

The Impact of Different Sustainable Extraction Approaches on the Phytochemical Profiles and Antimicrobial Activities of the Extracts of *Cinnamomum cassia* and *Illicium verum*

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Background

'Nutraceutical' is a term that was created by Stephen DeFelice in 1989 from the combination of nutrition and pharmaceuticals.¹ A nutraceutical is defined as a food or substance present in food which can provide health benefits such as the prevention and the treatment of diseases, including cancer, heart conditions, arthritis, diabetes, etc. The use of nutraceuticals is becoming a preferred approach instead of traditional pharmaceuticals based on the advantage of providing a natural way to achieve therapeutic results without causing negative side effects (e.g. nausea, impaired cognitive function, drowsiness, diarrhoea, headaches, etc). Another advantage of use of nutraceutical is that it offers a way to self-medicate rather than depending on medical advice from the healthcare system, thus allowing people to take responsibility for their own health.² *Cinnamomum cassia* and *Illicium verum* are ancient spices which date back to 3000 BC, and both have been used in Traditional Chinese medicine, contemporary medicine in East Asian countries, as well as being more often used in the culinary industry as species. *Cinnamomum cassia* is an evergreen tree that is distributed in southern China, India, Vietnam. Ancient Egyptians used it for mummification as well as making perfumes, and it was also used by the Chinese to preserve dead bodies. It has also been used as a therapeutic agent to treat different inflammatory diseases, atopic dermatitis, and anti-diabetic activities.³ *Illicium verum* is known by the name of Star aniseed and Chinese star anise and is a part of the Schisandraceae family.⁴ The *Illicium verum* tree is also a fragrant dark evergreen tree type which is native to China and southern Vietnam and is now also cultivated in Thailand and Japan. *Illicium verum* possesses a number of beneficial nutraceutical and pharmaceutical properties. It has been of interest in the cosmetic industry due to its antimicrobial, phytochemical, antioxidant and anti-inflammatory properties.⁵



Fig. 1. Powdered and dry sample of *Cinnamomum cassia* (top) and dry fruit of *Illicium verum* (bottom).

The overall aim of the project is to investigate the impact of the different extraction methods (ultrasound assisted extraction, pressure assisted extraction, hot water extraction, hot methanol extraction, microwave assisted extraction) with different parameters (temperature, time and power) on the phytochemical profiles of the crude extracts and the related antimicrobial activity of the extracts of *Cinnamomum cassia* [against *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*)] and *Illicium verum* [against *Candida albicans* (*C. albicans*) and *Salmonella enterica* (*S. enterica*)].

