not solve the fundamental problem of beer innovation. Adding honey to a beer pales against the challenge of going organic, tackling difficult pollution and effluent problems, and maximizing marketing image on saleable results from new research. Breweries that have reached an "irritating" equilibrium would be wise to learn from the experiences of breweries at the fore of environmental technology and those successfully reinventing their place in society.

The brewing industry is one of the few remaining that still relies on a growing cycle and a seasonality in taste preferences. Despite industrialization, it remains difficult to locate a Märzen (March-beer) or an Oktoberfest out of season. Try getting your hands on local hops before the autumn harvest, or that specialty barley before the chaff dries, and you'll come up empty-handed. This brings culture and the cycle of nature in-line and is a boon for brewers seeking the opportunity to place their "pilot product" in a receptive market. The brewing industry is also fortunate to be stewarding a product that still has enormous innovation potential. Just survey the range of beers from the dark stout of Guinness to the light and refreshing Japanese *happoshu* to the sorghum beer industry in Nigeria and it is clear that the range of products is exceedingly large. New genotypes for hops and barley are always in production. Wild brews (like Belgian lambics), lost beverages from ancient cultures, and experimental beers from American



Source: Moir (2000)

microbrewers are making headlines and bringing in consumers. Just ask Sam Calagione, the founder of Dogfish Head Brewery, the fastest growing brewery in the United States, and the author of Brewing up a Business: Adventures in Entrepreneurship (2005). Because the value of a recipe for a successful beer never depreciates (a phenomenon called beer loyalty), new recipes, innovation, and general experimentation is under the backdrop of a consistent sales outlook. The nature of brewing is also such that experimentation can essentially be carried out on identical equipment. Initial investment costs in the brewing industry are, in theory, some of the lowest in the world.

Due to the unique embededness of beer in culture, and the motivation for breweries to assert this position in as many avenues as possible, adopting an environmental outlook in response to cultural shifts or social priority is a logical response. The Japanese brewery Sapporo opens a recent article as follows: "When we make beer products, it is increasingly important to consider their influences on the environment. Global warming is the most important environmental issue" (Takamoto et al. 2004). Another even bolder article written in 2003 opens by stating, "It is now known with certainty that the concentration of greenhouse effect gases in the atmosphere causes global warming" and continues to explain how Sapporo is poised to reduce CO_2 emissions in a variety of ways (Yoshida et al. 2003). Other companies are taking similar positions and acting on behalf of water quality, becoming players in national bottle recycling programs, innovating energy and waste reduction methods, and creatively using their byproducts in a variety of ways.

But as the most outspoken and well-written example in the industry, the story of Sapporo is a clear example of an embedded cultural response to a larger social priority. Whether the impetus for Sapporo's improved environmental outlook was the result of government pressure or green leadership, their actions represent an honest understanding of the cultural realm they exist within. In a series of three articles the Japanese researchers working for Sapporo cover strategies report on successful implementation for carbon fixation, perform a life cycle analysis of their beer production facility, and invest significant capital into what they call an "eco-factory" (Yoshida 2003; Takamoto 2004; Kawasaki 2005). The depth of their analysis is displayed when they include the added pollution value of agrochemical cultivation for their inputs. Their goals are very much tied into the overall environmental priorities of Japan: CO_2 reduction goals are in relation to the Kyoto Protocol benchmarks, exhaust goals are ahead of standards, involvement

and responsibility within the bottle/can recycling system is acknowledged, and investment in green technologies matches Japanese hi-tech disposition (Kawasaki 2005).

Similar responsibility on behalf of brewers has gained a scholarly focus in Canada, the United States, Germany and other places. A landmark study by Miller Brewing Company in 1992 reported the success of a major resource saving and landfill minimization, but creative solutions have also been developed at the small scale. Karl Ockert (2002) of the small-scale Bridgeport Brewery in Portland, Oregon gained international recognition in the *Technical Quarterly of the Master Brewers Association of the Americas* for his wastewater pretreatment system. Major breweries (upwards 1 million hL/year) in Germany, such as the Karlsberg in Homburg, developed their own efficient wastewater treatment system that completely avoided burdening the municipal sewer system (Kormelinck 2005). Canadian brewers, in the same vein, have researched out a solution for bottle washing that minimizes label adhesive residue and improves the aesthetic value of returnable bottles (a very important issue within the bottle return system) (Agius et al. 2005). Not to be left out, the Sri Lankans have developed a system for recapturing energy from spent grain slurry (Kanagsooriyam 2005).

