

Hong Kong Student Science Project Competition 2021

Extended Abstract (Invention)

(Word Limit: 1,000 words, Pages: 2 pages only)

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Project Title: Edible disposables of kombucha of fruit skin 3.0

Project Type: Invention

**To our best knowledge and after thorough literature research, as at 1 / 3 /2022 , there are / ~~are no~~
* similar works. If there are, the reference links are as below:**

<https://journal.stemfellowship.org/doi/pdf/10.17975/sfj-2021-007>

Kombuchas of putrescibles as bio-disposables 2.0

The enhancement our project has made for the existing related products or research is summarized as below:

- In the above work, roasting time for kombucha of lemon skins and orange skins were 15 minutes and 30 minutes respectively. In our project, the roasting time can be controlled by the pH of the kombucha solution used so that kombuchas of skins other than lemon, such as pomelo skins and other fruit skins, when brewed in kombucha solution of lemon skins ($\text{pH} \leq 2.3$) could be roasted for 15 mins to increase the strength of kombuchas and waterproof property.
- In the above work, kombucha disposables were NOT tested to be edible. In our project, grilled kombucha disposables were tested to be edible as 48.0 μg of acrylamide (a carcinogen) per kilogram was found in drinking water soaked with edible kombucha of lemon skin grilled at 110-120°C for 15mins and 418 $\mu\text{g}/\text{kg}$ for 30mins using UV-spectrometer at 210nm and 275nm. They were within safety limits.

*Please delete if not applicable. HKSSPC values the originality of works. Students must conduct literature research thoroughly to ensure that their works are unique, and to list relevant reference materials to complement the research or invention.

I. Background

Edible disposables of grilled kombucha should be eco-friendly alternatives materials to replace plastics such as plastic straws. About 3300 metric tonnes of food wasted were produced daily in 2019 in HK and half of US produce were thrown away as they were not 'perfect'. Fruit skins actually could be the raw material to produce kombuchas. Kombuchas are cellulose membranes which are formed when bacteria present in scoby secrete bacterial cellulose membrane using tannin and other carbon-containing compound like glucose as raw materials. (Aduri, 2019) (Melih Güzel, 2020) Kombuchas obtained were roasted at 120°C for 15 mins so that strength of kombuchas and waterproof property would be enhanced.

II. Objectives

Edible disposables of grilled kombucha should be eco-friendly alternatives materials to replace plastics such as plastic straws. About 3300 metric tonnes of food wasted were produced daily in 2019 in HK and half of US produce were thrown away as they were not 'perfect'. Fruit skins actually could be the raw material to produce kombuchas. Kombuchas obtained from brewing fruit skins in sugar solution are edible and bio-degradable. When kombuchas were roasted at 120°C for 15 mins so that strength of kombuchas and waterproof property would be enhanced. Edible grilled and roasted kombuchas of fruit skins were tested and certified based on GB 18006-2008, ISO18188:2016 and New EU acrylamide legislation comes into force (foodingredientsfirst.com), so they are safe for consumption, biodegradable and had good strength.

III. Methodology

- Production of kombucha by brewing fruit skins such as pomelo skins in kombucha solution of lemon skins to attain $\text{pH} \leq 2.3$.
- Confirming structural changes taken when roasting/ grilling kombuchas at 120°C for 15 minutes using FTIR Spectrum II as ratio of absorbance at 3400cm^{-1} to that at 1660cm^{-1} .
- Testing and certifying the safe consumption and eligibility for marketing of edible kombucha disposables by carrying out the following: counting of bacterial colonies, determination of content of acrylamide using UV-spectrometer at 210nm and 275nm, testing based on GB 18006-2008 for cups and that on ISO18188:2016 for straws.

IV. Design of Invention

Kombuchas obtained from brewing fruit skins in sugar solution are edible and bio-degradable. When kombuchas were roasted at 120°C for 15 mins so that strength of kombuchas and waterproof property would be enhanced. Edible grilled and roasted kombuchas of fruit skins were tested and certified based on GB 18006-2008, ISO18188:2016 and New EU acrylamide legislation comes into force (foodingredientsfirst.com), so they are safe for consumption, biodegradable and had good strength.



V. Application / Market Need

Domestic science about restaurant equipment.

- Edible disposables of grilled kombucha should be eco-friendly alternatives materials to replace plastics such as plastic straws. According to the HKSAR government, 2,320 tonnes of plastic were sent to Hong Kong's landfills daily in 2019. Single-use plastic cups and straws were among them.
- Limitation: Laboratory analysis of content of acrylamide (a carcinogen) recommended by the Centre for Food Safety in HKSAR is by Liquid Chromatograph-Tandem Mass Spectrometry (LC-MS/MS) technique. There are eco-friendly and biodegradable edible utensils made of flours having about 65% w/w or above carbohydrate content (<https://patents.google.com/patent/WO2012098448A1/en?q=edible+cutlery&oq=edible+cutlery>) are basically food shaped into disposables. This carbohydrate-based edible cutlery had low tensile strength and dissolved in water rapidly. On the contrary, kombucha disposables are edible, bio-degradable, have high tensile strength and water-proof.

VI. Conclusion

1. Kombucha straws of grapefruit were bio-degraded completely in 6 weeks and grilled kombucha of grapefruit straws were completely bio-degraded in 9 weeks, so they are more bio-degradable and environmentally friendly than bio-degradable paper straw (bio-degraded by 60.4% in 9 weeks) and PLA straws (78.0% in 9 weeks). Plastic straws were not bio-degradable.
2. Grilled (at 110-120°C) kombuchas of tannin-rich sources such as black tea, grapefruit skins, lemon skins and pomelo skins were shaped into cups and straws. Edible disposables of grilled kombucha were safe for consumption as NO bacterial colonies were present in drinking water soaked with them for 2 hours and apparently,
3. 48.0 µg of acrylamide (a carcinogen) per kilogram was found in drinking water soaked with edible kombucha of lemon skin grilled at 110-120°C for 15mins and 418 µg/ kg for 30mins using UV-spectrometer at 210nm and 275nm. They were within safety limits. [New EU acrylamide]
4. All commercially available disposable cups and roasted kombucha cups (4.2<5%) met the standard of volume of deviation, pass the drop test with no cracks or splits and remained intact, pass the hot-resistance test with no deformations, peelings or wrinkles, and pass the water leakage resistance test with no water leakage based on GB 18006-2008, so roasted kombucha cups should be suitable for serving as disposable cups.
5. All commercially available disposable straws (except PLA polylactic acid & bamboo straws showed 3.3 ruptures out of 5) and roasted kombucha straws showed no rupture in the bending test and neither showed deformations nor colour fading after testing based on ISO18188:2016, so roasted kombucha straws should be suitable for serving as disposable straws.

Our project is developed based on our school's previous project and the enhancement is as below:

- In the previous project, roasting time for kombucha of lemon skins and orange skins were 15 minutes and 30 minutes respectively. In our project, the roasting time can be controlled by the pH of the kombucha solution used so that kombuchas of skins other than lemon, such as pomelo skins and other fruit skins, when brewed in kombucha solution of lemon skins (pH ≤2.3) could be roasted for 15 mins to increase the strength of kombuchas and waterproof property.
- In the previous project, kombucha disposables were NOT tested to be edible. In our project, grilled kombucha disposables were tested to be edible as 48.0 µg of acrylamide (a carcinogen) per kilogram was found in drinking water soaked with edible kombucha of lemon skin grilled at 110-120°C for 15mins and 418 µg/ kg for 30mins using UV-spectrometer at 210nm and 275nm. They were within safety limits.