Lactate and pH in faeces from patients with colonic adenomas or cancer

H Hove, M Rye Clausen, P Brøbech Mortensen

Abstract

Earlier studies have reported that faecal pH is more alkaline in patients with colonic cancer, indicating a reduction in colonic carbohydrate fermentation to organic acids. The pH of faeces from 11 pre and 14 postoperative, selected colonic cancer patients without intestinal obstruction, major loss of appetite or weight, not treated with antibiotics, and without signs of dissemination or recurrence of the cancer, did not differ, however, from faecal pH in 17 patients with previous colonic adenomas removed by polypectomy and faecal pH in 17 age matched (mean 61 years) healthy controls (mean (SE) 7.03 (0.10), 7.15 (0.11), 7.20 (0.12), 7.11 (0.12) respectively; $p=0.82$). Faecal pH in 20 younger (mean 32 years) healthy controls tended to be lower (6.89 (0.07) compared with the older age matched control group ($p<0.06$).

Faecal concentrations of D-, L- or total D+L-lactate did not differ between the patients with present or previous colonic cancer, adenomas, and the healthy controls (D+L-lactate mean (SE) 3.2 (0.5), 3.1 (0.3), 3.5 (0.7), 4.1 (1.0) mmol/l respectively; $p=0.72$), and the production pattern of lactate from different carbohydrates (glucose and dietary fibre) in 16.6% faecal homogenates was similar in all the three groups of patients and the healthy controls.

Faecal pH was changed within days by modifications of the diet. An enteral diet free of fibre, starch, and lactose increased faecal pH within three days, whereas pH decreased when the colonic load of carbohydrates was increased by lactulose. Therefore, the reported alkaline faecal pH in patients with colonic cancer may reflect short term reductions in dietary intake and colonic fermentation secondary to the presence of the cancer, especially in patients with advanced disease, rather than long term differences in the precancer dietary habits.

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Epidemiological studies indicate that environmental factors influence the incidence of colorectal cancer and diet seems to be an important factor.¹ The risk of colonic cancer seems to correlate with diets low in dietary fibre.^{2,3} Faecal pH is often below 6.5 in populations eating high fibre, low fat diets, whereas persons belonging to 'western societies' eating low fibre diets have a faecal pH above this value.^{4,5} An alkaline faecal pH has been reported to be associated with a higher incidence of colonic cancer,⁶⁻⁹ suggesting that colonic neoplasia might be related to a reduction in the fermentation of dietary polysaccharides to organic acids in the large bowel.

Attention has mainly been focused on the formation of short chain fatty acids and the possible cancer protective role of butyrate.¹⁰⁻¹² Faecal lactate is known to increase in patients with acidorrhea caused by saccharide malabsorption¹³ and in patients with active ulcerative colitis,¹⁴ but the concentration and production of lactate have not, to our knowledge, been investigated in patients with carcinoma of the large bowel.

The reported changes in faecal pH in patients with colonic cancer have now been widely accepted and quoted in many investigations and review reports on this subject. Changes in dietary and bowel habits may occur, however, as a result of the growing cancer in some of these patients. Efforts should therefore be made to differentiate between early changes in faecal pH occurring before the cancer has evolved, and short term changes secondary to loss of appetite, colonic obstruction, metastasis, etc, of no relevance for cancer pathogenesis.

Pre and postoperative patients were enrolled in this study as two separate groups, but patients were excluded if they had clinical signs of intestinal obstruction, major weight loss, loss of appetite, infections treated with antibiotics, or dissemination or recurrence of the cancer. Dietary habits of the selected patients were supposed to be unchanged and representative for the diet considered carcinogenic and harmful in the years before the cancer evolved. Because the adenoma-carcinoma sequence is accepted as the developmental pathway for most cases of colorectal cancer,¹⁵ a third group of patients with previous neoplastic adenomas was included. Faecal pH and lactate in the three groups of patients with removed adenomas and colonic cancers before and after surgery were then compared with healthy controls.

Materials and methods

COLONIC CANCER AND ADENOMA PATIENTS

The study population comprised 11 preoperative patients with present colonic cancer (seven men and four women, mean age 79, range 69-91 years), 14 postoperative patients with previous colonic cancer (six men and eight women, mean age 64, range 50-77 years, and 17 patients with previous colonic adenomas removed by colonoscopy (11 men and six women, mean age 66, range 49-87 years) participated in the study. Seventeen healthy subjects with no history of gastrointestinal disease (eight men and nine women, mean age 61, range 30-82 years) served as controls.

