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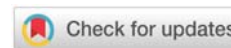
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Mini Review

A Review of side effects of Kombucha

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Abstract

Kombucha is a mushroom fermented in sweetened black or green tea, originally found in Asia, being used as a remedy for many ailments in this region. Kombucha is not a usual mushroom because it represents the symbiosis between yeast and a variety of bacteria aggregated through a permeable membrane. Among the benefits of Kombucha tea are the potential antioxidant effect against free radicals, and the clinical effects on diabetes for its hypoglycemic, lipid-lowering, and immune stimulation. But secondary to the lack of evidence to support these benefits, several publications emerged to mention the side effects of Kombucha consumption. The present article is trying to collect the data reported in the literature regarding the side effects of Kombucha.

Introduction

Alternative and complementary medicine incorporates the usage of both plants and food supplements in their practice. In recent years their use has become popular amongst the general population. Often, the possible adverse effects following the ingestion of these supplements are not known. In addition, often the patient does not admit to using these alternative therapies thus their unwanted effects go unnoticed. Still, medical literature notes a few possible side effects of these therapies as hepatotoxicity, digestive reactions, allergic reactions, and nephrotoxicity. For example, Kombucha (also known as Manchurian or Kargasoc) is a mushroom fermented in sweetened black or green tea, originally found in Asia, and is used as a remedy for many ailments in this region. Kombucha is not a usual mushroom because it represents the symbiosis between yeast and a variety of bacteria aggregated through a permeable membrane [1].

The earliest recorded data about these mushrooms dates to 220 BC, in the period of the Tsin dynasty. In 414, Dr. Kombu

brought this mushroom from Korea as a gift for the king of Japan. Kvass tea reaches Russia via oriental traders after which it was introduced in Eastern Europe [2,3]. The main active ingredients in fermented Kombucha tea are lactic acid, gluconic and glucuronic acid, hyaluronic acid, ethanol (0.5%) and glycerol acid, chondroitin sulfate, mukoinin sulphate, heparin and usnic acid [2,3].

Kombucha tea is made using sugared black tea, which serves as a sweet substrate for the symbiotic fermentation of acid bacteria, lactic acid bacteria, and yeasts [4]. The recipe for the production of Kombucha starts with preparing the substrate, using 5 g of tea leaves and 50 grams of sugar per liter of water, then letting it cool down until about 20 °C. The next step is to add the starter culture which can be a commercially available SCOBY (Symbiotic culture of bacteria and yeast) or some already fermented kombucha. The process requires very clean utensils and a clean working space to prevent contamination with pathogenic microorganisms [5]. In aerobic conditions, in 7–10 days, these bacteria and yeasts will convert sugar and tea into several acids (mostly acetic acid, gluconic acid, glucuronic

acid, and ethanol), 14 amino acids, vitamins (B1, B2, B6, B12, C) and some hydrolytic enzymes. This leads to the formation of a two phase's beverage: a sour liquid and a floating biofilm [4].

The most frequent acid bacteria found in Kombucha are *Komagataeibacter*, *Gluconobacter*, and *Acetobacter species*. Of the lactic acid bacteria, we note *Lactobacillus*, *Lactococcus* and of the yeasts *Schizosaccharomyces pombe*, *Saccharomyces ludwigii*, *Kloeckerapiculata*, *Saccharomyces cerevisiae*, *Zygosaccharomyces bailii*, *Torulaspora delbrueckii*, *Brettanomyces bruxellensis*. It is to be noted that the process is subjected to variability, thus a perfect characterization of involved bacteria and contained substances is not possible [4].

A study from Germany compared two commercialized Kombucha tea products and came to the conclusion that there were differences in bacterial composition [6]. The most frequent species found include *Saccharomyces ludwigii*, *S. Pombe*, *Bacterium xylinum* *Schizosaccharomyces pombe*, *Brettanomyces bruxellensis*, *Bacterium xylinum*, *Bacterium gluconic*, *Bacterium xylinoides*, *Bacterium katogenum*, *Pichia fermentans*, *Candida stellata*, and *Torulas*.

In some instances when the mixture is fermented at home and is thus not verified from a biological point of view, it can be contaminated with pathogenic species [1]. In some cases, there were *Penicilinum species* and *Candida albicans* positive cultures [6]. In controlled laboratory conditions, the pH drops to 1.8 in about 24 hours, thus contamination with pathogenic agents should be avoided.

Benefits of using Kombucha

The reason for this popularity lays in the numerous marketed benefits, although yet unproven in high level of confidence studies [4].

The animal model literature suggests that kombucha's health benefits are derived from the tea and from the products of fermentation, which include glucuronic acid, polyphenols, phenols, acetic acid and B-complex vitamins, including folic acid [7,8]. A number of in vitro and animal model studies have identified antimicrobial benefits, immune stimulation, detoxification, antioxidant, liver and gastrointestinal functions, anti-tumor properties, health prophylactic and recovery effects through immune stimulation; inhibiting the development and progression of cancer, cardiovascular disease, diabetes, and neurodegenerative diseases; and normal central nervous system function [7,8]. There are few clinical studies that follow the beneficial effects of Kombucha on diabetes for its hypoglycemic, lipid-lowering, and antioxidant effects [5].

