Effect of Fibre Supplementation and Activated Charcoal on Faecal Parameters and Transits in the Tropics

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Abstract
Increasing dietary fibre in the diet is known to increase faecal weights and lower intestinal transit time in Western subjects. Addition of 18 g of dietary fibre per day in the form of baked beans to the normal diet of six South Indian subjects had no significant effect on faecal parameters, except a 22% increase in intestinal transit time which was not statistically significant. Absorption of the gas produced by consumption of beans by the addition of activated charcoal did not alter the faecal parameters, although transit times returned to pre-fibre supplementation levels. Additional fibre does not influence faecal weight in tropical subjects who already have large faecal weights and low transit time. Administration of activated charcoal has little effect on colonic function.

Key words: Dietary fibre, transit time, activated charcoal, faecal bulking, tropical subjects

Introduction
Studies in Western subjects have demonstrated that increasing dietary intake of fibre is very effective in increasing faecal weight and reducing transit time. However, faecal weights recorded in the tropics are much higher than in the West and are associated with short intestinal transit times despite comparable intakes of dietary fibre.

Faecal bulking is attributed to two major dietary constituents—fibre and starch. The mechanisms of faecal bulking are through water holding by dietary residue as well as the result of the utilization of dietary fibre or other available substrates such as starch by colonic bacterial flora, resulting in an increased bacterial mass. Bacterial fermentation of substrates such as fibre and starch in the colon results in the release of gases such as methane, hydrogen and carbon-dioxide. Little is known whether the increased production of intestinal gases following the ingestion of increased amounts of fibre in the diet, especially as beans and other legumes, distends the large bowel and alters colonic motor activity resulting in changes in transit times.

This study was done to evaluate the effects of increasing intakes of dietary fibre in subjects from the tropics who have large faecal weights and short transit times; it also looked at the influence of administration of activated charcoal on faecal parameters and transit times.

Material and Methods
Six healthy male South Indian subjects were chosen for this study. The subjects were kept on ad libitum diets, and dietary inventories were maintained for later dietary analysis. Dietary constituents were computed from daily intake using Food Composition Tables.

Experimental protocols
The subjects went through a three week experimental protocol. The first week was a control period; the second week, a period of fibre supplementation over the normal ad libitum intake; and the third week, a period of fibre supplementation along with the administration of activated charcoal. Complete 24-h faecal collections were made on the last three days of each week. The fibre supplement during the second week consisted of 125 g of baked beans at 8.00 am and 6.00 pm daily in addition to the normal intake of food. This intake was equivalent to 18.3 g of additional fibre per day. During the third week, activated charcoal was given in a dose of 4 g three times a day for 7 days.

Faecal parameters and transit
Intestinal transit time was measured giving a single dose of 80 plastic non-absorbable markers in the morning on the fourth day of each week. Complete marker recovery was effected; mean transit time (MTT) was estimated using the formula:

$$MTT = \frac{\sum_{i=0}^{n} x_i t_i}{\sum_{i=0}^{n} x_i}$$

The 24-h faecal collections were weighed. Faeces collected over the last 3 days of each period were homogenised in distilled water and aliquots of the homogenate were stored at -20°C. Faecal solids were estimated by drying the sample at 105°C in a hot air oven for 24 hours, with repeated drying to a constant
weight. Faecal water (g moisture) was estimated using wet weight and dry weight of sample. The faecal solids were ashed in a muffle furnace at 550°C and the weight of the ash recorded.

Neutral detergent fibre (NDF) content of the faeces was estimated using the method of Goering and Van Soest. The samples were refluxed with neutral detergent, and filtered under vacuum. They were then dried at 105°C for 24 hours, followed by weighing of the hot sample. Faecal nitrogen was estimated using the micro-Kjeldahl technique. The sample was initially digested with concentrated sulphuric acid and a catalyst. The digestate was subjected to steam distillation in the presence of concentrated sodium hydroxide using a Wagner-Parsons steam distillation unit. The effluent ammonia was trapped in boric acid and titrated against dilute sulphuric acid.

Statistical analysis was carried out using the Student's t test. Results are expressed as mean ± SEM and considered significant if p<0.05.

Results
The average calorie intake during the entire study period was 2213.3 ± 81.9 Kcal/day, of which 296.3 ± 17.2 g/day was the carbohydrate intake. The average unassuplemented dietary fibre intake was 12.2 ± 1.0 g/day.

The values of faecal parameters and transit time during the first week (control period) are shown in the Table. During the second week (diet fibre supplementation only), faecal weight, MTT and the faecal solids increased while the faecal NDF and faecal N remained unaltered. None of these changes was statistically significant.