The 11 patients with colonic cancer were selected as patients without complaints of appetite reduction or nausea, with a reported weight

Department of Medicine
A, Rigshospitalet,
University of
Copenhagen, Denmark
H Hove

M Rye Clausen
P Brøbech Mortensen

Correspondence to:
Dr H Hove, Department of
Medicine A, 2151,
Rigshospitalet, DK-2100
Copenhagen, Denmark.

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loss of less than 3 kg, no clinical signs of ileus or subileus, no preoperative findings of liver metastasis, and in whom surgery was feasible and later accomplished (all as elective surgery). Faecal sampling was performed in 14 patients fulfilling the criteria, but cancer was not found in the removed colonic segment from three patients, who were therefore excluded from the study with new diagnoses of colonic adenoma (two) and diverticulitis (one). The remaining 11 cancers were located in the ascending (one), transverse (two), sigmoid (four), and rectal (four) segments of the colon, and were Duke A (three), Duke B (seven), and Duke C (one) adenocarcinomas. The 14 patients with previous colonic cancer had undergone right sided (seven) or left sided (two) hemicolectomy, or segmental sigmoid resection (five) because of adenocarcinoma of Duke A (two), Duke B (nine), and Duke C (three). None of the patients showed signs of recurrence at the time of faecal sampling, which was at least three months after surgery. Patients with colostomies were not included. The patients with previous adenomas had undergone colonoscopic polypectomy at least three months before faecal sampling with the removal of one or more neoplastic adenomas of more than 0.5 cm in size, which were either tubular (nine), tubulovillous (six), or villous (two). All adenomas found during colonoscopy were removed. All patients were enrolled consecutively and none of the patients had familial adenomatous polyposis or Gardner's syndrome. None had received chemotherapy or radiation therapy, and antibiotics were not given within two weeks before faecal sampling. No dietary restrictions or recommendations were given. All subjects gave informed consent to participate in the study, which was approved by the local ethics committee.

DIETARY MODIFICATIONS IN HEALTHY SUBJECTS

Twelve healthy persons (four men and eight women, mean age 32, range 25–47 years) were given lactulose syrup (0.66 g/ml) twice daily (Merck Chemical Co, Darmstadt, Germany) in doses of 80 g/day for three consecutive days. Stools were collected on the third day and used immediately for incubation experiments. Stools sampled before lactulose intake served as controls.

Thirteen healthy subjects (six men and seven women, mean age 31, range 25–42 years) were given Nutridrink (Nutricia, Zoetermeer, Hol-

land) as the only caloric intake for three consecutive days with 24 hour faecal sampling on day three. Five of the subjects (three men and two women) had also participated in the lactulose study at least three months previously. The administered amount of Nutridrink (7500–11 500 kJ/day) was estimated from the body weight. Nutridrink contains 635 kJ/100 ml, 48% carbohydrates as maltodextrin and saccharose, 13% protein, 39% lipids, no starch or fibre, and only trace amounts of lactose. Fluid intake was free but restricted to non-sweetened tea, black coffee, or water. Control 24 hour faeces were sampled before the intake of Nutridrink was started.

STARVATION OF RATS

Forty male rats of the Sprague-Dawley strain with mean initial body weight of 238 (SE 5) g were used. They had free access to water and standard rat pellets (Altromin Werke, Lage, Germany). During the experiments the rats were taken off the stock diet and placed three in a cage without access to secreted urine and excrement. Ten animals were starved for 0, 24, 48, or 72 hours, resulting in an average weight loss of 0, 28, 41, and 49 g respectively. The animals were killed by a blow to the head and spinal dislocation. The colons were rapidly removed and caecal contents isolated and frozen for later analysis.

PREPARATION AND ANALYSIS OF SAMPLES

Freshly passed faeces were homogenised with five times their weight of isotonic solution (100 mmol/l NaCl; 50 mmol/l KCl) for study in an anaerobic faecal incubation system by the method of Vince *et al.*¹⁶ Several aliquots of 10 ml from each faecal sample were simultaneously incubated in duplicate. Glucose, wheat bran, pectin, ispagula, or albumin were added at zero time in concentrations of 10 mg/ml. Control incubations were faecal suspensions prepared with no addition of substrate. Incubation time was six hours at 37°C, and termination was performed by freezing. Specimens were stored at –18°C until analysis. The caecal contents of the rats were thawed and homogenised with five times their weight of distilled water before analysis.

