

What is Kombucha and why, specifically in July 2010, Should You Care?

The assumed non-alcoholic beverage kombucha has recently been found in several instances to contain higher than the legal 0.5% alcohol by volume here in the US. In response to a call for testing of alcohol content it was decided to present a brief review on this beverage and how best to get it tested.

Kombucha (pron: kom-BOO-cha) is a form of home brewed, specially fermented, tea that has been made since ancient Chinese times. It was estimated in 1994 that three million Americans were growing the fungi that ferments sugared tea into a highly acidic, thirst quenching (usually carbonated) beverage that is purportedly full of probiotic goodness (health beneficial nutrients). Kombucha which grows as a white gelatinous mass (a zooglear mat) was described as a “magic mushroom” since providing so many reported health benefits. In fact not a mushroom it is a symbiotic formation of several yeast strains and bacteria. It was widely touted (perhaps at the true homebrew level rather than for commercial production) that it is easy for such cultures or products of fermentation to become contaminated and lead to sickness or worse. It is like sour dough bread production in that the progeny discs need to be carefully tended to and sub-cultured. A particularly cogent discussion for the lay-reader on kombucha by Molly O’Neill appeared in the New York Times on December 28th, 1994. Since then quite a number of home-brewers have moved to commercial production and the popularity of this beverage in health food stores has bloomed.

Since 1994 a good number of peer reviewed papers have appeared on the topic of Kombucha and its properties (a few are cited below). The symbiotic culture is known to consist of at least three microorganisms: acetic acid bacteria (*Acetobacter xylinum*) that produces the decidedly acidic potency – vinegar character! and two yeasts (*Zygosaccharomyces rouxii* and *Candida sp.*)*. Such organisms produce ethanol, lactic and acetic acids, gluconic and glucuronic acids and an antimicrobial compound called usnic acid. A host of other by-products of metabolism such as antimicrobial agents, vitamins and minerals are produced which help producers promote the “health-giving properties” of such beverages and the reason why health food stores have been selling huge quantities of this beverage. *Note: recent research shows a whole host of other organisms within the “jelly membrane” (or zooglear mat) [see 2010 reference by Jayabalan *et al*, cited at the end of this article].

Traditionally grown on black tea and sucrose for about 7 days the collection of kombucha microorganisms produces a pleasantly sour and sparkling beverage. Longer term fermentation increases the vinegar character. More specifically the tea broth is 0.5% w/v and supplemented with sucrose at 10% w/v to which a commercially available starter culture is added. The pH decreases during the fermentation from 5 to 2.5 and this may provide one method of quality control for the small-scale producer. The organic acids produced are stated to provide protection against unwanted contaminating organisms and this helps to make the kombucha a relatively safe beverage if manufactured correctly. But optimum fermentation times are needed and careful culture management of this complex mix of organisms or the production of acids can become too much and pose some risks when consumed. The ecology of the organisms during kombucha production has been briefly discussed by Sreeramulu *et al*, and in several other articles (see references below).

While the complexity of fermentation and byproducts is becoming understood it is largely regarded that it is fructose (from the sucrose) that is primarily metabolized into ethanol and carbon dioxide (yeast fermentation). Ethanol is then oxidized, via acetaldehyde, to acetic acid by the *Acetobacter* strains.

Only a couple of earlier reports have stated the maximum amount of alcohol likely produced and this is a wide extreme of between 0.17% to 1.26% by volume. So as alcohol content has not been adequately addressed in the literature it is unclear to us at this time as to how the value of 0.5%

came to be generally accepted for Kombuchas to be claimed as being non-alcoholic beverages. [Though one other paper we just uncovered by C. J. Greenwalt's group from Cornell University states a typical value of 0.6% alcohol (though not stated as by weight but assumed so - translating to approx 0.75% alcohol by volume) and an elevated value as high as about 1.8%. At the higher alcohol level the acetic contents of the experimental batches of kombucha were also reported as high thus there could be a correlation between subjective acidic taste – the overall “sourness” and the alcohol content of kombuchas.]

