INSIGHTS INTO HYPERTHERMIA EFFECTS IN LASER-BASED THERAPIES

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INTRODUCTION

Laser-induced hyperthermia has gained recognition as an effective treatment modality offering potential benefits for various diseases, including cancer. To determine tissue damage accurately, hyperthermia treatments heavily rely on understanding tissue temperature and the duration of heating. However, laser safety is frequently underestimated due to the misperception that lasers emit non-ionizing radiation. To maximize treatment effectiveness and ensuring patient safety, it is important to understand tissue penetration depth and temperature changes in laser-induced hyperthermia [1][2].

OBJECTIVE

This study aims to investigate the depth of tissue penetration and temperature changes induced by laser-based hyperthermia, providing insights into the thermal response within tissue and optimization of laser therapy parameters.

CONCLUSION

In conclusion, hyperthermia treatments demonstrate their potential as promising therapeutic modalities. The key understanding between laser energy absorption, heat generation, and temperature changes are crucial. By customizing laser therapy parameters based on tissue depth considerations and real-time temperature monitoring, clinicians can achieve heightened treatment precision and safety. Further research in hyperthermia will continue to unlock new frontiers, leading to safer and more effective clinical implementation for the benefit of patients.

METHODOLOGY

A blue (473 nm) diode pumped solid-state (DPSS) laser with output power of 100 mW (5mm beam diameter) was used to irradiate breast chicken tissue (6 cm in diameter and thickness of 3 cm). The depth of tissue penetration was measured using spectrometer, and temperature changes were monitored using thermocouples at various distances (0.2 - 2.2 cm) from the laser source.

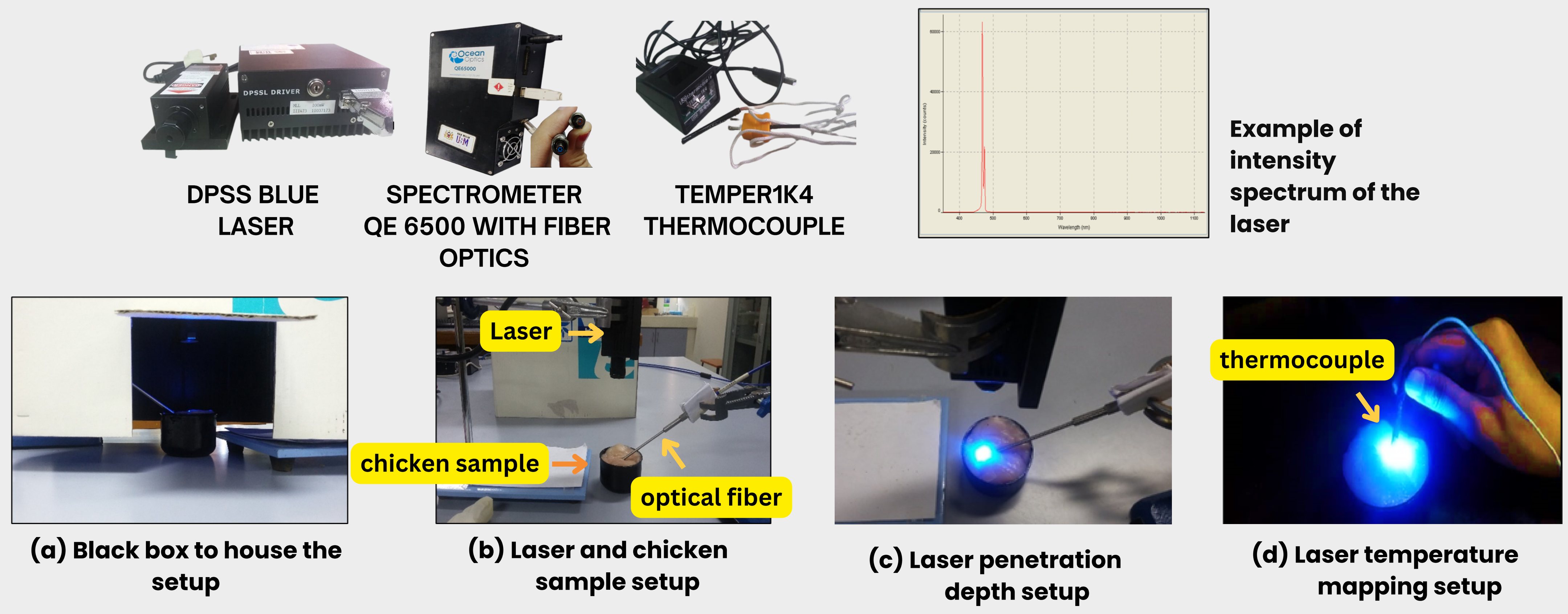

Figure 1: Temperature mapping materials and experiment setup.

RESULTS

The intensity of the laser light at the different distance between the optical fiber and the irradiated laser on the sample is presented in Figure 1. The maximum intensity transmitted was observed at 0.6 cm, reaching 63,121 a.u while the highest penetration depth at 2.6 cm recorded with only 904 a.u. The intensity of laser decreased as distance increased.