L-lactate was measured by the spectrophotometric Boehringer L-lactate test, with L-lactate dehydrogenase. D-lactate was similarly measured by changing the enzyme to D-lactate dehydrogenase. L- and D-lactate dehydrogenase, L- and D-lactate, and NAD⁺ were obtained from Boehringer Mannheim Company, W Germany. Lactate concentrations were linearly proportional to the increase in NADH absorbance at 340 nm measured on an LKB Biochrom 4050 spectrophotometer (Pharmacia Biosystems, Copenhagen, Denmark). The pH of faeces was measured with a pH meter (Radiometer, Copenhagen, Denmark).

STATISTICS

Data were analysed by paired rank test or one way analysis of variance with an evaluation of the

TABLE 1 Concentrations of L- and D-lactate and pH (mean (SE)) in faeces from patients with colonic adenomas and cancers

Subjects (n)	(mmol/l)			pH
	D+L-lactate	L-lactate	D-lactate	
Controls (17) (95% CIs)	4.13 (0.95) (2.12–6.14)	2.14 (0.44) (1.21–3.07)	2.00 (0.53) (0.88–3.12)	7.11 (0.12) (6.86–7.36)
Adenomas (17) (95% CIs)	3.48 (0.68) (2.04–4.92)	1.56 (0.32) (0.88–2.24)	1.92 (0.37) (1.14–2.70)	7.20 (0.12) (6.95–7.45)
Cancer; before surgery (11) (95% CIs)	3.20 (0.54) (2.00–4.40)	1.46 (0.26) (0.88–2.04)	1.73 (0.29) (1.08–2.38)	7.03 (0.10) (6.81–7.25)
Cancer; after surgery (14) (95% CIs)	3.11 (0.31) (2.44–3.78)	1.56 (0.20) (1.13–1.99)	1.55 (0.21) (1.10–2.00)	7.15 (0.11) (6.91–7.39)
Anova	0.72	0.47	0.84	0.82

Anova=one way analysis of variance; 95% CIs=95% confidence intervals.

differences between individual groups by the test of least significant differences.¹⁷

Results

Table I shows lactate concentrations and pH in faeces from 17 normal subjects, 17 patients with previous colonic adenomas, 11 patients with colonic cancer before operation, and 14 colonic cancer patients after operation. Faecal concentrations of total D+L-lactate in patients who had colonic adenomas (mean (SE) 3.48 (0.68 mmol/l) and cancer before (3.20 (0.54) mmol/l) and after surgery (3.11 (0.31) mmol/l) were not significantly different from concentrations in control subjects (4.13 (0.95) mmol/l); $p=0.72$). The ratios of L-lactate in % of total D+L-lactate in patients with colonic cancer before (mean (SE) 44% (2) and after surgery (50% (5)) and adenomas (42% (3)) were of the same order as in normal subjects (53% (3); $p=0.12$). Neither did the molar concentrations of L- or D-lactate differ among the four groups. No differences in faecal pH were found between patients with colonic cancer before (mean (SE) 7.03 (0.10)) and after surgery (7.15 (0.11)), patients with colonic adenomas (7.20 (0.12)), and healthy controls (7.11 (0.12); $p=0.82$; Table I).

Table II gives the D- and L-lactate production in 16.6% faecal homogenates incubated for six hours with 10 mg/ml of glucose, wheat bran, pectin, ispagula, or albumin. The endogenous production of lactate in control homogenates with no additions of substrate was negligible and

often slightly negative, because initially present lactate was metabolised in many homogenates. By contrast, the addition of 10 mg/ml glucose caused a pronounced accumulation of both D- and L-lactate, which was significantly larger ($p<0.01$) than six hour concentrations in assays with added wheat bran or pectin. The production of lactate was almost equally distributed between the L- and D-isomers. Lactate production from ispagula or albumin was negligible. The formation of lactate from glucose was significantly decreased in patients with previous colonic cancer when directly compared with healthy controls by an ordinary t test ($p<0.01$), but differences between the groups were not significant when all four groups were compared with any of the three others by one way analysis of variance. The main finding was that the patterns of lactate production from different substrates were similar in all four groups, although a significantly decreased production of D-lactate from pectin in faeces from adenoma and cancer patients was registered. The final pH in homogenates after six hours of fermentation did not differ between the groups (not shown).