Results and Discussion

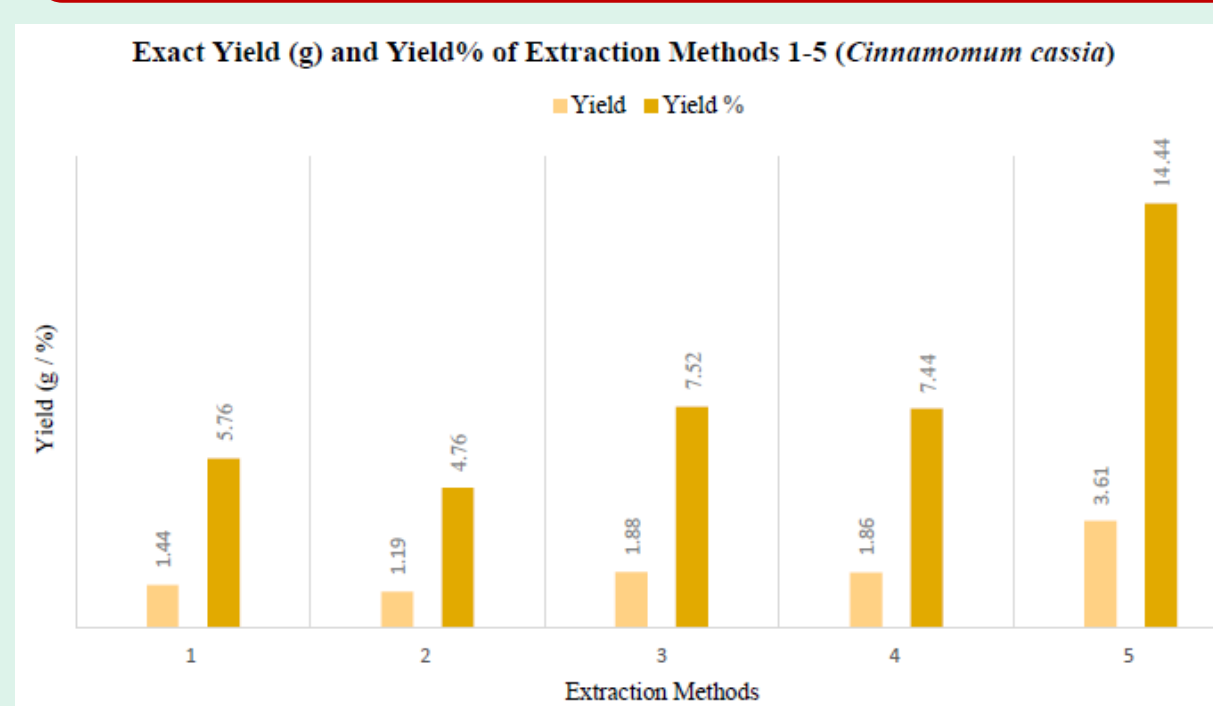


Fig. 2. Extraction exact yield and yield % of *Cinnamomum cassia* by method 1 (UAE-1), 2 (UAE-2), 3 (PAE), 4 (HWE-1), 5 (HME).

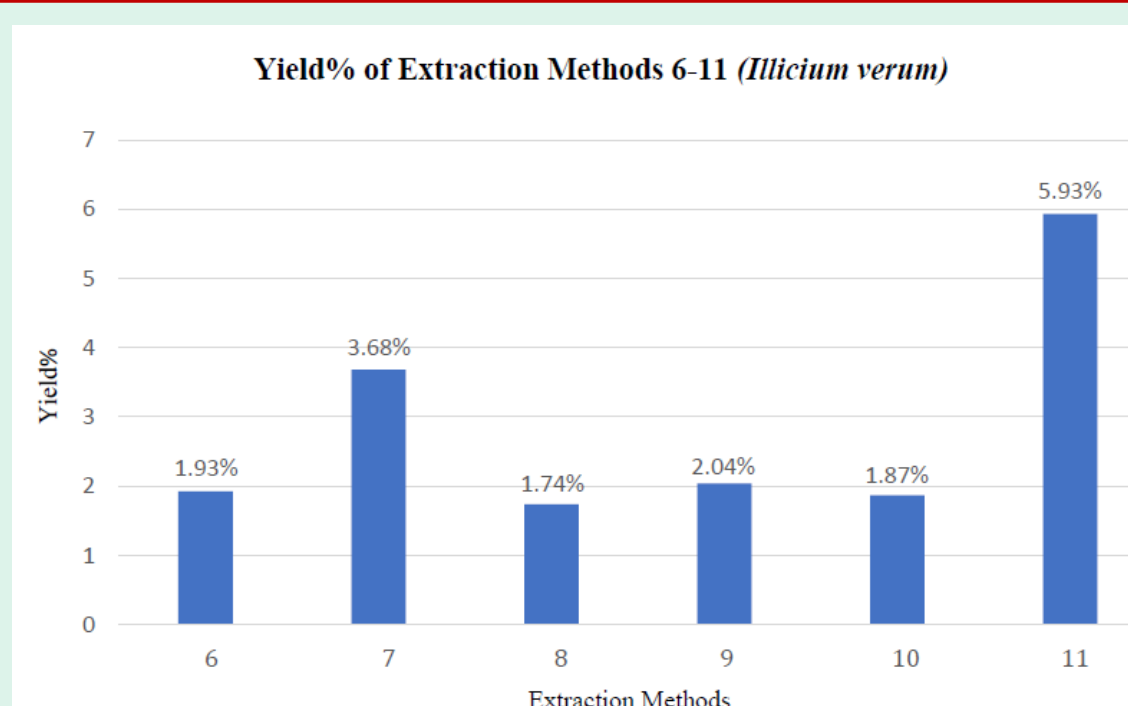


Fig. 3. Extraction yield % of *Illicium verum* by 6 (MAE-1, 150W/25°C), 7 (MAE-2, 150W/80°C), 8 (MAE-3, 400W/80°C), 9 (MAE-4, 400W/25°C), 10 (HWE-2, 25°C) 11 (HWE-3, 80°C).

