

Chemical Engineering Thesis Defense

Understanding Metabolic Health and Substrate Utilization in the Human Body

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Abstract

Obesity has consistently presented a significant challenge, with excess body fat contributing to the development of numerous severe conditions such as diabetes, cardiovascular disease, cancer, and various musculoskeletal disorders. In this study, different methods are proposed to study substrate utilization (carbohydrates, proteins, and fats) in the human body and validate the biomarkers enabling to investigate weight management and monitor metabolic health. The first technique to study was Indirect calorimetry, which assessed Resting Energy Expenditure, and measured parameters like oxygen consumption (VO_2) and carbon dioxide production (VCO_2). A validation study was conducted to study the effectiveness of the medical device Breezing Med with Medical Graphics (MGC) CPX Ultima™ determining REE, VO_2 , and VCO_2 . The results obtained were compared with correlation slopes and R - R-squared coefficients close to 1. Indirect Calorimetry can be used to determine carbohydrate and fat consumption based on the RQ values but protein utilization can be studied by analyzing urinary nitrogen, a secondary technique was studied for identifying urea and ammonia concentration in human urine samples. A colorimetric technique was validated against the Ion-Selective method. The results were then compared by plotting calibration curves. Equations were developed for carb oxidation and fat oxidation based on VO_2 and VCO_2 consumption. Substrate Utilization was studied for 16 subjects with a normal diet, the fat and carbohydrate in gram/minute was measured before and after three interventions - meal, fasting, and exercise.

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