APPLICATION OF NEAR INFRARED REFLECTANCE SPECTROSCOPY (NIRS) TO MEASURE PROTEIN, FAT, ENERGY, AND MOISTURE IN FISH, MEAT, AND WHOLE PREY

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Introduction

Knowledge of feed composition is critical for providing optimal nutrition to animals managed under human care. Fish, whole prey, and muscle meat are prone to wide fluctuations in nutrients depending on the species, region, season, storage conditions, and the animal part fed (Dempsey & Bernard, 1999). Same species may also vary in composition, depending on physiological stage, and diet (Bernand & Allen, 2002; Mejia-Fave *et al*., 2014). The use of imprecise feed data may have deleterious effect on animal health, therefore quality control is important. Gold standard methods of feed testing are costly and time consuming and are not practical in a fast-paced zoo setting with a modest budget. Near infrared reflectance spectroscopy (NIRS) is an environmentally safe, cost-effective analytical method, which allows for instant estimates of composition. This technology has been used in the agricultural industry for decades and has been applied to predict feed and fecal composition, digestibility of diets fed to cattle (Jancewicz *et al*., 2016, 2017), and to characterize meat products (Prieto *et al*., 2017). Near infrared reflectance spectroscopy has also been successful in predicting moisture, protein, and fat in fish fed in zoos (Valdes *et al*., 1997; William *et al*., 2015).

Abstract

The objective of this study is to begin the development of a universal NIRS calibration for feed from a variety of animal sources fed to animals managed under human care. Feed samples (n = 90) from animal sources including rodents, poultry, fish, squid, insects, horse, beef, and rabbit were collected over two years. Samples were homogenized using a heavy-duty grinder and, prior to lab analysis, were scanned using the industrial grade Labspec NIRS for collection of spectral data. Year 2 samples (n = 41) were also scanned using the TellSpec, an economical handheld NIRS instrument. The variety in samples provided a wide range in moisture (58.8-84.1%), protein (11.7-24.6%), fat (0.33-25.2%), and energy (624-2920 kcal/kg), on an as-fed basis. Prediction equations were developed using the lab analysis as reference values and the Labspec spectral data with promising cross validation equations for protein (R^2cv > 0.84, SECV = 4.51), fat (R^2cv > 0.89, SECV = 4.06), moisture (R^2cv > 0.83, SECV = 2.66), and energy (R^2cv > 0.70, SECV = 299.9). The accuracy of the two instruments was compared in year 2 by randomly removing a subset of the samples, to be used as a validation set (n = 11). Both instruments were excellent at predicting moisture (Tellspec R^2P = 0.93 and SEP = 1.48; Labspec R^2P = 0.97 and SEP = 1.03), and comparable at predicting fat (Tellspec R^2P = 0.88 and SEP = 3.35; Labspec R^2P = 0.87 and SEP = 3.45) and protein (Tellspec R^2P = 0.77, SEP = 3.99; Labspec R^2P = 0.77, SEP = 4.02). The Tellspec predicted energy (R^2P = 0.78, SEP = 214.3) more accurately than the Labspec (R^2P = 0.73, SEP = 235.7). These data indicate that the affordable handheld instrument can be used to develop calibrations for protein, fat, moisture, and energy in undried, homogenized fish, meat, and whole

prey items. With the help of technological advancements in data sharing, there is potential to create a zoo NIRS network that would allow nutritionists all over the world to collaborate by synchronizing spectral data and validate calibration models for similar samples.

Acknowledgments
This research was funded and made possible by the Zoo and Wildlife Nutrition Foundation.

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