The effect of "beer culture" can most clearly and vividly be seen in the case of Germany, which, needless to be said, is hailed as perhaps the most major beer country in the world. Specifically, the amount of beer served on draught is 19.5% and returnable glass bottles of high standard soak of a remaining 65%. Only 15% of beer is sold in nonreturnable bottles and cans—many of which are recycled (DBB). To actually see this culture in action is simply to buy a bottle of beer and inspect the white rings around the glass lips on the bottle, which, very much like tree rings, will indicate of the bottle has seen two, ten, or fifty beers in its lifetime.

KOMBUCHA MARKETING

The origins of this mystical drink are as numerous as the beers of Germany. Some claim that it is of Tibetan origin, although most now agree it can only be linked more generally to East Asia. It reached Western Europe in the late 1800's and now boasts a worldwide fan base. Some of kombucha's supporters, says FOCUS magazine (1995), are Daryl Hannah, Ronald Reagan, Oliver Stone, and, of course, Madonna. Perhaps the biggest pioneer and promoter of the

kombucha drink is Günther Frank, a German who maintains the largest kombucha website and has written numerous books on the subject. The fizzy, tangy tea that results from the kombucha fermentation, however, has achieved its biggest success by being served to people who have not seen the process take place. Unlike beer, for which the yeast are microscopic, the kombucha fermentation culture is generally as large as an open hand, murky brown in color, and gelatinous in texture. Suffice to say that is does not make friends easily. While the scientific health benefits of kombucha are still in debate, the task of diffusing this fermentation process has required some resourceful marketing and intervention.

The boasted health effects of kombucha are too numerous to enumerate, although only some of these benefits have anything more than anecdotal science behind them. Most benefits are linked to stomach and intestinal activity, headaches and detoxification, joint pain, and even cancer. The taste, on the other hand, is very much up to perception. Some of the adjectives used to describe it have been fizzy, tangy, tart, fruity, rich, vinegary, starchy, sweet, crisp, etc. There does not seem to be any consensus on whether the taste is, on the average, more good than bad or whether the drink defies definition because it tastes a little different each time. The unclear scientific picture, strange shape, and lack of consensus on the taste have not allowed kombucha to grow very much beyond its grassroots niche. However, recent advances in marketing have enabled some companies to capitalize on this drink.

The company Kombucha Wonder Drink, based in Portland, Oregon, recently joined the small community of firms that have successfully marketed and manufactured kombucha. The design of the drink itself took some reworking—the "purist" approach was abandoned for snazzy *Himalayan Blend*, *Asian Pear Ginger*, and *Rooibos Red Peach*, among others. The overall marketing design, carried out by a firm called Sandstrom Design, reworked the bottle to look contemporary and ancient, and came up with the name Kombucha Wonder Drink. It is not clear that if the manufacturing process has detracted from the purported health benefits of kombucha (if they are true), but the company's clear success is in their advertising campaign and the fact that the flavor continues to spread across the United States and even into several other foreign countries (LogoLounge 2003). As a product with many of the biotic qualities found in all fermented

drinks, kombucha has the flair to become one the latest live food additions to a diet of overly processed food.

CONCLUSIONS

As a cultural element in Western societies, beer has undergone many shifts in identity and character to reach its modern state. Each of these shifts has been marked by social, environmental, and economic challenges that redefined the way it moved onto to the next stage of its existence. But at its heart, beer remains a simple fermented drink, that, by nature of its accessibility and charisma has maintained high levels of innovation and cultural prominence. Precisely this prominence (and ensuing identity shifts) has allowed beer to give rise to a new movement that focuses on quality and environmental stewardship while maintaining a semblance of its recent industrialized past. And while the "Real Beer Movement" slowly branches out of the niche in which it developed, it continually challenges the conservative forces remaining beholden to an antiquating manner of viewing beer.

