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Non-Invasive Estimation of Metabolite Concentrations Using Infrared Thermal Imaging and Machine Learning

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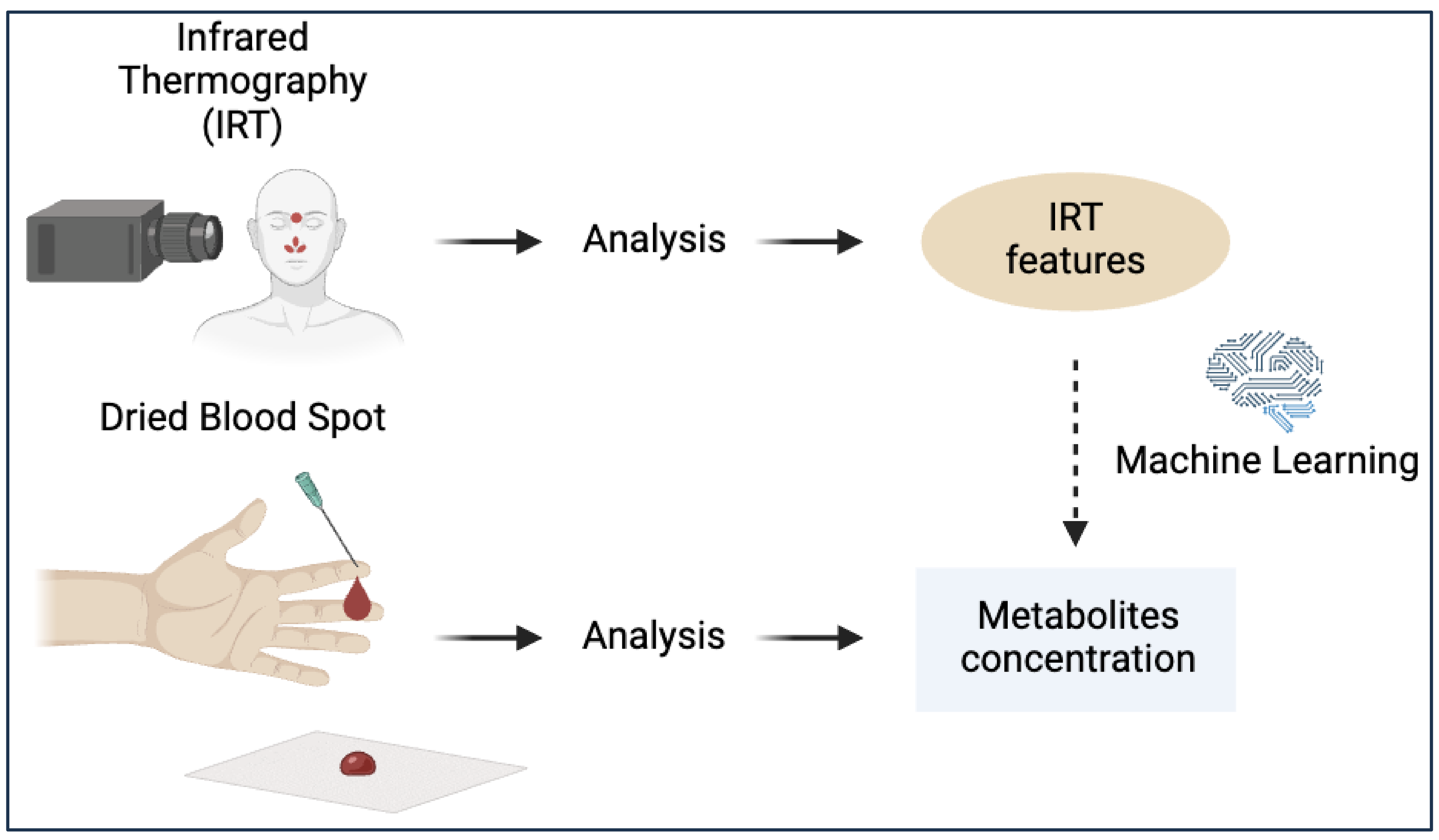
INTRODUCTION & AIM

Evaluating the concentration of metabolites is crucial for understanding metabolic pathways and for disease diagnosis and monitoring[1].

The development of non-invasive techniques able to measure metabolites avoiding blood withdrawal could be beneficial for healthcare outcomes. In this context, estimating the concentration of metabolites from skin temperature is an intriguing approach that leverages the relationship between metabolic processes and physiological parameters. Skin temperature can depend on fat metabolism and peripheral blood circulation[2]. In this study, a machine learning model applied to facial thermal imaging features was implemented to predict the metabolites' concentration as assessed through blood samples.