During irradiation, the laser energy is absorbed by the water in the chicken tissue sample, leading its conversion into heat [3]. As the irradiation duration increased, the accumulation of laser energy in the tissue also increased, causing a rise in sample temperature, which is measured using a thermocouple. Maximum temperatures recorded at 0.5 cm is 50 °C, while at 1.0 cm, was 37.5 °C. However, caution should be exercised during prolonged laser exposure, as the chicken sample's surface exhibited signs of burning and discoloration as shown in Figure 4. This outcome highlights the importance of controlling the irradiation duration and intensity to avoid adverse effects on the sample and ensure patient safety.

The findings emphasize the correlation between laser energy absorption, heat generation, and sample temperature rise. Understanding these relationships is crucial for optimizing laser-induced hyperthermia treatments and minimizing potential risks associated with laser exposure.

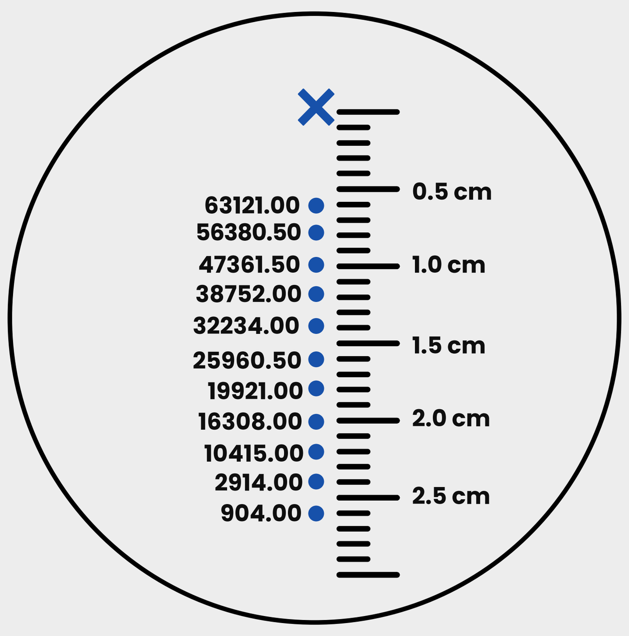

Figure 2 : Intensity of laser light at different distance

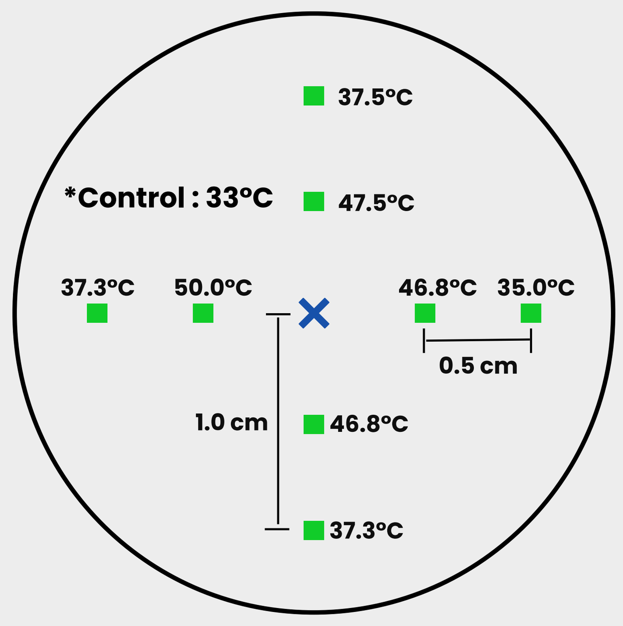

Figure 3 : Temperature mapping at 0.5 and 1.0 cm distance

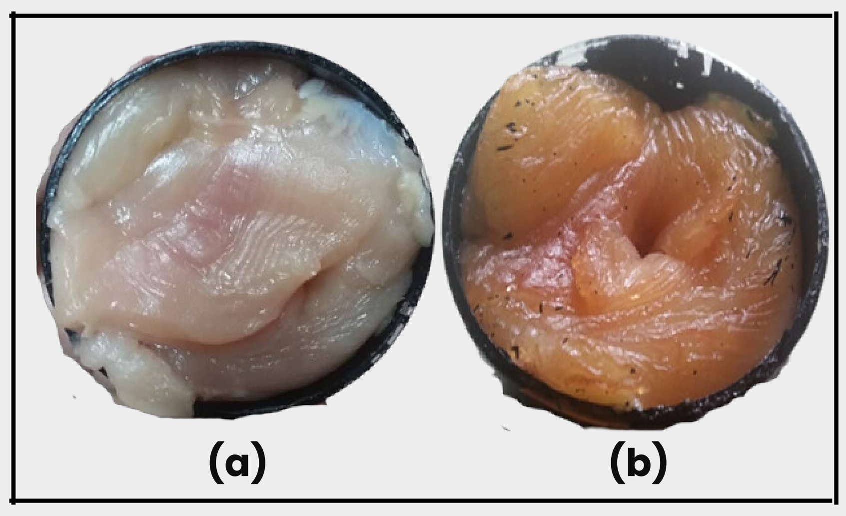

Figure 4 : Chicken sample (a) before and (b) after laser irradiation

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