

Evaluation of wedge wire screen as a new tool for faeces collection in digestibility assessment in fish: The impact of nutrient leaching on apparent digestibility of nitrogen, carbon and sulphur from fishmeal, soybean meal and rapeseed meal-based diets in rainbow trout (*Oncorhynchus mykiss*)

Jon Øvrum Hansen

Department of Animal and Aquaculture Sciences, Faculty of Biosciences, Norwegian University of Life Sciences, P.O. Box 5003, NO-1432 Aas, Norway

Abstract

The study was carried out to evaluate wedge wire screen as a potential tool for collecting fish faeces from the tank outlet water. Apparent digestibility (AD) estimates of carbon (AD_c), nitrogen (AD_N), sulphur (AD_S), organic material (AD_{ORG}) and individual amino acids obtained by the wire screen were compared with stripping. Three diets, with fishmeal, [soybean meal](#) (SBM) or [rapeseed meal](#) (RSM) as main protein source were extruded and fed to triplicate groups of 120-g [rainbow trout](#) (*Oncorhynchus mykiss*). Faeces were obtained by gentle stripping from the distal abdomen, and by collection from a wedge wire screen 15, 30, 60, 120 and 240 min post feeding. AD_{ORG}, AD_N and AD_S obtained by collection on the screen were significantly ($P < .05$) higher than those obtained by stripping, except for some values for AD_c. Differences in AD between stripping and faeces collected with the wire screen were lower than reported for other methods of collection from water media. Most of the increase in AD of nutrients for wedge wire screen occurred during the first 15 min after defecation. The AD_{ORG}, AD_c, AD_N and AD_S were lowest in the RSM diet. The AD of amino acids followed the same pattern as AD_S. AD_S in the rapeseed diet was particularly low (54.7%), compared to the fishmeal (72.4%) and SBM diet (70.1%). In addition to AD of cysteine, low digestibility of [glucosinolates](#), its degradation products and other sulfonated components are likely reasons for the low AD_S. Faeces from the RSM based diet had higher dry matter (DM) concentration than the SBM based diet. Faecal DM recovery for SBM was lowest among the diets for both collection methods. The low DM recovery for the SBM faeces did not affect AD estimates of faeces at the different time intervals, possibly due to simultaneous leakage of nutrients and indigestible marker. In conclusion, the use of wedge wire screen for collection of faeces represents an interesting supplement to stripping. The AD estimates had low random variation and nutrient leaching during faeces collection were dependent on dietary composition.

Keywords:

Apparent digestibility, Stripping, Wedge wire screen, Fish meal, Soybean meal, Rapeseed meal, Antinutrients.

Introduction

Determination of apparent digestibility (AD) is an important first step in nutrient optimization of fish feed. Digestibility measurement in fish relies on collection of faecal samples and use of inert markers added to the feed ([Edin, 1918](#)). The methods that have been used for faecal collection in fish include direct collection from the intestine through anal suction ([Spyridakis et al., 1989](#); [Windell et al., 1978](#)), stripping of faeces from the posterior intestine ([Austreng, 1978](#)), dissection and removal of faecal material from the posterior intestine ([Austreng, 1978](#); [Percival et al., 2001](#)) and collection of faeces from the water medium ([Cho and Slinger, 1979](#); [Choubert et al., 1982](#); [Spyridakis et al., 1989](#); [Windell et al., 1978](#)).

Stripping of faeces has been reported to give reliable and highly correlated AD estimates to the dissection method ([Austreng, 1978](#)). However, this method and other direct collection methods from the posterior intestine are criticized for the risk of removal of faeces before natural retention time is completed, and thereby limiting digestion and nutrient absorption capacity ([Possompes, 1973](#); [Vens-Cappell, 1985](#)). Faeces collected from water media have a natural retention time in the gut but are subject to leaching which will result in overestimation of AD ([Choubert et al., 1979](#); [Choubert et al., 1982](#); [Glencross et al., 2007](#); [Spyridakis et al., 1989](#); [Vandenberg and De La Noüe, 2001](#); [Windell et al., 1978](#)). The rate of nutrient leaching from faeces increases with time exposed to water ([Windell et al., 1978](#)), but is reported to be rapid within the first 5 min in water ([Possompes, 1973](#)). Rapid collection of faeces from water is therefore necessary to reduce leaching. The rapid faeces

collection techniques, such as the continuous filtration method and immediate pipetting of faeces from water showed the lowest rate of leaching compared to the decantation method in the study by [Spyridakis et al. \(1989\)](#).

Diet composition affects faecal consistency and is a key factor that can determine the rate of nutrient leaching from faeces. The presence of non-starch [polysaccharides](#) (NSP) from plant ingredients in salmonid feed has been reported to cause increased water content in faeces ([Storebakken, 1985](#)). [Soybean meal](#) (SBM) in salmonid diets is also associated with increased faecal water content caused by osmotically active short [oligosaccharides](#) that reduce water absorption in the distal intestine ([Kraugerud et al., 2007](#); [Olli et al., 1994](#); [Refstie et al., 1997](#); [Refstie et al., 1999](#)). [Rapeseed meal](#) (RSM) have often low protein digestibility in salmonids and contains antinutritive components such as [glucosinolates](#), [lignins](#), [phytic acid](#), [tannins](#), protease inhibitors, indigestible oligosaccharides and NSPs ([Francis et al., 2001](#); [Knudsen, 1997](#); [Mwachireya et al., 1999](#)).

The wedge wire screen is a stainless-steel wire mesh placed at an inclined position in the outlet water column of the tank. It is used for the collection of uneaten feed and faeces that are removed from the tank along with the outlet water. The design of the wire screen ensures efficient drainage, such that uneaten feed and faeces trapped on the screen have minimal contact with water. This may provide an advantage of reduced nutrient leaching from faeces required for the AD estimation of nutrients.

The aim of this experiment was to evaluate the wedge wire screen as a tool for faeces collection in AD assessment in fish. The rate of nutrient leaching on the wire screen collector was also investigated with time of faeces collection, and AD estimates were compared with the stripping method. Three different diets containing fishmeal (FM), SBM and RSM differing in their contents of NSP and indigestible sugars, as main protein sources were used in the digestibility assessment. In addition, the total amount of faecal nutrient and DM, over a given period, were compared with the digestibility values and the relative amount of DM collected by the stripping method. This was done to investigate the leakage of nutrients to the [recirculating aquaculture system](#) (RAS) depending on the dietary composition of the diet given.

Conclusions

The low rate of leaching observed with time using the wedge wire screen, compared to other methods of faeces collection in water, indicates that it is an effective tool for faeces collection from the water medium. The major challenge observed with collection of faeces from water media in the present study was the immediate loss of nutrients after defecation. Digestibility results obtained for faeces collected from the water column, independent of collection method, should not be used as indicator for nutrient loss from faeces. Furthermore, feed composition and characteristics play a significant role in determining faecal properties and can to a significant extent reduce nutrient loss from faeces.

jon.hansen@nmbu.no