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SHORT COMMUNICATION

Evolutionary perspective on dietary intake of fibre and colorectal cancer

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From an evolutionary perspective, the ongoing discussion of fibres role in colorectal cancer is possibly limited by the overall low intake of fibre across study groups. Our ancestral diet consistently included a *diverse* range of plants that regularly contributed up to and often >100 g/day of dietary fibre. Importantly, this diversity assured that, owing to a range of physical and chemical structures, a steady flow of fermentable substrates promoted metabolic activity into the distal regions of the colon.
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Modern humans are the latest in a diverse line of species within the genus *Homo* that evolved on a nutritional landscape very different from the one we find ourselves today. During the two million years since the first member of our genus made an appearance in the fossil record, humans subsisted on foraged wild plants and animals from a dynamic environment that literally changed at a glacial pace. It is only within the last 5000–10 000 years did that food supply include agricultural crops and domesticated animals and their by-products. Therefore, the modern human genome and its nutritional and physiological parameters were selected during our non-domesticated foraging lifeway conditioned, in no small way, by a diet of *diverse* fibre- and nutrient-rich plants and lean meats.

Even though this important reality underlies the basic evolutionary biological principles of modern human nutrient requirements, it is all but missing from current discussions of dietary fibre intake and our attempts to understand its role in the aetiology of colorectal cancer. As the steady stream of European- and US-based studies demonstrate (e.g., Fuchs *et al*., 1999; Bingham *et al*., 2003; Park *et al*., 2005), the protective role of dietary fibre is inconsistent, often frustrating, and made more allusive with a growing list of confounding risk factors (e.g., smoking, alcohol, red meat). This is further complicated when well-known fibre sources, such as resistant starch and inulin-type fructans, are not consistently considered when calculating total fibre intake among many studies.

Part of the dilemma in our ability to derive clear answers to the possible role of dietary fibre in colorectal cancer may be, from an evolutionary perspective, the remarkably low intake of fibre among various populations and study groups (Park *et al*., 2005) – even for those that fall within the upper quintiles. It is well known that dietary habits among westernized societies are characterized by increasing caloric intake from added sugars, fats and highly processed nutrient- and fibre-poor grains. This caloric shift is in discordance with our evolutionary past (Eaton *et al*., 2002) and continues to be at the expense of dietary diversity and consumption of fibre- and nutrient-rich plants. A few examples from the archaeological and ethnographic record demonstrate the magnitude of this shift as it pertains to the diversity and quantity of fibre in human diet.

Located along the shores of the Sea of Galilee in modern-day Israel, a remarkably well-preserved collection of plant remains were recovered from the 23 000-year-old archaeological site of Ohalo II (Weiss *et al*., 2004). Ohalo II has provided an extraordinary window into a broad-spectrum diet that yielded a collection of >90 000 plant remains representing small grass seeds, cereals (emmer wheat, barley), acorns, almonds, raspberries, grapes, wild fig, pistachios and various other fruits and berries. Owing to excellent preservation, a stunning 142 different species of plants were identified, revealing that a rich diversity of fibre sources was consumed by the site inhabitants.

In Australia, Aborigines are known to have eaten some 300 different species of fruit, 150 varieties of roots and tubers and

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a dizzying number of nuts, seeds and vegetables (Brand-Miller and Holt 1998). Based on the analysis of over 800 of these plant foods, the fibre intake was estimated between 80 and 130 g/day, depending on the contribution of plants to daily energy needs (Brand-Miller and Holt 1998). This daily intake is most likely higher when you consider that fibres in the form of resistant starch and oligosaccharides were not measured by the researchers among the economically important roots and tubers.

In the semi-arid Trans-Pecos region of west Texas, a nearly continuous 10 000-year record of a foraging lifestyle has been documented in dry cave deposits. Considered one of the most complete records of foraging lifestyle in North America, nearly three decades of excavation and extensive analysis of well-preserved macrobotanical remains and human coprolites (faeces) from a number of cave sites (Sobolik, 1994) reveal a plant-based diet that conservatively providing between 150 and 250 g/day of dietary fibre from dozens of plant species. The fibre-rich diet is well illustrated by the visual presence (Figure 1) of undigested fibre (cellulose) in nearly 100% of the human coprolites studied throughout the entire 10 000-year sequence (Sobolik, 1994).

Although the diversity and quantity of fibre varied spatially and temporally in the past, our ancestors clearly evolved on a diet that included daily intake of fibre from a diversity of sources that far exceed those recorded among populations in recent intervention and prospective studies concerned with the protective role of fibre against colorectal cancer. While stool bulking, dilution of colonic contents and reduced transit time are clearly positive mechanisms of this ancestral intake of fibre, of particular interest may be the increased opportunities for consumption of long-chain molecules (e.g., inulin), in combination with insoluble fibres (e.g., cellulose, hemicellulose), that are known to slowly and selectively stimulate anaerobic bacterial fermentation into more distal areas of the colon. The slow, sustained effect of metabolic activity and production of short-chain fatty acids (specifically butyrate), and corresponding reduction in pH and conversion of bile acids, into more distal regions, has been shown to have a strong physiological impact in biomarkers (Van Loo, 2004).