Table III shows the effect of bowel surgery on pH, lactate concentration, and glucose induced six hour production of lactate. Differences associated with type of surgery – that is, sigmoid resections (five), right sided (seven) and left sided (two) hemicolectomies were not significant.

A modification of the diet of healthy young subjects towards a fibre, starch, and lactose free enteral nutrition based exclusively on the administration of Nutridrink, caused a significant rise in faecal pH from 6.81 (0.09) to 7.15 (0.13) ($p=0.025$), whereas faecal lactate concentrations remained unchanged (Table IV). On the other hand, an increased load of carbohydrates, as lactulose, to the colon resulted in a pronounced decrease in faecal pH from 6.93 (0.10) to 5.94 (0.25) ($p=0.005$), and a five to sevenfold increase in D- and L-lactate concentrations (Table IV). It was noticed that the faecal pH (7.11 (0.12) in the older age matched control group (mean age 61 years; Table I) was higher than the pH (6.89 (0.07); $p=0.056$) in faeces sampled in the control period from the 20 younger healthy volunteers (mean age 32 years) who participated in the Nutridrink or lactulose study (five subjects participated in both studies, with a total number of 20 subjects).

The endogenous (with no substrate addition) or glucose stimulated production of lactate in faecal homogenates were not influenced by total enteral nutrition with Nutridrink (Table V). The intake of lactulose (80 g/day), however, resulted in a pronounced increase in the endogenous L-lactate production comparable with production seen only after the addition of glucose to homogenates from subjects on an ordinary diet. The increase in D-lactate production was of borderline significance ($p=0.055$; Table V).

Table VI shows the pH and L- and D-lactate concentration in the caecal contents from fed and starved rats. Starvation for 24 hours increased pH by 1.5 units, corresponding to a more than 10-fold decreased caecal proton (H^+) concentration, and was associated with a decrease in lactate concentration. Prolonged starvation for 48 and

TABLE II Production of L- and D-lactate (mean (SE)) in 16.6% faecal homogenates from patients with colonic adenomas and cancer (a, before surgery; b, after surgery), incubated for six hours with glucose, wheat bran, pectin, ispagula, or albumin

Substrate	Controls	Adenomas	Cancer ^a	Cancer ^b	Anova (p value)
<i>D+L lactate production</i>					
None	-6 (96)	-26 (10)	24 (41)	5 (31)	0.97
Glucose	4046 (446)	2975 (621)	3152 (1157)	2202 (588)	0.12
Wheat bran	218 (43)	306 (100)	214 (149)	275 (68)	0.83
Pectin	198 (45)	94 (32)*	45 (18)*	79 (26)*	0.04
Ispagula	15 (15)	34 (37)	-16 (42)	33 (14)	0.69
Albumin	-3 (15)	-3 (17)	-2 (5)	-33 (19)	0.50
<i>L-lactate production</i>					
None	1 (48)	-10 (5)	12 (20)	1 (16)	0.98
Glucose	2056 (208)	1629 (376)	1722 (660)	985 (285)	0.13
Wheat bran	107 (20)	148 (51)	111 (79)	140 (34)	0.85
Pectin	89 (22)	48 (17)	18 (11)	42 (15)	0.12
Ispagula	3 (7)	27 (17)	-10 (19)	19 (6)	0.27
Albumin	-7 (7)	6 (10)	-4 (4)	-5 (6)	0.56
<i>D-lactate production</i>					
None	-7 (48)	-15 (7)	12 (21)	4 (16)	0.95
Glucose	1990 (262)	1346 (259)	1431 (514)	1036 (313)	0.13
Wheat bran	112 (24)	159 (49)	103 (69)	135 (35)	0.80
Pectin	108 (24)	47 (16)*	27 (7)*	37 (13)*	0.02
Ispagula	13 (9)	7 (19)	-7 (23)	14 (9)	0.87
Albumin	5 (8)	-9 (9)	1 (2)	-28 (15)	0.18

* $p<0.05$; all values are $\mu\text{mol/l}\cdot\text{h}$; negative values=net consumption of lactate; production from substrates is corrected for production in control homogenates.

