

Kurzmitteilung

Exocrine pancreatic secretions in pigs as influenced by the source of carbohydrate in the diet

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Untersuchungen am Modelltier Schwein zum Einfluß unterschiedlicher Kohlenhydrate in der Diät auf die exokrine Pankreassekretion

Summary: Four barrows, initial wt. 70 kg, fitted with permanent pancreatic cannulas according to the "Pouch Method", were used to investigate the effect of dietary inclusion of pectin on pancreatic secretions. The pigs were fed two corn starch-based diets, containing 16 % crude protein from soybean meal, with 0 or 7.5 % pectin. The pigs were fed twice daily, at 08:30 and 20:30, 900 g each meal. Pancreatic juice was collected continuously at 1-h intervals for a total of 24 h. The inclusion of pectin did not affect ($p > .05$) the flow of pancreatic juice and the total secretion of nitrogen, lipase, trypsin and chymotrypsin. However, there was a significant ($p < .05$) decrease in the secretion of α -amylase, which was actually a direct result of the replacement of starch by pectin.

Zusammenfassung: Vier Börgе mit einem mittleren Anfangsgewicht von 70 kg wurden nach der „Pouch Technik“ mit Pankreas-Umleitungskanülen versehen, um den Einfluß von Stärke bzw. Pektin auf die exokrine Pankreassekretion zu untersuchen. Die Tiere erhielten halbsynthetische Rationen ohne Pektin (Kontrolle) bzw. mit 7.5 % Pektin im Austausch gegen Maisstärke. Die Diäten wurden in zwei Mahlzeiten (900 g um 08:30 und 20:30) verabreicht. Pankreassaft wurde kontinuierlich über 24 h gesammelt. Während die Pektinsupplementierung keinen signifikanten Einfluß auf das Pankreassekretionsvolumen und die Gesamtsekretion an Stickstoff, Lipase, Trypsin und Chymotrypsin hatte, wurde die Gesamtaktivität an α -Amylase im Pankreassekret signifikant ($p < .05$) reduziert.

Key words: Pig – polysaccharides – cannulation – exocrine pancreatic secretion

Schlüsselwörter: Schwein – Polysaccharide – Pankreasfistulierung – exokrine Pankreassekretion

Introduction

Recent studies suggest that the viscous property of some of the dietary fibers is a major factor affecting gastrointestinal functions (5–7). However, there is a scarcity of information in the literature on the effect of fiber, in particular the viscous sources of fiber such as pectin, on the exocrine pancreatic secretions of the pig, whereas several studies have been published using the rat as a model (3, 7, 9, 17, 19).

The objective of the present study was to investigate the effect of two different polysaccharides, starch and pectin, on the rate of pancreatic secretion of protein, trypsin, chymotrypsin, α -amylase and lipase using pigs fitted with permanent pancreatic re-entrant cannulas as a model.

Materials and Methods

Four barrows, initial wt. 70 kg, were fitted with permanent re-entrant cannulas for collection, sampling and subsequent return of pancreatic juice. A cannula is used to conduct pancreatic juice from a small isolated segment of the duodenum which receives the pancreatic duct, through permanent intercostal fistulas, and back into the duodenum within 3 cm of the normal entry point of the pancreatic duct. This procedure, also referred to as the "Pouch Method", allows for collection of pancreatic juice for up to 4 to 5 months, compared to the direct cannulation method by which pancreatic juice can be collected for only 1 to 2 months following surgery (2). Procedures for pre-operative care, surgery, post-operative care and construction of the re-entrant cannula were carried out according to Hee et al. (4) with modifications described by Ozimek et al. (14) and Mosenthin (10). The pigs were fed two corn starch – based diets formulated to contain 16 % crude protein from soybean meal. The diets included dextrose (10 %), canola oil (4 %) and a vitamin-mineral premix (3 %). Diet 1 was devoid of pectin; diet 2 contained 7.5 % citrus pectin included at the expense of corn starch. The diets were fed twice daily, at 08:30 and 20:30, 900 g each meal (as fed). The experiment was carried out according to a cross-over design. Each experimental period comprised 11 days. Pancreatic juice was collected continuously at 1-h intervals from 08:30 on day 10 to 08:30 on day 11. Samples were immediately frozen at -20°C after collection. Procedures for collection, sampling and subsequent return of pancreatic juice were previously described by Hee et al. (4) and Mosenthin (10). A detailed description of the chemical and statistical analysis of the parameters measured was previously presented by Mosenthin (10) and Mosenthin and Sauer (11).

Results and discussion

There was no significant effect ($p > .05$) of the dietary inclusion of pectin on the volume of secretion of pancreatic juice, total nitrogen and the secretion (measured as total activities) of lipase, trypsin and chymotrypsin (Table 1).

Table 1. The effect of diet composition on the daily volume, nitrogen and total enzyme activities in pancreatic juice

	Control	Pectin	SE ^a
Volume, ml/24h	3830	4710	874.4
Nitrogen, mg/24h	4080	4320	536.9
Total enzyme activity ^b			
Trypsin	198.0	201.0	37.43
Chymotrypsin	160.0	163.0	20.67
α -amylase	1868.0 ^c	1369.0 ^d	61.05
Lipase	228.0	204.0	17.96

^a Standard error of the mean

^b U/24 h \times (10^{-3})

^{c, d} Means in the same row with different superscripts differ at $p < .05$

There was considerable variation between animals, which has also been observed in other studies with pigs (e.g., 8, 11, 15). According to Partridge (15), this variation is of biological origin rather than an artefact and, despite the use of different techniques, this variation was observed in three separate studies. There was a significant ($p < .05$) decrease in the secretion of α -amylase when pectin was included in the diet. Previous studies with pigs have demonstrated that the secretion of pancreatic α -amylase is very sensitive to changes in the dietary content of starch. Studies by Ozimek et al. (13) showed a significant ($p < .05$) decrease in the total α -amylase secretion when 15 % corn starch was replaced by 15 % fat in a 15 % crude protein corn starch-based diet. Differences in dietary starch intake were also reflected by corresponding changes in α -amylase secretion in pancreatic juice in studies with rats (3, 17). The effect of dietary inclusion of viscous polysaccharides, such as pectin, on pancreatic secretions has not been studied before with swine. On the other hand, many studies have been carried out with rats. However, the results from these studies show wide discrepancies. Some studies (1, 3, 18) report only minor dietary effects of pectin on the secretory activity of the exocrine pancreas; other studies (7, 9, 16) report major effects.

As was pointed out by Imbeah et al. (8), comparing results between different studies relating to pancreatic secretion in pigs is difficult, because these are confounded by differences in feed intake, feeding regimen, diet composition, pig weight and different methods used to collect pancreatic secretions and analysis of enzyme activity. This previous statement also applies to studies with rats. For example, different methods have been used to determine pancreatic enzyme activities, including measurements in defatted pancreatic tissue (1, 3), in intestinal contents (3, 16) and in pancreatic biliary juice (7, 9).

In conclusion, this study provides evidence that the secretion of pancreatic α -amylase is very sensitive to changes in the dietary content of starch. However, it should be emphasized that the total secretion of α -amylase in both treatments exceeds by far the amounts theoretically required for intestinal hydrolysis of starch under optimal conditions. This enigma provides an interesting challenge for future research.

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