METHOD

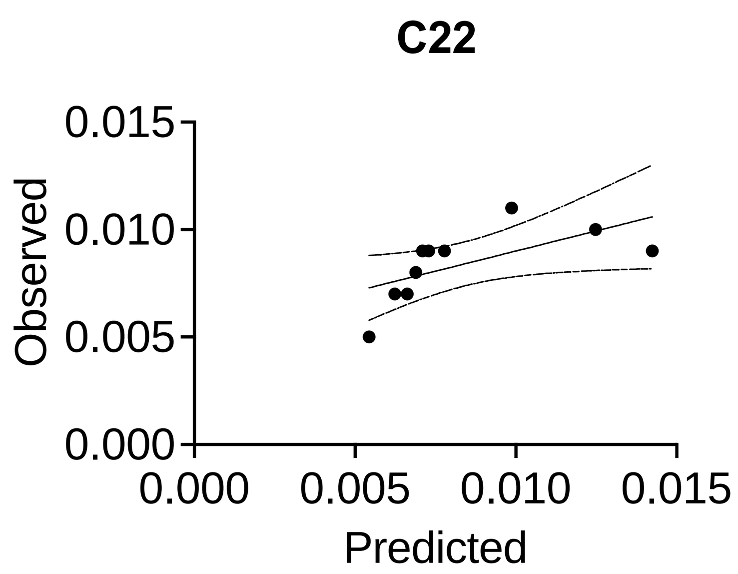
Figure 1. Experimental procedures

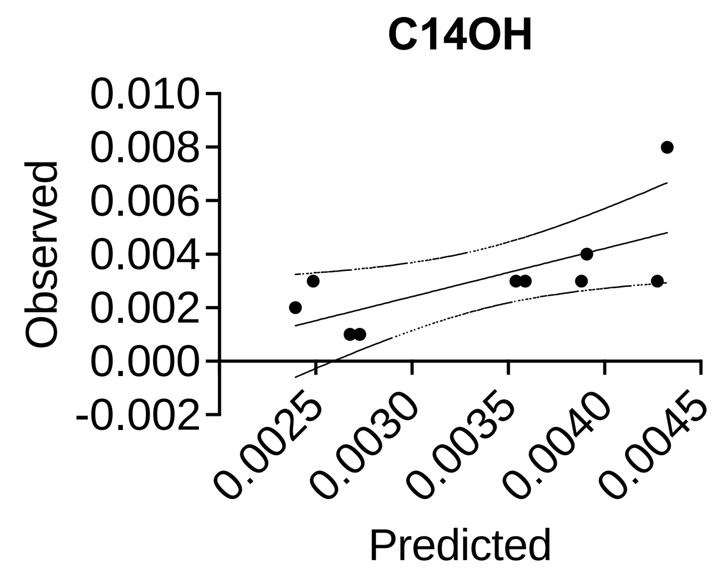


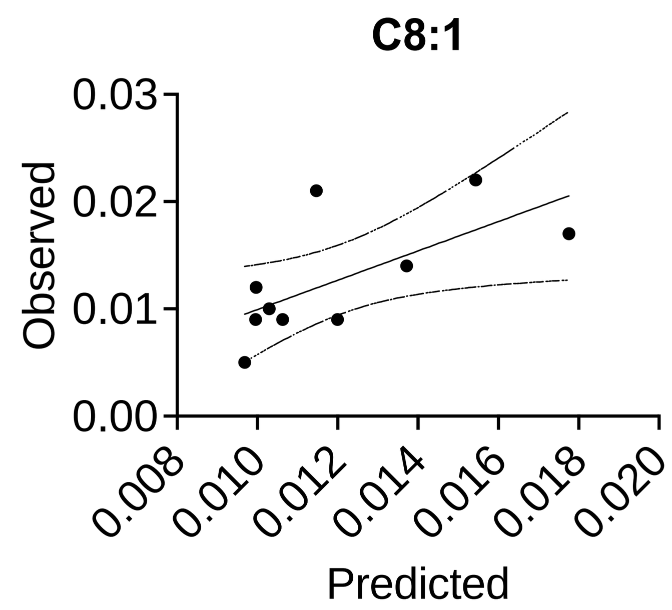
Whole blood was collected as a dried blood spot (DBS). The determination of metabolites was performed in DBS samples by the addiction internal standards for each analyte of interest before the extraction. Regarding the IRT, three ROIs were selected on the glabella, nose tip, and nostrils. Mean, SD, kurtosis, skewness, delta of the signal, sample entropy, 75° percentile, the PSD of the thermal signal for the respiratory, cardiac, and myogenic frequency bands were computed. These features were used as input for a cubic SVR model. A subset of the features was employed as an input of the ML framework, after a selection based on wrapper method. A fivefold cross-validation was implemented. The performance of the models was evaluated by correlation analysis.

RESULTS & DISCUSSION

The approach delivered good results for the C22 (R=0.63, p=0.001), C14OH (R=0.67, p=1.7·10-4), and C8:1 (R=0.66, p=1.8·10-4). The approach seems to be able to evaluate the concentration of metabolites related to obesity and metabolic disorders.







Metabolite	RMSE	R	P value
C22	0,0021	0.63	0.001
C14OH	0,0015	0.67	1.7·10-4
C8:1	0,0042	0.66	1.8·10-4

Figure 2. Summary of main results.

CONCLUSION

The results highlight the possibility of evaluating metabolites concentration from thermal imaging, providing a novel approach that offers advantages, including increased patient comfort and compliance, and reduced risk of infection.

FUTURE WORK / REFERENCES

Future work should include bigger samples and different populations to confirm such results.

References

1) Qiu S. et al., Signal Transduction and Targeted Therapy (2023)
2) Veselá S. et al., Journal of Thermal Biology (2019)