Three decades of gastroenterology in Soweto South Africa: from descriptive to scientific observations

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Chapter 6

Fecal Short Chain Fatty Acids in South African Urban Africans and Whites

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Summary
Diminished levels for fecal short chain fatty acids (SCFAs) have been linked to occurrence of ulcerative colitis, colorectal polyps, and colon cancer, diseases that are rare or uncommon in African populations. Purpose: The aim of this study was to determine fecal SCFA concentrations and fecal pH values in groups of black South Africans (African) and white South Africans (white) subjects. Methods: Twenty healthy Africans (all women; mean age, 35 years) and 17 healthy whites (7 women; 10 men; mean age, 32 years) were tested. Results: Mean total concentrations of SCFAs in the two groups were 142.1 (+/−33.9) and 69.2 (+/−26.0) mmol/kg wet feces, respectively (P = 0.0001). Mean values for Africans were significantly higher in all subfractions except butyrate. There was a significant inverse correlation between fecal pH value and total fecal SCFA concentration (r = 0.704; P = 0.001). Conclusion: High concentrations of fecal SCFAs in the African group could protect against chronic bowel diseases.

Introduction
Short chain fatty acids (SCFAs) are the principal end products of fermentation of carbohydrates in man.\(^1\) The major SCFAs are C2.0 (acetic), C3.0 (propionic), and C4.0 (bucyric), which account for 85 to 95 percent of total fecal SCFAs.\(^1\) Molar ratios are approximately 57:22:21. In western populations in most publications, total average SCFA concentrations range from 65 to 130 mmol/kg (wet feces).\(^2\)\(^-\)\(^5\) Physiologic effects include stimulation of the absorptions of sodium, potassium, and water and the evoking of increases in luminal bicarbonate concentration.\(^6\) Acetate is a valuable fuel for tissues and is oxidized as free fatty acids.\(^7\) The role of propionate remains uncertain.\(^1\)\(^,\)\(^6\)

Butyrate is an important fuel for colonic mucosa and may also regulate gene expression and cell growth.\(^1\)

Diminished concentrations of SCFAs have been noted in the presence of adenomatous polyps and colon cancer, diseases that are very common in western populations. Such diseases are rare or uncommon in African populations.\(^8\)\(^,\)\(^9\) The aim of the present preliminary study was to determine fecal SCFA concentrations and fecal pH values in groups of African and white subjects.
Methods

Subjects
Unfortunately, the recruiting of African men proved impossible. Accordingly, 20 outwardly healthy Africans (all women; mean age, 35 years) and 17 outwardly healthy white adult hospital workers (10 men; 7 women; mean age, 32 years) were studied.

Dietary Intakes
A recent study on two series of African women was carried out in Soweto. Ages ranged from 20 to 35 years. Mean dietary data were energy intake = 1,950 kcal, protein = 55 g (11 percent energy), fat = .52 g (22 percent energy), carbohydrate = 265 g (67 percent energy), and fiber = 13.5 g. Results of the same pattern were obtained from a local suburban series of women and those in Cape Town. In brief, the habitual diet is relatively low in energy, with a higher fat but lower fiber intake than is usual in African women in rural areas.

Analysis
Fecal samples were collected and deep frozen (-20°C) within 2 hours of voiding. Fecal SCFAs were determined in duplicate by the method described by Pomare et al. and Scheppach et al. Fecal pH values were determined by the method described by Stephen et al.

Statistics
Results for the two groups of subjects were compared at the 0.05 level of significance using Student's t-test and taking into account whether the groups had equal variances as tested with Levene's test for equal variance.

Results
Mean concentrations of fecal SCFAs and subfractions with standard deviations and mean fecal pH values, are given in Table 1. Mean values for all components, except butyrate, are significantly higher in Africans compared with white subjects. There was a significant inverse correlation between fecal pH and total SCFA concentration (r = 0.704; P = 0.001). Table 2 gives local data reported by other authors.
Table 1: Concentrations of Fecal SCFAs in African and White Subjects