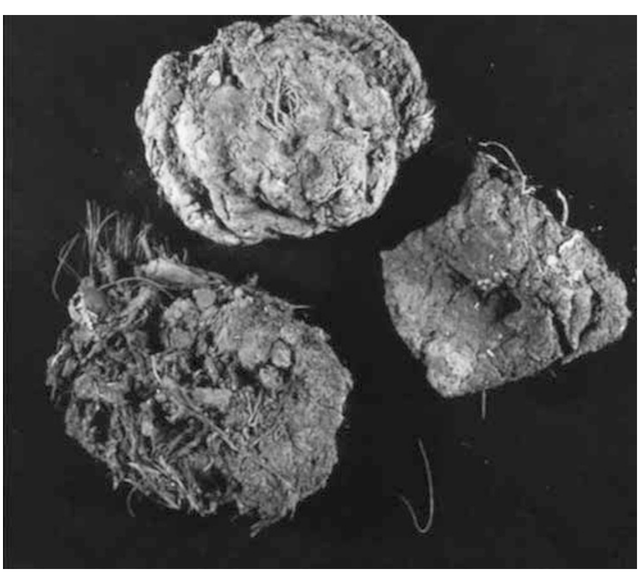

Figure 1 Human faeces (5500 years old) (coprolites) recovered from dry cave deposits in west Texas. Undigested fibre (cellulose), visible in all three samples, is characteristic of nearly all coprolites analysed from this region. Photograph courtesy of K Sobolik.

With modern palates that trend towards less lignified portions of plants, in combination with a food industry that is likely to select added fibres more for their technical or economical characteristics than physiological ones (Redgwell and Fischer 2005), modern populations 'most likely' consume more rapidly fermented fibres over more slowly fermented ones than at any point in our evolutionary past. Said differently, rapid technological advances within food industry and a decreasing variety and quantity of fibre sources throughout much of western civilization has resulted in decreased metabolic and physiological activity in the distal colon, thus opening the pathogenic door to cancer in this region.

Future studies on the protective role of dietary fibre against colorectal cancer may benefit from a research agenda that includes an overarching understanding of the evolutionary landscape in which our current nutrient requirements were selected. In the case of even the best-designed intervention or prospective study, clear and optimal results may never be achieved as the diet and lifestyle of participants may differ significantly from their evolution-based and thus genetically determined optimal intake of fibre and other nutrients.

Until we have better understanding of the diversity and quantity of fermentable substrates that entered our ancestral bowels, and thus conditioned our current nutritional parameters and physiological responses, accompanied with modern analytical tools and techniques that allow us to compare the range of chemical and physical fibres present in the modern food supply, the possible and important protective role of fibre in aetiology of colorectal cancer may not be forthcoming.

References

Bingham SA, Day NE, Luben R, Ferrari P, Slimani N, Norat T *et al.* (2003). Dietary fibre in food and protection against colorectal cancer in the European Prospective Investigation into Cancer and Nutrition (EPIC): an observational study. *Lancet* **361**, 1496–1501.

Brand-Miller JC, Holt SHA (1998). Australian Aboriginal plant foods: a consideration of their nutritional compositional and health implications. *Nutr Res Rev* **11**, 5–23.

Eaton SB, Strassman BI, Nesse RM, Neel JV, Ewald PW, Williams GC *et al.* (2002). Evolutionary health promotion. *Prev Med* **34**, 109–118.

Fuchs CS, Giovannucci EL, Colditz GA, Hunter DJ, Stampfer MJ, Rosner B *et al.* (1999). Dietary fiber and the risk of colorectal cancer and adenoma in women. *N Engl J Med* **340**, 169–176.

Park Y, Hunter DJ, Spiegelman D, Bergkvist L, Berrino F, van den Brandt PA *et al*. (2005). Dietary fiber intake and risk of colorectal cancer: a pooled analysis of prospective cohort studies. *J Am Med Assoc* **14**, 2849–2857.

Redgwell RJ, Fischer M (2005). Dietary fiber as a versatile food component: an industrial perspective. *Mol Nutr Food Res* **49**, 421–535.

Sobolik KD (1994). Paleonutrition of the Lower Pecos region of the Chihuahuan Desert. In: KD Sobolik (ed). *Paleonutrition: The Diet and Health of Prehistoric Americans*, Center for Archaeological Investigations: occasional paper no. 22. pp 247–264. Center for Archaeological Investigations, University of Illinois, Urbana.

Van Loo J (2004). The specificity of the interaction with intestinal bacterial fermentation by prebiotics determines their physiological efficacy. *Nutr Res Rev* **17**, 89–98.

Weiss E, Wetterstrom W, Nadel D, Bar-Yosef O (2004). The broad spectrum revisited: evidence from the plant remains. *Proc Natl Acad Sci USA* **101**, 9551–9555.