TABLE III Effect of colonic surgery on faecal D+L-lactate concentration, pH, and D+L-lactate production (mean (SE)) from glucose in 16.6% faecal homogenates

Surgery	D+L-lactate concentration (mmol/l)	pH	D+L-lactate production ($\mu\text{mol/l}\cdot\text{h}$)
Sigmoid resection	3.56 (0.75)	7.23 (0.08)	2251 (1038)
Right sided hemicolectomy	2.61 (0.26)	7.27 (0.17)	1103 (934)
Left sided hemicolectomy	3.34 (0.25)	6.86 (0.06)	1857 (100)
Anova	0.46	0.35	0.58

72 hours did not change the pH further and caused comparably small changes in lactate.

Discussion

Dietary fibre, resistant starch, and other saccharides escaping digestion in the small bowel are hydrolysed and converted to pyruvate and lactate by bacterial glycolysis. These intermediates are further converted to the short chain fatty acids, acetate, propionate, and butyrate.¹⁸ Organic acids formed by fermentation may reduce caecal pH below 5–6,^{19,20} but colonic secretion of bicarbonate and other buffers increases pH in colonic contents during their distal passage along the large bowel,^{20,21} and faecal pH is usually higher and changes less than pH in the proximal part of the colon. An excessive production of lactate is known to occur in the large bowel of some patients with short bowel syndrome, who malabsorb large amounts of saccharides into the colon. Colonic bacteria are able to produce both L- and D-lactate, by contrast with the intermediary metabolism of the human organism, which produces and degrades L-lactate only. D-lactate absorbed from the large bowel may therefore accumulate and cause acidosis.^{22–24} The addition of glucose to faecal homogenates (Tables II and

V) parallels the in vivo conditions of D-lactate acidosis, and shows that simple and rapidly fermented saccharides, normally absorbed in the small intestine, may cause considerable lactate formation in the large bowel.

Low intake of dietary fibre reduces colonic fermentation, which also decreases in persons with an exceptionally efficient small intestinal starch absorption.²⁵ Several investigators have found that pH in faeces from patients with colorectal cancer is increased compared with healthy controls.^{6–9} The percentage of unabsorbed (resistant) starch is less in patients with colonic adenomas than in control subjects, and it has been suggested that the resultant diminished carbohydrate fermentation promotes colonic neoplasia.²⁶ It has also been argued that subjects deficient in lactase may benefit from the colonic production of organic acids from lactose.²

Dietary modifications in healthy subjects were associated with changes in faecal pH. A decrease in the flow of carbohydrates into the colon obtained by the fibre, starch, and lactose free dietary formula (Nutridrink) was expected to decrease colonic organic acid formation and make the contents of the large bowel and faeces alkaline. The pH decreased, but the concentration and production of lactate remained unchanged (Table IV). Starvation reduces colonic carbohydrate fermentation and increases faecal pH,²⁷ and starvation of the rats accordingly decreased caecal lactate and H⁺ concentrations (Table VI). The reverse changes in pH were achieved by lactulose (Table IV), similar to earlier observations of the association between the intake of lactulose or dietary fibre and faecal pH.^{4,5,20}

This study failed to show that faecal pH is increased in patients with colonic cancer (Table I). We suggest that this disagreement with the mentioned earlier work is related to the way patients were selected. Earlier studies probably included patients in whom surgery was impossible or not radical. The general food intake may have been diminished in several patients due to colonic stenosis, metastasis, loss of appetite, etc, causing a reduction in the amount of carbohydrates available for fermentation. Antibiotics may have been given to treat infections or as prophylaxis in relation to abdominal surgery, decreasing bacterial formation of organic acids²⁸ and possibly increasing faecal pH. Bacterial degradation of proteins to organic acids proceeds without lactate accumulation (Table II; incubations with albumin), and does not reduce colonic pH (not shown),²⁹ because the organic acid production is buffered by the concomitantly formed ammonia. Therefore, degradation of proteins from a bleeding or secreting colonic cancer stabilises rather than decreases pH, by contrast with the fermentation of saccharides in the healthy colon. Moreover, comparison of the two control groups indicated that younger people have a slightly more acidic faecal pH than older people, and patients with colonic cancers may therefore seem to have more alkaline pH when compared with younger controls.