<table>
<thead>
<tr>
<th></th>
<th>Africans (n = 20)</th>
<th>Whites (n = 17)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total SCFAs</td>
<td>142.1 (53.9)</td>
<td>69.2 (26)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Acetate</td>
<td>83.55 (30.38)</td>
<td>40.5 (15.9)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Propionate</td>
<td>32.3 (18.5)</td>
<td>11.9 (4.2)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Butyrate</td>
<td>17.86 (8.7)</td>
<td>12.4 (6.2)</td>
<td>0.07</td>
</tr>
<tr>
<td>Isobutyrate</td>
<td>2.02 (1.6)</td>
<td>1.5 (0.7)</td>
<td>0.16</td>
</tr>
<tr>
<td>Valerate</td>
<td>3.57 (2.0)</td>
<td>1.6 (0.9)</td>
<td>0.0005</td>
</tr>
<tr>
<td>Isovalerate</td>
<td>3.6 (2.1)</td>
<td>1.9 (1.0)</td>
<td>0.004</td>
</tr>
<tr>
<td>PH value</td>
<td>6.7 (0.8)</td>
<td>7.1 (0.50)</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Mean (standard deviation) units: mmol/kg feces, wet weight.

There was a significant inverse correlation between pH and total SCFA concentration ($r = 0.704; P = 0.001$)

Table 2: Fecal SCFAs in Western Compared with South African Populations (mmol/kg wet feces)

<table>
<thead>
<tr>
<th></th>
<th>Hoverstad and Bjorneklett$^4$</th>
<th>Zijlstra et al.$^2$</th>
<th>Hoverstad et al.$^3$</th>
<th>Cummings et al.$^5$</th>
<th>South African Whites</th>
<th>South African Africans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>67</td>
<td>73</td>
<td>77</td>
<td>98</td>
<td>68</td>
<td>142</td>
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<tr>
<td>Acetate</td>
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<td>48</td>
<td>37</td>
<td>50</td>
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<tr>
<td>Propionate</td>
<td>11</td>
<td>11</td>
<td>13</td>
<td>20</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td>Butyrate</td>
<td>14</td>
<td>5</td>
<td>12</td>
<td>18</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Isobutyrate</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Valerate</td>
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<td>2</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Isovalerate</td>
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<td>4</td>
<td>3</td>
<td>4</td>
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</tr>
</tbody>
</table>

Discussion

Of chronic bowel diseases, the frequency of appendicitis in African children is only one-tenth that of white children. Incidences of ulcerative colitis and Crohn's disease are also far less. Incidence of colon cancer in the African population is 1.1 compared with the figure of 10.5 per 100,000 world population in the white population. Very low incidences of colon cancer have been noted in other African populations. For perspective with relation to other cancers, in Africans the incidences of breast and prostate cancers are also low; however, those of the esophagus, cervix, and, to a lesser extent, liver are very high. As for polyps, colonoscopic evidence indicates that polyps remain rare. Colonoscopies performed on urban Africans reveal the colon to be elastic and mobile, even in the very elderly. The "stiff colon," so usual in elderly whites, is virtually unknown in this population. Evidently, conditions prevailing in the bowel milieu interior inhibit the aging of the colon.
Mean fecal pH values were lower in Africans, although not significantly (6.7 ± 0.8) compared with whites (7.1-0.5). In previous studies, values on local African children indicated that only 5 percent had pH values of 6.5 or more, whereas the proportion of white children was 70 percent¹⁹ Thornton²⁰ and Phillips²¹ noted that vegetarian Seventh Day Adventists, who are at reduced risk of large bowel cancer, have a lower mean fecal pH than patients with colorectal cancer. Conceivably, fecal pH value could be used as a marker for susceptibility to chronic bowel diseases.¹⁹ Regarding possible explanations, Walker, Burkitt et al., and others⁸⁹ postulated that a low incidence of chronic bowel diseases and other degenerative diseases in Africans is closely linked with their high fiber intake, which is 30 to 40 g or more daily in rural dwellers living traditionally. However, the present transitional daily diet of suburban and urban Africans has a relatively low fiber content (10-15g)¹⁰,¹¹. Why have chronic bowel diseases not started to rise? It is possible that the contribution of "resistant" starch remains high and fulfills a protective role, as stressed by Cummings and Englyst.²⁴ In the bowel behavior of African children compared with that of white children in Johannesburg, transit time remains shorter.²⁵ The percentage with breath methane is much higher, 84 percent vs. 52 percent in the white population.²⁶ Moreover, as revealed in the present study, fecal SCFA concentrations are much higher, and fecal pH value is relatively lower. This concatenation of factors is likely to constitute the main protective features in urban Africans who are still at relatively low risk for chronic bowel and other degenerative diseases.

References