Free radicals or metals like iron and copper found in a free state can oxidize lipids, proteins, and nucleic acids, and thus damage them. Most of the benefits of Kombucha derive from its content of antioxidant substances. The catechins found in green and black tea are polyphenol derivatives with potent antioxidant effects. They help prevent the oxidative damage of molecules. Glucuronic acid, another compound of kombucha helps create an enterohepatic circuit of polyphenols, leading to longer presence in the bloodstream and prolongation of

their antioxidant effect. Vitamin C and D-saccharic acid-1,4-lactone (DSL) can also be found in Kombucha and have proven antioxidant properties.

Protection against cardiovascular disease is given by tea polyphenols that prevent oxidation of low-density lipoproteins and therefore, the formation of atheroma. They also inhibit pancreatic lipase leading to lower cholesterol, and triacylglycerol levels, and increase smooth muscle relaxation leading to lower blood pressure. Ethanol is also found in Kombucha at low doses, no more than 5.5 g/L. Moderate consumption of alcohol is known to increase levels of high-density lipoproteins with a protective effect against coronary heart disease.

Tea polyphenols induce apoptosis of stomach cancer, colon cancer, and leukemic cells. They also inhibit key processes in the formation of tumors, such as kinase, methylase, and acetylase activity. These mechanisms explain the potential importance of Kombucha in cancer protection.

Glucuronic acid has the ability to bind with exogenous or endogenous toxins (bilirubin) and increase their clearing from the organism, enhancing liver detoxification.

Another feature of Kombucha is the potential hormonal regulation. Glucuronic acid can have a regulatory effect on steroid metabolism. It prevents deficiency by increasing steroid water solubility and bioavailability. It also prevents excesses by favoring intestinal elimination.

Moreover, several animal model studies showed antidiabetic properties, greater than those of tea alone [6].

A paper published in 2018 mentions the effect of Kombucha on gut microbiota in mice with non-alcoholic fatty liver disease (NAFLD). The results of the study showed favorable changes in gut microbiota, with beneficial effects on NAFLD [9].

Side effects reported of Kombucha

Even if Kombucha seems to have many potential benefits, yet to be investigated in large trials, we must, at the same time, start active research on side effects before being able to draw its safety profile. Current literature on this topic consists of case reports to mention various possible effects.

Toxic hepatitis was noted in one patient after drinking kombucha tea daily for two years. The diagnosis was based on the patient's history and the exclusion of other causes of acute hepatitis. There were no postulated mechanisms of toxicity [10]. Four other cases of increased liver enzymes are noted in literature after prolonged consumption of kombucha with remission after discontinuation as proof of causality [1,11,12,]. Cholestatic hepatitis was reported in one patient who consumed significant amounts of Kombucha for a month [13].

Lactic acidosis was one of the most cited side effects. It was noted in one patient with a prior diagnosis of only mild asthma who consumed Kombucha tea daily for several months [20]. Centre for disease control and Prevention in the US reported lactic acidosis in two women who drank Kombucha from the same source, daily for two months [14].

Hyperthermia, lactic acidosis, and acute renal failure in a patient newly diagnosed with human immunodeficiency virus were reported within 15 hours of ingesting kombucha. The suspected cause was bacterial or fungal contamination of the tea [11].

Anti-Jo1 antibody-positive myositis was noted in one patient after consuming Kombucha for 15 days. In this case, it is thought that tea components acted as a trigger of autoimmunity in a genetically predisposed patient [15].

Lead poisoning from brewing kombucha in a ceramic pot was reported in a couple in Australia. The female patient had symptoms consisting of chronic constipation and abdominal pain while her husband showed only fatigue. They both had significantly increased lead levels in their blood. After extensive measurements in their home, the toxic metal was found in high concentration in Kombucha tea. Some ceramic pots are covered with glaze or pigments rich in lead oxide and brewing acidic beverages in such pots may cause the release of high quantities of lead in the tea [16].

A cutaneous anthrax outbreak was reported in an Iranian community using kombucha mushrooms as a cutaneous painkiller [17].

Pellagra developed in a woman with malnutrition after consumption of more plant-based remedies and supplements, including Kombucha. It was not possible to determine the actual culprit, therefore, it was thought that complex interactions between malnutrition, ingestion of Kombucha, Acidophilus tablets, calcium, and zinc supplements led to decreased niacin absorption [18];

Allergic reactions were reported in 2 patients. They presented with shortness of breath, hypotension, tachycardia, and tachypnoea after consumption of Kombucha [1].

Hyponatremia is another side effect to be reported in one patient [19].

Another patient was admitted with xerostomia, dizziness, nausea, vomiting, and headache. Blood analysis found high levels of caffeine, linked to drinking caffeine-rich Kombucha tea [1].

Discussions

The health benefits of kombucha tea, the nutritional compounds, and metabolites, have seen an increased interest from the scientific community in recent years. Side effects on the other hand are only mentioned in some papers, mostly case reports with a low level of confidence. This makes it inaccurate to expand any of them to larger populations. In this research of literature, we noted 2 common points of developing side effects: constant consumption for longer periods and improper brewing conditions, probably resulting in contamination.

Some papers mention Kombucha being contraindicated in pregnant women and people with significant renal, pulmonary, or liver disease [5].

Still, important questions remain regarding the optimal dose and duration of Kombucha consumption, as well as some individual particularities which might dictate the risk of side effects associated with consumption.

Until finding answers to all these questions, we advise caution in recommending consumption. Also, when faced with unexplained pathologies, we stress the importance of asking about the use of plant-based remedies.

Conclusion

Because there are no studies on large numbers of humans, a conclusion cannot be taken. The human health benefits of kombucha need to be tested in further clinical trials.

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