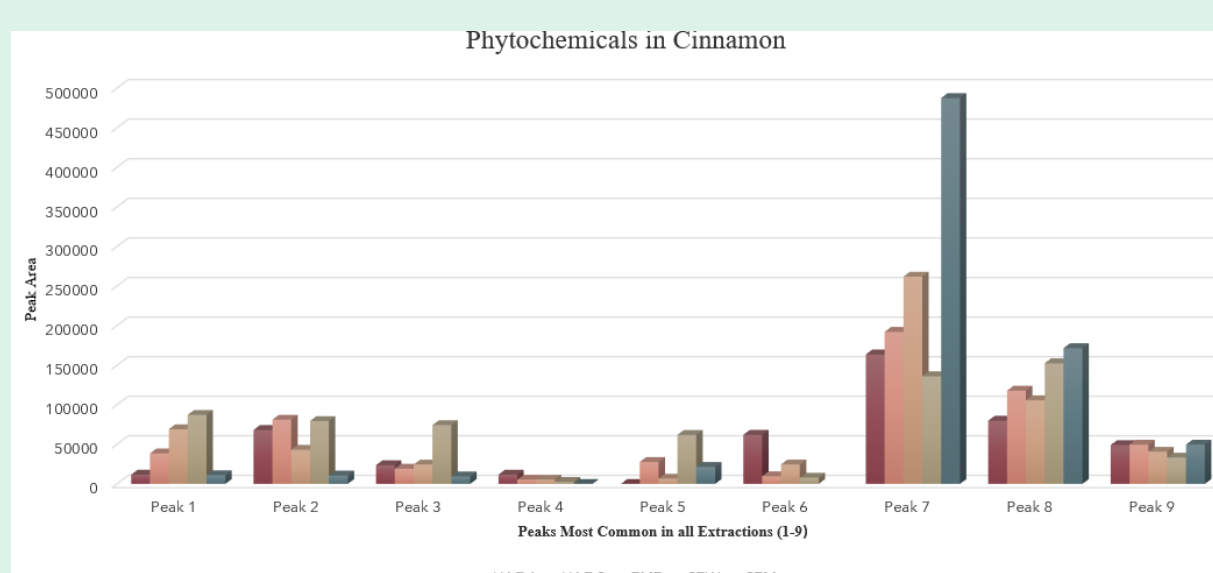


Fig. 4. Comparison of phytochemicals 1-9 found in the extracts 1-5 *Cinnamomum cassia*.



Fig. 5. ZOI testing (*Illicium verum*) against *S. enterica* (left) & *C. albicans* (right).