The climax of the formulation of beer we are familiar with today (water, hops, malted cereal grains) occurred in Europe after hundreds of years of beer and tonic innovation yielded to hops as the preferred flavoring agent. But the ensuing dominance of hops caused a dependence on monocropped cultivation, which enabled centralized industrialization of beer and, on the agricultural side, increased dependence on pesticides, herbicides, and fungicides. The German *Purity Law* of 1516, which secured the place of hops as the reigning bittering agent, remained unchanged despite the contamination of agricultural chemicals, and new technologies for pasteurization and filtration. Some quite persistent agricultural chemicals have been shown to survive the brewing process and arrive into your beer. A law aimed at safeguarding beer's so-called "purity" failed to adapt to the new world list of pollutants and is now seen more as a restraint on innovation rather than a protection. But the "Real Beer Movement" of the past few decades has shown that the single individual can be a strong force in beer innovation, and can do so with very little equipment and initial investment. The result: entrepreneurial beer activities are proliferating across the world while volumes of industrialized beer consumed are going down in all of the old "stronghold countries."

The "Real Beer Movement" also echoes the willingness and even duty many beer producers show toward safeguarding the cultural dominance of their product. Beer producers are prepared to spend time and resources innovating methods to lower their environmental impact and increase the nutritional value of their beer. Sapporo brewery in Japan is a leading example of a firm that has taken the charge of meeting global warming mitigation requirements and reducing their overall footprint to a very small amount. Germany (as well as Japan) continues to show extremely high rates of draught beer consumption (in the pub) and returnable bottle usage (at home)—echoing the industry's overall strong environmental presence in the container industry. In addition to improving the environmental outlook of brewing, beer producers have, armed with new scientific information about the nutrition of beer (particularly the antioxidant xanthohumol), quickly moved toward healthier styles, more organic inputs, and are experimenting with even more technologically advanced techniques.

The overall outlook of beer remains quite good, despite high-profile brewery closures and declining per capita consumption rates in major countries. Beer is quickly finding a home in many developing countries, and, in the developed countries, followers of the "Real Beer Movement" are at the pulse of beer taste and ecological innovation. Old ideas like the *Reinheitsgebot* and "non-beer" are losing ground to progressive initiatives; industrialized beer members who adapt to this new world beer regime, such as Sapporo, are the first to reap the benefits of it. And initiatives like the kombucha drink, which have reached critical mass and are moving into more broad awareness provide a barometer for the post-industrial step "backward" to some of the most basic tenets of fermentation.

References

Agius, George and Angelo Tobia. (2005) "Enhancing the Performance of Bottle-Wash Solutions." Master Brewers Association of American Technical Quarterly 42(2), pp. 117-119.

Bamforth, C.W. (2005) "Beer, Carbohydrates, and Diet." Journal of the Institute of Brewing 11(3), pp. 259-264.

BBC News. (2005) "Is beer less fattening than wine?" March 8. Web: http://news.bbc.co.uk/go/pr/fr/-/1/hi/magazine/4329323.stm

Blech, Rabbi Zushe Yosef. (2000) "The Making of Kosher Wine, Beer, and Spirits." Vaad Ha'ir of Montreal 1(8), March. Reprinted in Kashrut.com, ed. Arlene J. Mathes-Scharf.

Bode, Christiane. (2004) "Lässt sich einem Konsum von Bier und Bierinhaltsstoffen eine präbiotische Wirkung zuordnen?" Wissenschaftsfoerderung der Deutschen Brauwirtschaft sponsored by Univ. Hohenheim. Web: http://www.wifoe.org/Berichte%20und%20Dokumente/SchlBB67.pdf

Calagione, Sam. (2005) Brewing up a Business: Adventures in Entrepreneurship. Wiley.

CBMC – The Brewers of Europe. (2002) "The Benefits of Moderate Beer Consumption." *Beer & Health*.

