



Short Communication

High amylase resistant starch to decrease stool output in people with short bowel syndrome: A pilot trial

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SUMMARY

Short bowel syndrome (SBS) is defined as having less than 200 cm of functional small bowel. Mal-absorptive diarrhoea and dehydration are difficult to manage despite medical therapy and dietary manipulations. Evidence shows that supplementing the diet with High Amylase Resistant Starch (HARS) can reduce diarrhoea from a number of causes including gastroenteritis. It is hypothesised HARS will decrease stool output via the production of short chain fatty acids and the resultant increased water reabsorption. This study aimed to determine if the addition of HARS can reduce diarrhoea in patients with SBS.

Methods: Patients with SBS with colon in continuity were recruited from the intestinal rehabilitation clinic at Austin Health. The study was a 2 week crossover trial. Each participant completed the control and the intervention (addition of 50 g HARS to usual diet). Total daily stool weight and number of bowel actions per day were compared between groups using paired *t*-tests.

Results: Eight adults (58% male, mean age 55.7 yrs) were recruited. Five participants completed the trial. Total daily stool weight was reduced in all participants when consuming HARS. Mean daily stool output was significantly decreased 1049 ± 519 g/d to 804 ± 585 g/d (*p* = 0.023). Number of bowel actions per day showed a trend to reduction.

Conclusion: This study gives some support to the hypothesis that the addition of HARS into the diet of patients with short bowel syndrome reduces stool output. Longer trials are required to confirm the effect on nutritional/hydration status.

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Introduction

Short bowel syndrome (SBS) is defined as having less than 200 cm of functional small bowel. The aetiology of short bowel syndrome can be either congenital (in children) or as a result of massive surgical resections. The prevalence of SBS in Australia is not known however it is estimated from unpublished industry reports there are 220 patients on home parenteral nutrition in Australia for which SBS is a major indication. The number of SBS patients with colon in continuity is unknown. Despite the low prevalence of the condition these patients are complex to manage

due to chronic diarrhoea, dehydration, macro and micronutrient deficiencies and electrolyte disturbances.

Dietary modification is standard practice in patients with SBS to attempt to reduce stool output. The specific nutritional management of SBS varies according to the type of residual bowel and is covered in detail elsewhere [1] however in general patients are encouraged to follow a low insoluble fibre diet, drink oral rehydration solutions (ORS) and take medications to slow intestinal transit. There are currently no known dietary supplements that can reduce diarrhoea in any subset of this population. Numerous studies have investigated the use of dietary additives to reduce the incidence of diarrhoea [2,3] of other causes. A therapeutic benefit of adding fermentable fibre to oral rehydration solutions has been described, due to its ability to decrease stool output and shorten the interval of diarrhoea in cases of short to moderate duration [4–6].

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One such form of fermentable fibre is high amylase resistant starch. (HARS). HARS is a form of dietary fibre present naturally in foods including cereals and under ripe bananas. Resistant starch escapes digestion and remains in the bowel to be fermented by the resident bacterial population of the colon. A by-product of this bacterial fermentation are short chain fatty acids (SCFA). SCFA are beneficial not only for the health of the epithelium of the bowel but can also enhance sodium and water absorption in the colon.

In a randomized controlled study of 183 children with acute diarrhoea who received either standard rehydration solution or rehydration solution with 50 g/L of resistant starch, diarrhoea resolved significantly more quickly in those that received resistant starch [5]. In a similar study of 48 adults with cholera, those who received resistant starch supplemented oral rehydration solution not only significantly reduced the duration of diarrhoea but also significantly decreased total stool weight [6]. Green banana (a rich source of amylase resistant starch) significantly reduced stool weight in two trials compared to rice based cereal alone [7,8]. There is currently no published evidence on the use of HARS to decrease diarrhoea in short bowel syndrome.

While this is a pilot trial aimed to determine proof of concept it is hypothesised that by adding 50 g/d of HARS to the diet of people with SBS will result in decreased stool weight.

Methods and materials

Selection criteria

Adult patients with SBS attending Austin Health Intestinal Rehabilitation clinic were invited to participate. Exclusion criteria included patients without colon, gastrointestinal conditions (intestinal pseudo-obstruction, recent bowel resection, gastroparesis and infection such as Clostridium difficile). Patients who were fluid restricted to less than 1500 ml/day and those unable to consume an oral diet were excluded. The procedures, risks and inconveniences were explained to the patient and written informed consent obtained.

Experimental design

The study was a two-week crossover trial. Each week, participants were asked to consume their usual diet which included a minimum of one litre of ORS. In week two, 50 g/d of HARS (Hi-Maize amylase resistant starch) was added to the ORS. One tablespoon of HARS was added per glass of ORS four times daily. HARS was added immediately prior to consumption. All participants had received prior dietary counselling and were instructed to follow a low insoluble fibre, low fat, high complex carbohydrate, high salt diet as described elsewhere [1]. Participants were encouraged not to make changes to their usual diet for the study duration and dietary history was collected by a specialist dietitian at each clinic review. Compliance with HARS was self-reported by participants during post participation clinic review.

Primary outcome measure

On days 2, 4, and 7 of the trial participants were asked to weigh total daily stool output.

Secondary outcome measures

Frequency of bowel actions was recorded for all study days.