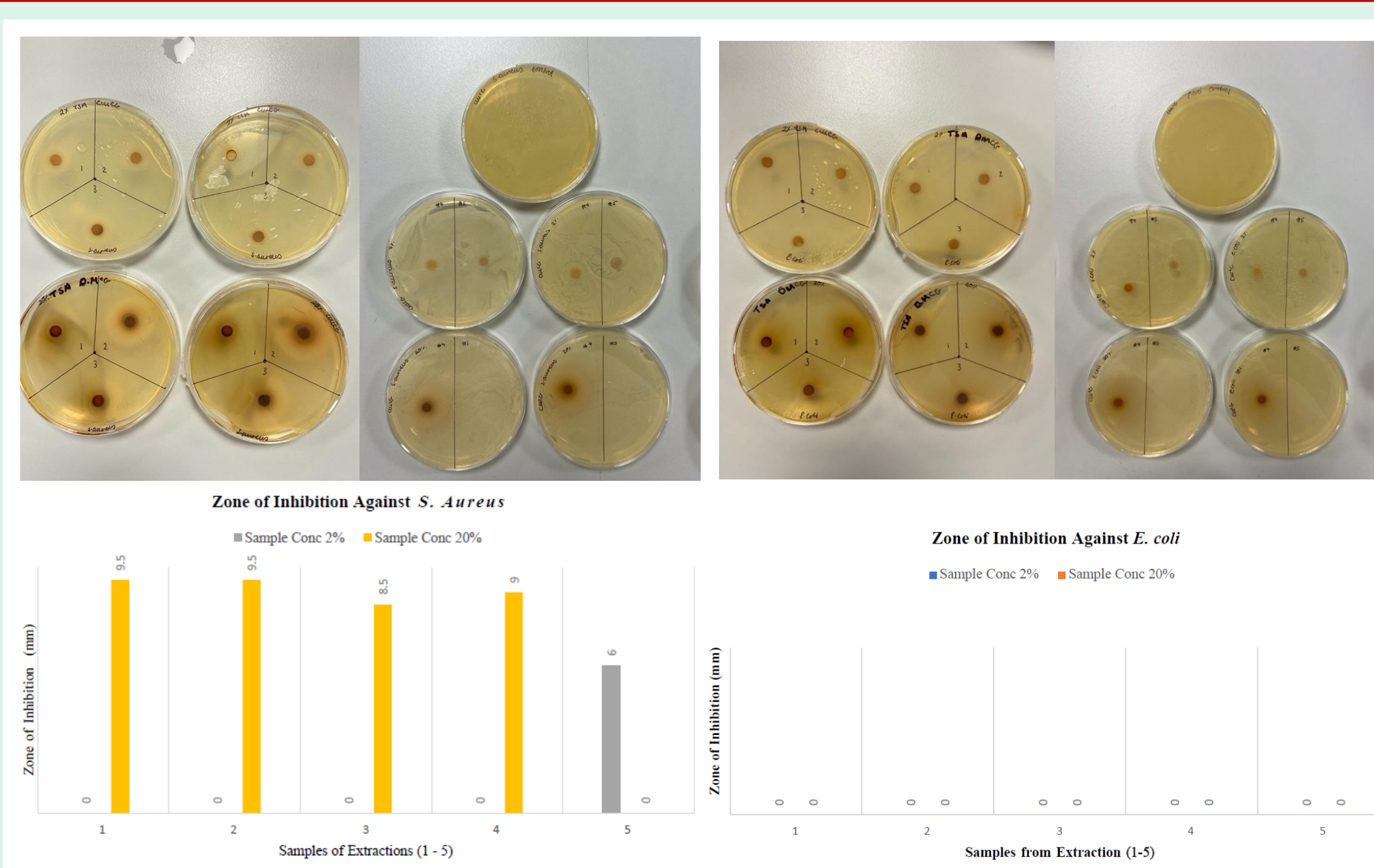
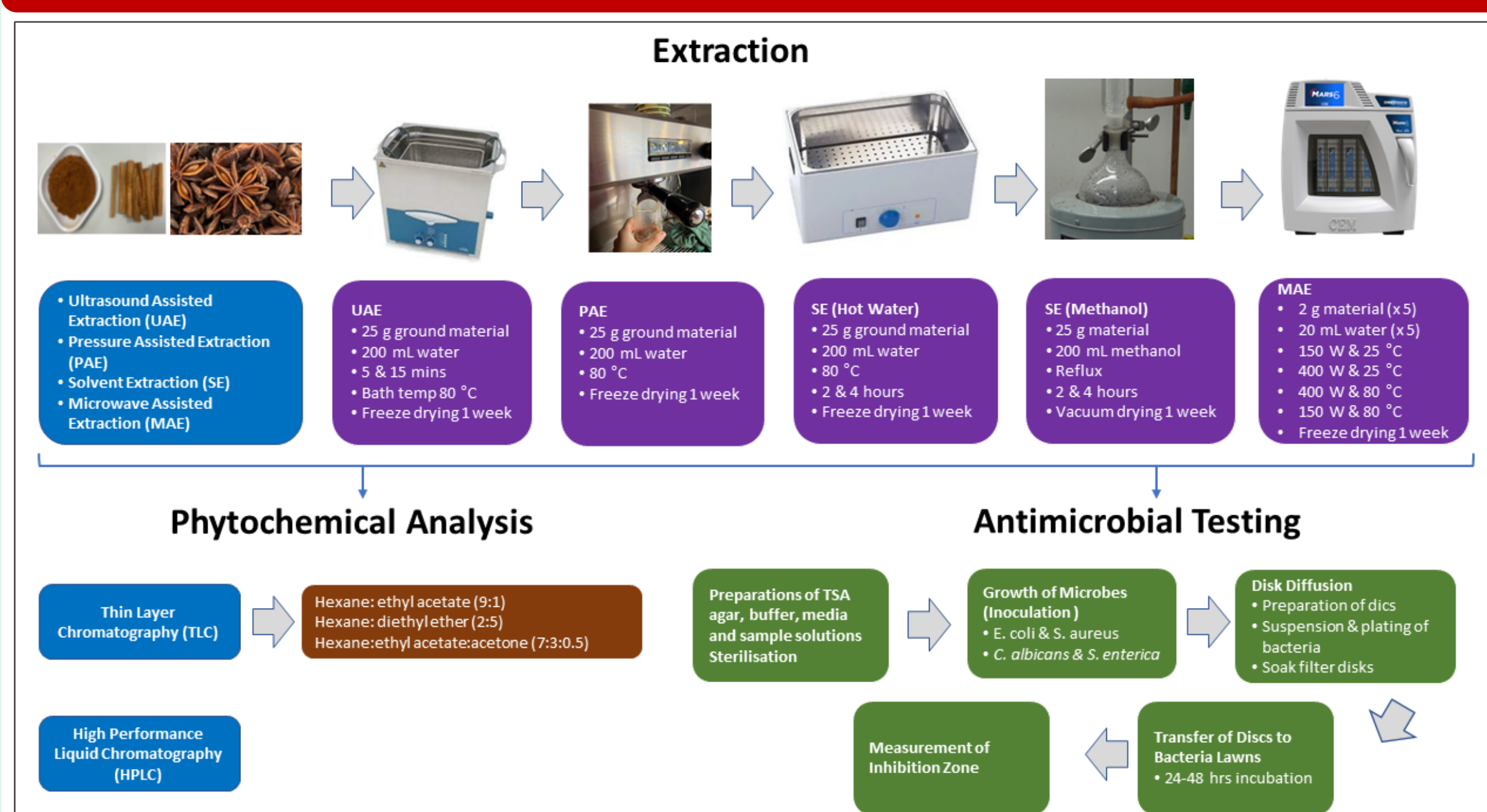


