Microwaving wine – a scientific perspective

If you do an internet search for "microwave wine" you'll find that using a microwave oven to warm a glass of wine is a controversial subject. While some don't see anything wrong with warming a cool or cold wine to room temperature using a microwave oven, others seem to find the whole concept practically sacrilegious! In this column, AWRI Senior Oenologist Adrian Coulter approaches the question "Is it OK to bring a glass of wine to room temperature in a microwave oven?" from a scientific perspective.

Before we get stuck in, how do microwave ovens actually work?

Household microwave ovens use a device called a magnetron to emit electromagnetic (EM) radiation with a typical frequency of 2,450 megahertz (MHz), which is in the microwave range of the electromagnetic spectrum. Electromagnetic radiation travels in a waveform with oscillating electric and magnetic field components. When polar molecules such as water are subjected to EM waves, they align themselves with the electric field and oscillate (rotate) with the oscillations associated with the EM waves. However, in the case of microwaves, where the oscillations might be 2,450 million times per second, water's oscillations lag behind the microwave oscillations and become disordered. These disordered oscillations result in collisions (friction) with neighbouring molecules, which manifests as heat. In summary, when a liquid such as water, or a food containing water molecules, is placed in a microwave oven, energy from microwave EM radiation is transferred to both rotational and kinetic energies of water, the kinetic component of which results in heating.

Hang on, did you say radiation?!

Yes, microwaves are a form of EM radiation, as are the other types of waves in the electromagnetic spectrum, as shown in Figure 1. While the word 'radiation' might sound alarming, it is high-energy, ionising radiation that is generally associated with damage to biological tissue. Electromagnetic radiation does not become ionising until the frequency is in the ultraviolet region, which has much shorter wavelengths and higher frequencies than microwaves.

Microwave radiation is non-ionising radiation and the heating of water and aqueous materials produces only thermal effects that are equivalent to conventional heating (Huang and Richert 2008).

So, what's the difference between 'conventional' heating and microwave heating?

In conventional heating, heat is transferred to the surface of a material by conduction, convection or radiation. Consider heat applied to a container holding water (Figure 2). The container warms up and transfers heat to the water in contact with it via conduction, and then heat is transferred throughout the body of water via conduction and convection. This type of heating is non-uniform, with the water touching the surfaces of the container becoming hotter than the water in the middle of the container. It takes longer for the water in the middle of the container to reach the required temperature than the water touching the surfaces of the container, which is likely to be hotter. This is also the case if a bottle of wine (which is largely water) is held under a the hot water tap to warm it up.

In contrast to conventional heating, microwave radiation penetrates the water directly, transferring heat throughout the volume without the need for any intermediate heat transfer medium. Water in the microwave scenario is heated uniformly throughout the volume, whereas water in the conventional scenario is not heated uniformly, with some of the water likely being 'over-heated'. In their review of microwave processing of fluid foods, Salazar-González *et al.* (2012) indicated the advantages of microwave heating over conventional heating included reduced processing time, high energy efficiency and improved food quality. Consequently, warming a glass of wine using a microwave oven is likely to be less detrimental to the wine than warming using other methods.