Statistical analysis and sample size calculation

This study was a pilot trial to determine a trend rather than statistical significance hence a power analysis was not done. Due to the small number of patients with short bowel syndrome attending the clinic the aim was to recruit as many as possible. Statistical analysis of stool weight between trial periods was via paired t tests. An alpha error of $P < 0.05$ was used to determine statistical significance in all analyses and data was analysed using SPSS statistical software.

Results

Eight patients (58% male) with a mean age of 56 years consented to participate. Causes of SBS for this group were bowel ischemia (40%), resections due to cancer (30%), Crohn's disease (20%) and volvulus (10%). Remaining length of bowel ranged from 20 to 120 cm. Five participants completed the trial and their results are presented. Whilst taking HARS, total mean daily stool output decreased by 20% (from 1049 g/d to 840 g/d) ($p \leq .023$) as seen in Fig. 1.

The mean number of bowel actions per day is displayed in Fig. 2.

Conclusion

The results of this pilot trial give validity to the hypothesis that the addition of 50 g/d of HARS can decrease stool output in people with SBS. As seen in previous research, supplementation of 50 g per day of HARS decreased total daily stool weight and time to first formed stool in both children with acute diarrhoea [4] and adults [5] with cholera. Children with shigellosis given a diet containing 30 g/kg of cooked green bananas (very rich source of HARS) also showed decreased diarrhoea and time to first formed stool [6]. Similarly, a trial providing 30 g/kg of cooked green banana showed a decreased time to formed stool and decreased stool weight over rice based cereal alone [6,7].

A study investigating an alternative fibre supplement (a mixture of resistant starch, soy polysaccharide, alfa cellulose, fructooligosaccharide, inulin and arabic gum) showed no difference in stool weight or duration of diarrhoea in boys with non-cholera diarrhoea [8]. Partially Hydrolysed Guar Gum (PHGG), an alternative soluble dietary fibre additive, decreased non-cholera diarrhoea when added to ORS but the effect only reached statistical significance on day 7 of the trial [3]. HARS showed a statistically significant effect 12 h after introduction potentially demonstrating a superior effect to other dietary fibre additives.

The proposed mechanism of action of HARS is via the production of SCFA via fermentation of undigested carbohydrate products. Starch is rapidly and preferentially fermented by the colonic

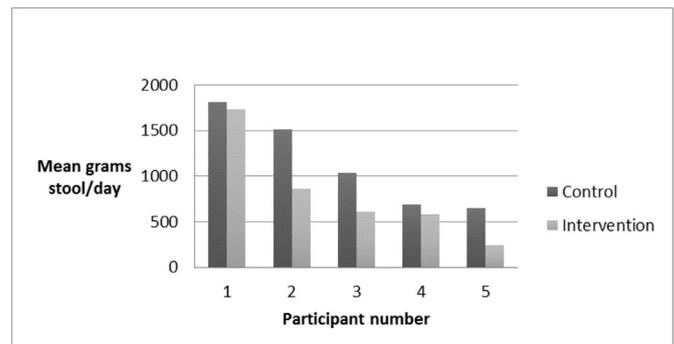


Fig. 1. Mean total daily stool output, control versus intervention.

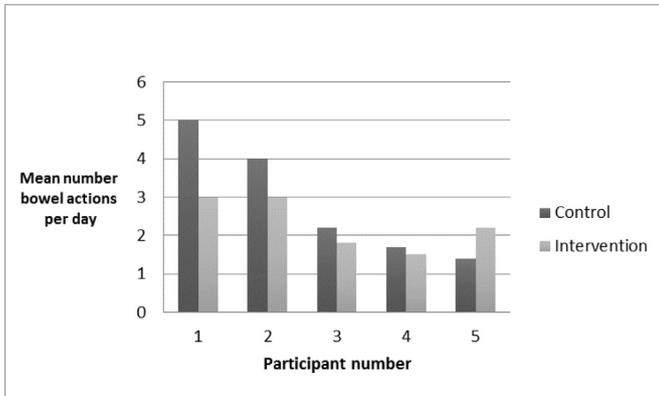


Fig. 2. Mean number daily bowel actions control versus intervention.

bacteria. The fermentation of starch produces increased amounts of butyrate comparative to other fermentable substrates [9]. With butyrate being the most effective SCFA at stimulating sodium and water uptake [10] this may be the reason that HARS was seemingly more effective than the other fibre supplements at decreasing diarrhoea.

The average daily number of bowel actions showed a trend toward a reduction in this study with all but one participant showing a numerical decrease in stool frequency. Stool frequency was not examined in the Ramakrishna or Ragupathy studies however was significantly decreased from day 3 onwards in both of the Green Banana trials.

An obvious limitation of the present study was sample size by being a pilot study in design. The high withdrawal rate (38%) can be explained by the challenging nature of participation in this trial. Participants became unwilling to continue due to the difficulties associated with collecting and weighing stool output. The only adverse effect noted from the HARS was mild bloating in one participant. Every effort was made to minimise inconvenience to participants however, determination of the primary outcome necessitated stool collection. Future trials may need alternate outcome measures to enhance participation. SBS is a rare condition making recruitment of large numbers from a single institution impossible. The positive results of this trial however warrant further investigation in the form of a multi-centre trial.

In conclusion, this pilot trial showed that HARS can decrease stool output in people with SBS however larger and longer trials are required to confirm this effect.

Conflict of interest and funding source

None.

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Statement of authorship

KH designed the trial, recruited participants and collected the data. TC completed statistical analysis of the data. AT assisted with design of the trial and participant recruitment. All authors contributed to development of the manuscript.

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