We have found some commercial kombuchas to be close to the 1.26% value and clearly it would be possible for many to be above the legal maximum (non-alcoholic statements) of 0.5% alcohol by volume. Any alteration of the conversion of ethanol to acetic acid will affect the final alcohol content. Also changes in glucose or the fructose content in recipes (or that sugar possibly added along with any fruit flavorings) along with the “live culture” nature of the kombucha organisms might lead to continued fermentation in the bottle and to further ethanol production while in trade. Extra carbon dioxide production could also pose issues as well. Tea stored at 20 °C continues to form the biofilm (the growth of the organisms) which may be disconcerting to consumers and provides for potential further fermentation/bottle conditioning. It maybe that such products need to be Pasteurized to prevent further activity but this is argued against by Jayabalan *et al*, (2008) “Preservation of Kombucha Tea – Effect of Temperature on Tea Components and Free Radical Scavenging Properties”, J. Agric. Food Chem. 56, pp.9064-9071. Heat preservation can affect the color, clarity and flavor of treated beverages. If Pasteurization is not then possible or feasible then it may be necessary to maintain kombucha chilled in trade and prior to consumption to prevent increased alcohol levels perhaps. In summary to this point, it seems the ethanol content has not been measured extensively during production of kombucha nor with aging in trade. Such has now become an issue.

Recently the Tax and Trade Bureau (TTB) have commissioned the examination of claims that many kombucha products on the market contain higher than the legal limit of 0.5% alcohol by volume. Below this level beverages can be passed as non-alcoholic but recently we and clearly others have found several Kombucha products on the market to have above 1.0% alcohol by volume contents. This shows the need to be careful regarding production and also testing of final product. As briefly stated above sucrose is the traditional carbohydrate source for kombucha fermentations but the use of other sugars can influence the ethanol and acetic and even lactic acid contents. How the producer actually manufactures the kombucha may need to be more closely addressed and examined. Flavored kombuchas are also a concern. Some flavorings are supplied in a stabilized alcohol solution (which needs to be accounted for - possible taxation purposes and beverage classification) and certain flavorings can mask alcohol content during measurement by certain methodologies. Added flavorings may also carry added sugar which could be bottle fermented affecting carbonation levels and ethanol content especially if the kombucha organisms remain in a viable and vigorous state.

Testing alcohol content of Kombucha beverages.

Brewing and Distilling Analytical Services, LLC prides itself on testing alcohol content at all levels in all beverages. Using TTB approved methodology including Anton Paar Digital density meters, Alcoyzers, distillation and enzymatic means we can test Kombucha for alcohol content. We note that sometimes flavorings can interfere with alcohol measurements and will test via several methods if ever artifactually high or low alcohol contents are suspected. Contact us for further details as needed. We can supply basic reports for ongoing QC work or notarized certificates for TTB recognition. We are also a TTB certified lab for both wine and distilled spirits. Though most of our work involves beer and/or malt beverages. GC is also approved for alcohol content determination though we do not use our GC for such work. We prefer the other approved methods instead of GC.

Other relevant citations.

[Discussions on the history and health benefits of the “tea fungus” appear in such articles as: “Kombucha, the Fermented Tea: Microbiology, Composition, and Claimed Health Effects” Greenwalt, C. J., *et al.* (2000). *J. Food Protection* 63(7), pp.976-981; “Characterization of the Tea Fungus Metabolites” Philippe J. Blanc, (1996). *Biotechnology Letters* 18:2, pp.139-142; “Tea, Kombucha, and health: a review” Dufresne, C. and Farnworth, E. (2000). *Food Research International* 33, pp.409-421; “Comparison of the products of Kombucha fermentation on sucrose and molasses” Malbasa, R. *et al.* (2008). *Food Chemistry* 106, pp.1039-1045; “Kombucha Fermentation and Its Antimicrobial Activity” Sreeramulu, G., *et al.* (2000). *J. Agric. Food Chem.* 48, pp.2589-2594. Antimicrobial activity in kombucha fermentations has been discussed by Zhu and Knol (2001). in *Acta Biotechnol.* 21, pp.49-56. See also: “Microbial fermented tea – a potential source of natural food preservatives” Mo, H., *et al* (2008). *Trends in Food Science and Technology* 19, pp.124-130 and “Biochemical Characteristics of Tea Fungus Produced During Kombucha Fermentation”. Jayabalan, R. *et al* (2010). *Food Sci. Biotechnol.* 19(3), pp.843-847. For alcohol content statements we reviewed/recommend: “Determination and Characterization of the Antimicrobial Activity of the Fermented Tea Kombucha” by Greenwalt, C. J. *et al.* (1998). *Lebensmittel-Wissenschaft und-Technologie* 31(3) pp.291-296. Other papers are available in the BDAS, LLC collection (or are currently on request from the respective authors) discussing various aspects of the composition and properties of fermented teas. For a list of complete references please contact us. With issues being raised about ethanol levels the commercial producer of kombucha needs to be aware of these studies in order to best manufacture a safe, stable and consistent beverage and to be able to monitor the overall quality for safety and assurance purposes.]