Fig. 6. ZOI testing (*Cinnamomum cassia*) against *S. aureus* (left) & *E. coli* (right).

- Disc diffusion highlighted the antimicrobial activities of *Cinnamomum cassia* against *S. aureus* (ZOI 9.5 mm at 20% concentration) and also indicated that in order to inhibit *E. coli*, higher concentrations are needed.
- Zone of inhibition (ZOI) of *Illicium verum* samples 6-11 against microorganism *S. enterica* (on tryptic soy agar) and *C. albicans* (on sabouraud dextrose agar) was performed.
- *Illicium verum* extract 10 (HWE-2, 25°C) with 10% concentration had the highest zone of inhibition of 1.3 cm against *S. enterica*. No other major inhibition was found.
- *Illicium verum* extract 8 (MAE-3, 400W & 80°C) with 2% concentration had the highest zone of inhibition of 1.0 cm against *S. albicans*.

Methodology



Conclusion

- Based on the TLC and HPLC analyses, extraction methods, temperatures and solvents directly impact the phytochemical profiles of the crude extract.
- Concentration of phytochemicals is directly proportional to the total antimicrobial activity.
- Espresso machine extraction (pressure-assisted) is a suitable method for the extraction of phytochemicals from natural products. It is a rapid, environmentally friendly and reproducible method.
- However, other measures could be put in place to increase the concentration of phytochemicals such as combining it with UAE for further extraction.
- Hot water extraction at 80°C for 4 hours produced the highest yield, 5.93%.
- Microwave assisted extraction 400W & 80°C for 15 minutes didn't produce expected high yield, 1.74%.
- HPLC results showed that sample 7 (MAE-2 150W & 80°C) contained the highest concentration of compounds present in the extracted sample, and sample 8 (MAE-3 400W & 80°C) had the lowest concentration of compounds present in extracted sample.

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