Dahl, Stephan. (2000) "Cultural Values in Beer Advertising: A look at beer commercials from the UK, the Netherlands and Germany." Intercultural Research Group, Univ. of Luton, July. Web: http://www.stephweb.com/capstone/beer.shtml

DBB. "Statistik" (2005) Web: http://www.brauer-bund.de/index1.html

Stevens & Page. (2004) "Xanthohumol and related prenylflavonoids from hops and beer: to your good health!" Phytochemistry 65, pp. 1317-1330.

FOCUS Magazine. No. 34. August 21, 1995, 128.

Gromes, R., Zeuch, M. and Piendl, A. (2000) "Further investigations into the dietary fibre content of beers." Brau. Int., 18, 24–28.

Kanagachandran, Kanagasooriyam. (2005) "Optimization of Spent Grain Slurry for Energy Generation." Master Brewers Association of America Technical Quarterly, 42(4), pp. 324-328.

Kawasaki, Yasutsugu and Hiroto Kondo. (2005) "Challenges in the Brewing Business in Japan Toward an Environmentally Friendly Company." Master Brewers Association of America Technical Quarterly 42(2), pp. 107-112.

Kendall, N.T. (1994) “Recent changes affecting barley cultivation and their possible impact on brewing.” Masters Brewers Association of the Americas Technical Quarterly, 31(3), pp. 83-84.

Kormelinck, Vera Groot. (2005) “Happy Fish Due to or In Spite of an Optimized Wastewater Treatment System?” Master Brewers Association of America, 42(4), pp. 309-314.

LogoLounge. (2003) “Kombucha Wonder Drink.” Rockport Publishers. Web: http://www.logolounge.com/articles/default.asp?Archive=True&ArticleID=74

Miyake, Y., Koji, K., Matsuki, H., Tajima, R., Ono, M., Mine, T. (1999) “Fate of Agrochemical Residues, Associated with Malt and Hops, During Brewing.” Journal of the American Society of Brewing Chemists 57(2), pp. 46-54.

Moir, Michael. (2000) “Hops-A Millenium Review.” Journal of the American Society of Brewing Chemists 58(4), pp. 131-146.

Muehlbauer, Gary J and D.A. Somers. (2001) “Genetically Modified Barley and the Brewing Industry.” Master Brewers Association of America Technical Quarterly, 38(3), pp. 145-154.

Ockert, Karl. (2002) “Practical Wastewater Pretreatment for Small Breweries.” Master Brewers Association of America, 39(1), pp. 39-46.

Oliver, Garrett. (2003) The Brewmaster's Table: Discovering the Pleasures of Real Beer with Real Food. Harper Collins.

Pollock, J.R.A., and A. A. Pool. (1978) “New Method of Malting Designed to Reduce Energy Consumption.” Journal of the American Society of Brewing Chemists, 37(1).

Samaras, T.S, P.A. Camburn, S.X. Chandra, M.H. Gordon & J.M. Ames. (2005) “Antioxidant properties of kilned and roasted malts.” Journal of Agricultural and Food Chemistry, 53(20) p. 8068-8074.

Stevens, J.F. and J.E. Page. (2004) “Xanthohumol and related prenylflavonoids from hops and beer: to your good health!” Phytochemistry 65, pp. 1317-1330.

Takamoto, Yuji, Yutaka Mitani, Masachika Takashio, Kentaro Itoi and Katsuhiko Muroyama. (2004) “Life Cycle Inventory Analysis of a Beer Production Process.” Master Brewers Association of America, 41(4), pp. 363-365.

Watson, C. (1993). “Wastewater minimization and effluent disposal at a brewery.” Tech. Q. Master Brew. Assoc. Am. 30: 114-117.

Wornson, G.O. (1992) “Secondary resources utilization/landfill minimization.” Master Brewers Association of America Technical Quarterly, 29(3), pp. 78-80.

Yoshida, Tamio, Saburo Kato, Tetsuo Choso, Masaaki Ota, Yoshifumi Kise, Yutaka Mitani, Shinji Yagihashi, and Masachika Takashio. (2003) “Carbon dioxide fixation technology from brewery processing wastes.” Master Brewers Association of America 40(1), pp. 39-43.