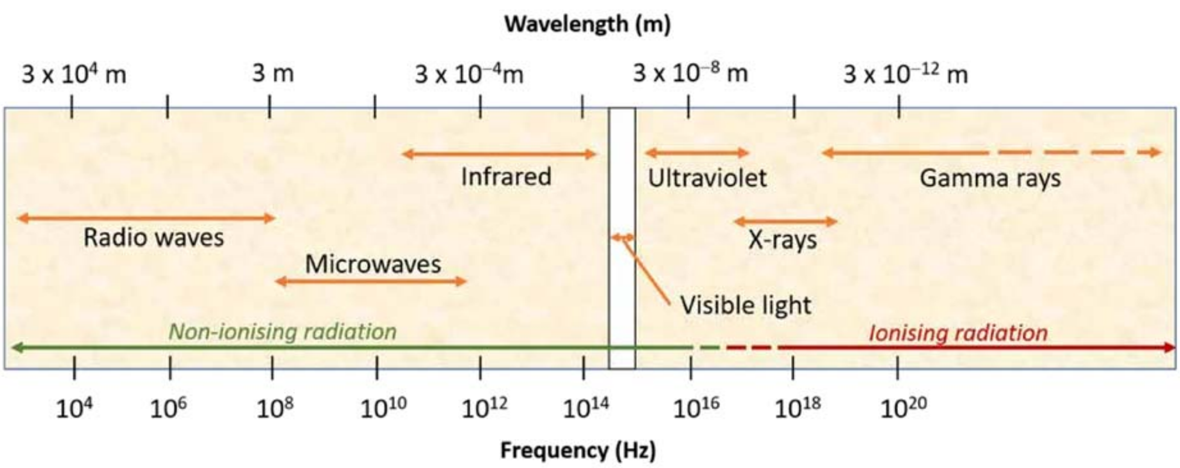

Figure 1. Electromagnetic spectrum

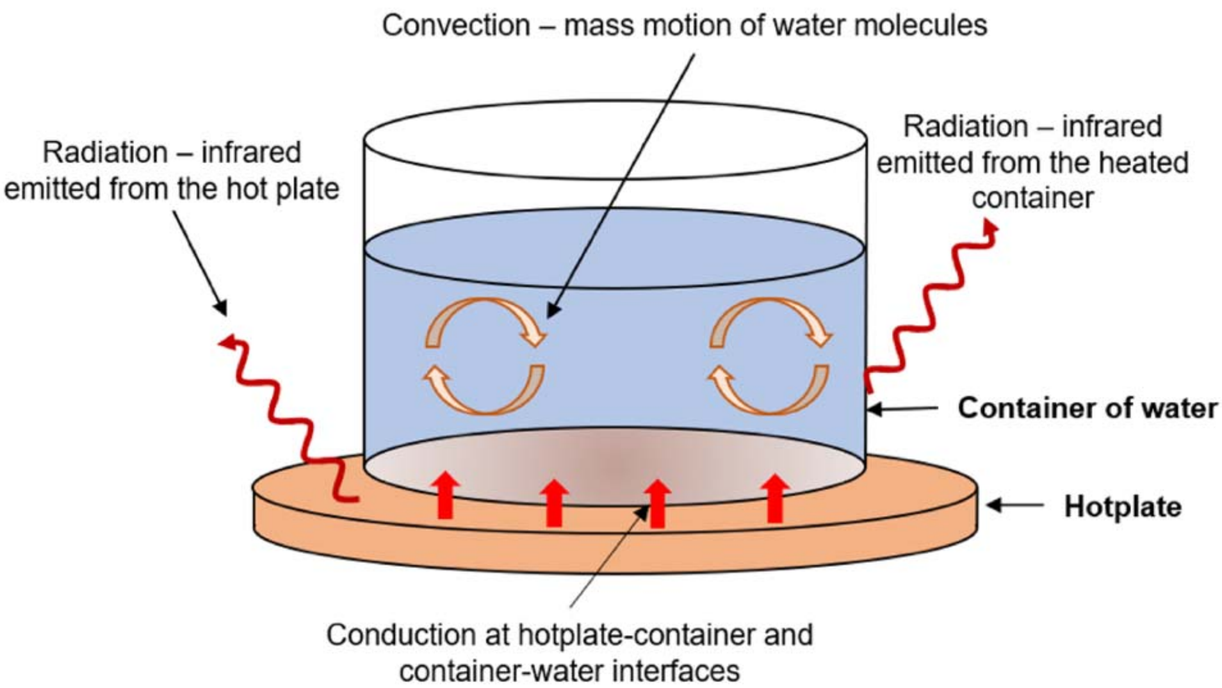

Figure 2. Heat from a hotplate applied to a container holding water shows the different ways energy is transferred. With conduction, kinetic energy is transferred during molecular collisions, which results in the transfer of energy (heat); with convection, heat is transferred by the mass movement of water molecules; and with radiation, heated bodies emit energy in the form of electromagnetic radiation.

Since it's ok to use a microwave, how long should I 'cook' my glass of wine for?

The answer to this question is: not very long! However, the exact time will depend on the output power of the microwave oven and the temperature of the wine. The author found it took approximately 15 seconds to warm 100 mL of red wine in an XL5 wine glass from 4°C to 20°C using a microwave oven with an output power of 1,000 W (input power 1,500 W). However, it is best to take a cautious approach by starting with 5 seconds, checking the result and then warming for a few more seconds if the wine is still too cold.

For further information on microwaving wine or any other technical winemaking or grapegrowing issues, contact the AWRI helpdesk on helpdesk@awri.com.au or 08 8313 6600.

References

Huang, W. and Richert, R. 2008. The physics of heating by time-dependent fields: microwaves and water revisited. *J. Phys. Chem. B.* 112(32): 9909-9913.

Salazar-González, C., San Martín-González, M.F., López-Malo, A. and Sosa-Morales, M.E. 2012. Recent studies related to microwave processing of fluid foods. *Food Bioproc. Technol.* 5(1): 31-46.

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