During the third week, the corrected effect of exerted charcoal on faecal weight and other parameters was calculated by finding the amount of the ingested charcoal exerted per day as a function of transit time on that day. Similarly, the ash content was also corrected by finding the ash content of activated charcoal, which was 0.046 mg/g of activated charcoal. During the third week (fibre-supplemented period), the faecal weight rose, even when corrected for the effect of charcoal. The faecal solids increased significantly (p<0.05), but was comparable to levels seen during the second week when corrected for exerted charcoal. Faecal NDF was high, but this included some charcoal administered to the subject. This charcoal could not be separated from the NDF in the analytical method used. Microscopic examination of the NDF revealed specks of charcoal which were visible even to the naked eye, attached to the particles of fibre. The only significant increase in the third week was that of faecal ash, which rose to 5.3 ± 1.1 mg/day (p<0.05); this included ash from the charcoal present in the faecal solids.

A significant inverse relationship between MTT and the ratio of NDF to faecal solid existed in the control state of the study (r = 0.91, p<0.05). However, with supplements of dietary fibre over the next week this relationship between MTT and NDF disappeared (r = 0.09, NS). Flatus diaries maintained by the subjects indicated that all the subjects noticed a subjective increase in number of flatus events during the second week, which reduced considerably with activated charcoal during the third week.

Discussion
Dietary fibre is one of the important determinants of faecal weight. One of its recognised effects is the capacity to increase faecal output in man. Different sources of fibre seem to have differing effects on faecal weight in experimental human studies. The addition of baked beans in the diet providing an additional intake of 13-5 g of fibre per day would be expected to increase faecal weight by at least 5% per g fibre in Western subjects. However, in the present study in South Indian subjects, addition of 13.5 g of fibre produced an increase of only 20 g in faecal weight (i.e., +1-1%). We have

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<th>Table: Faecal parameters and transit times</th>
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<td>Control Period</td>
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<tr>
<td>MTT (h)</td>
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<td>Faecal weights (g.d.)</td>
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<td>% increase per g increase in fibre</td>
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<td>Faecal solids (g.d.)</td>
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<td>Faecal NDF (g.d.)</td>
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<td>Faecal N (g.d.)</td>
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<td>Faecal moisture (%)</td>
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<td>Faecal ash (g.d.)</td>
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<td>Faecal NDF/Faecal solids (%)</td>
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Values mean ±SEM  *p<0.05
previously reported that faecal weights are high and transit times short in tropical subjects, despite intakes of dietary fibre comparable to that in the West. When faecal weights are already high, it appears that increasing fibre intake does not change the faecal output very much.

Supplements of fibre from baked beans led to a marginal though insignificant increase in transit time. Beans contain oligosaccharides and polysaccharides which cannot be digested by the enzymes of the small bowel.15 In the colon, they undergo bacterial degradation. The increase (+32/2-1%) in transit may be of physiological importance since the output of NDF remains the same despite additional intake of fibre. This could be accounted for by the increased bacterial breakdown associated with a slightly longer transit in some of the subjects, thus providing additional time for bacterial action. It has been demonstrated that slowing transit by administering codeine increases bacterial breakdown of fibre in the colon.17 This increased bacterial action should be reflected by an increase in faecal N, since faecal N excretion increases with increase in fermentable carbohydrate in the diet and the increase in faecal N is largely due to increased microbial cell output.18 However we have earlier demonstrated that faecal N is not necessarily a true reflection of bacterial growth in the colon.

Activated charcoal is widely reputed as an adsorber of intestinal gas, although some gastroenterologists remain skeptical. A recent study reported a significant and impressive reduction in the hydrogen excreted in breath after a meal of beans when patients took activated charcoal along with the meal. With the addition of activated charcoal in the present study, the marginal increase in faecal weight observed was partly the result of the additional charcoal present in the faeces. Faecal NDF also increased although part of this increase is accounted for by the strongly adherent charcoal particles on the NDF. The increase in fibre intake may result in greater bacterial growth which could account for the increase in faecal N seen, although it is likely that soluble waste products such as urea and ammonia may be absorbed by the activated charcoal and carried down in the faeces.

Fermentation of dietary fibre releases gases. Increased passage of flatus was recorded by all our subjects on baked beans. With activated charcoal, flatus events were reduced and transit times dropped from the values measured when fibre alone was administered. This may imply that the gaseous products of fermentation in the colon may tend to distend the bowel and slow down the transit rather than speed it up. It is also possible that the other breakdown products of fibre in the colon influence colonic motor activity. The effects of these fermentation products (both gases and other chemicals) may be annulled by their adsorption by activated charcoal. It is also possible that the adsorption of certain other normal faecal constituents by activated charcoal may influence this. However, the functional changes seen are small, both in transit time and faecal weights, and the views expressed are at best speculative.

We conclude that additional intake of fibre does not influence faecal weights in tropical subjects with large faecal weights and short transit time, unlike in Western subjects who have small faecal weights associated with long transit time. Changes in faecal weight do not make much difference to transit in the tropics. Removal of the products of fermentation in the colon or other colonic constituents by activated charcoal also produces little effect on colonic function in the tropics.

References