Recently, Charalambides *et al.*³⁰ found that faecal pH from sigmoid colostomies did not differ when five non-cancer trauma patients were

TABLE IV Concentrations of L- and D-lactate and pH (mean SE) in faeces from 13 volunteers given fibre, starch, and lactose free enteral nutrition, and 12 volunteers given lactulose (80 g/day)

	(mmol/l)			
	D+L-lactate	L-lactate	D-lactate	pH
Controls	3.88 (0.38)	1.99 (0.21)	1.89 (0.18)	6.81 (0.09)
Enteral nutrition	4.64 (0.64)	2.18 (0.31)	2.45 (0.40)	7.15 (0.13)
p Value	0.29	0.48	0.26	0.03
Controls	3.64 (1.35)	1.75 (0.58)	1.89 (0.95)	6.93 (0.10)
Lactulose	17.22 (4.78)	9.59 (3.26)	7.63 (2.24)	5.94 (0.25)
p Value	0.005	0.03	0.01	0.005

p Value from rank test for paired samples.

TABLE V Production of L- and D-lactate (mean (SE)) in 16.6% faecal homogenates from 13 volunteers given fibre, starch, and lactose free enteral nutrition, and 12 volunteers given lactulose (80 g/day)

Substrate	Controls	Enteral nutrition	Lactulose intake	p Value
Total D+L-lactate production:				
None	–23 (6)	3 (34)	–	0.62
Glucose	3156 (833)	2197 (821)	–	0.50
L-lactate production:				
Glucose	1856 (509)	1100 (412)	–	0.40
D-lactate production:				
Glucose	1300 (340)	1096 (409)	–	0.76
Total D+L-lactate production:				
None	–22 (15)	–	2475 (637)	0.004
L-lactate production:				
None	–14 (11)	–	2395 (612)	0.004
D-lactate production:				
None	–8 (6)	–	80 (37)	0.055

p Value from rank test for paired samples; all values are $\mu\text{mol/l} \cdot \text{h}$.

TABLE VI Concentrations of L- and D-lactate and pH (mean SE) in caecal contents from fed and starved rats

Rats (n=10)	D+L-lactate	L-lactate	D-lactate	pH
Not starved	6.90 (0.64) ^a	3.45 (0.31) ^a	3.45 (0.33) ^a	6.42 (0.10) ^a
Starved 24 hours	1.45 (0.18) ^b	0.72 (0.10) ^b	0.73 (0.09) ^b	7.94 (0.12) ^b
Starved 48 hours	1.40 (0.14) ^b	0.72 (0.08) ^b	0.69 (0.07) ^b	7.98 (0.12) ^b
Starved 72 hours	0.83 (0.08) ^b	0.42 (0.03) ^b	0.41 (0.05) ^b	7.78 (0.11) ^b
Anova (p value)	<10 ^{–4}	<10 ^{–4}	<10 ^{–4}	<10 ^{–4}

Test of least significant difference, $p < 0.01$: homogenous groups are marked with same superscript. All values are mmol/l.

compared with five patients who had undergone sigmoid colectomy for distal colonic cancer. Pye *et al*³¹ measured intestinal pH in 30 patients with colorectal cancer and 37 patients with colorectal adenomas with the elegant technique of a pH sensitive radiotelemetry capsule. These values were compared with those recorded in 66 normal subjects. No differences in intestinal pH, including right, mid and left colonic pH, were found, and they concluded that these results did not support the hypothesis that colonic pH plays a part in the aetiology of colorectal neoplasia. They did not explain why their results differed from earlier reports, but we believe that it is due to the fact that radiotelemetric measurements are possible only in cancer patients in a good condition – that is, probably excluding acute patients with ileus or sepsis, vomiting patients, patients immediately after surgery, etc. Their patients therefore probably resembled our preoperative but electively chosen patients. Much research, including our own, has been initiated and based on the assumption that faecal pH in patients with colonic cancer is alkaline, and we think that it is important that the previous reports are balanced with the results of Pye *et al*, Charalambides *et al*, and ourselves.

Faecal pH is interpreted as a guidance for the kind of diet ingested in the years before the cancer evolves, but a change in diet can alter the faecal pH within days. Faecal pH measured in patients with colonic cancer, who are clinically unaffected by an early cancer or have regained health after surgery, may therefore be a more appropriate index for the half a century diet suspected of being carcinogenic, than faecal pH in non-selected patients. Another approach is to investigate patients with neoplastic adenomas believed to be in a precancer risk situation, but in agreement with previous investigations,^{8,9} faecal pH was not altered in patients with colonic adenomas (Table I). Therefore, the alkaline faecal pH in patients with colonic cancer may not be a primary event associated with the evolution of neoplasia. It is suggested that pH may increase as a result of short term changes in fermentation secondary to the progressive growth of a colorectal cancer.

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