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NAHRUNGSEASERN  
DIETARY FIBRES

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edited by

RENATO AMADÔ

and THOMAS F. SCHWEIZER

# Nahrungsfasern

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# Nahrungsfasern

## Dietary Fibres

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## VORWORT

Die Bedeutung der Nahrungsfasern in einer ausgewogenen Ernährung ist zwar im Laufe der Geschichte vereinzelt immer wieder betont und auch wissenschaftlich untersucht worden. Mit der Industrialisierung von weiten Teilen der Welt und den damit verbundenen Änderungen der Lebens- und Ernährungsgewohnheiten wurden aber unsere Lebensmittel zunehmend faserarm. Als nicht eigentlich essentielle Inhaltsstoffe der Nahrung fanden Nahrungsfasern im Zeitalter der Erforschung unentbehrlicher Vitamine, Mineralsalze, Fett- und Aminosäuren auch seitens der Wissenschaft wenig Beachtung.

Dies änderte sich vor rund 15 Jahren fast schlagartig mit der Veröffentlichung von Arbeiten von Burkitt, Painter, Trowell und Walker, die einen Zusammenhang zwischen ungenügendem Verzehr von Nahrungsfasern und einer Reihe von sogenannten Zivilisationskrankheiten postulierten. Jährlich zeigen hunderte von wissenschaftlichen Publikationen, dass diese Hypothese auf fruchtbaren Boden gefallen ist. Auch der Konsument zeigte rasch grosses Interesse an Nahrungsfasern. Möglicherweise werden Ernährungsempfehlungen, die ein "Mehr" (Nahrungsfasern) beinhalten, angenehmer empfunden als das alt bekannte "Weniger" (Kalorien, Fett, Zucker, Cholesterin, Kochsalz). Viele Aspekte der Nahrungsfasern-Hypothese sind aber noch unergründet und umstritten.

Im Hinblick auf die rasche Entwicklung auf diesem Gebiete veranstaltete die Schweiz. Gesellschaft für Lebensmittel-Wissenschaft und -Technologie, in Zusammenarbeit mit dem Schweiz. Verband der Ingenieur-Agronomen und Lebensmittelingenieure und der Schweiz. Gesellschaft für analytische und angewandte Chemie am 20./21. März 1986 einen Fortbildungskurs "Nahrungsfasern", der an der Eidgenössischen Technischen Hochschule (ETH) in Zürich stattfand und von 220 Teilnehmern besucht wurde. Als Verantwortliche für das Tagungsprogramm danken wir den Veranstaltern, den Mitorganisatoren vom Institut für Lebensmittelwissenschaft der ETHZ, den Referenten und den Tagungsvorsitzenden für ihre unentbehrliche Hilfe. Sie alle haben zusammen mit den interessierten und rege diskutierenden Teilnehmern, zum Gelingen dieser Veranstaltung beigetragen. Wir danken auch der Academic Press Inc., London, welche die Veröffentlichung der Vorträge in Buchform ermöglicht.

Bei der Durchsicht der einzelnen Kapitel wird dem Leser auffallen, dass einige deutschsprachige Autoren den Begriff "Ballaststoffe" der im Buchtitel erscheinenden Bezeichnung Nahrungsfasern vorziehen. Wir haben bewusst darauf verzichtet, die mit beiden Begriffen angestrebte Benennung eines komplexen Substanzgemisches pflanzlichen Ursprungs zu vereinheitlichen. Die Titelwahl erleichtert hat uns aber die Tatsache, dass sich in anderen Sprachgebieten "dietary fibre" und dessen wörtliche Uebersetzungen gegenüber vielen anderen vorgeschlagenen Begriffen durchgesetzt hat. Auch rufen "Nahrungsfasern", im Gegensatz zu "Ballaststoffe", keine negative Assoziationen im Sinne von Last und Belastung hervor und machen klar, dass von Bestandteilen der Nahrung die Rede ist. Demgegenüber wog die Einschränkung, dass nicht alle Nahrungsfaserkomponenten faserigen Charakter haben, nicht so schwer, besonders wenn man bedenkt, dass nicht alle Vitamine Amine sind.

So darf denn die Dualität der Benennung stellvertretend und bezeichnend für die noch unsichere und kontroverse Beurteilung vieler Aspekte der Nahrungsfasern durchaus zum Vorschein kommen.

Zürich und Vevey, im Herbst 1986

Renato Amadò

Thomas F. Schweizer

## PREFACE

The knowledge on dietary fibre has increased dramatically during the past decade. Initially, dietary fibre research was a domain of nutritionists and physicians, but, more recently, food chemists, food technologists and food manufacturers became interested in this fascinating field of research and development.

The Swiss Society for Food Science and Technology found it appropriate to organise, together with the Swiss Society for Analytical and Applied Chemistry and the Swiss Federation of the Agricultural and Food Engineers, an advanced study course with the general title "dietary fibre". This symposium took place on March 20 and 21, 1986 at the Swiss Federal Institute of Technology (SFIT) in Zurich and was attended by 220 participants. The main objective of the study course was to review different topics in the field of dietary fibre research. The following items were treated in 7 sessions: epidemiology of dietary fibre, chemistry, analytical methods, physiological aspects, functions of dietary fibre in food, fibre-rich food products, and legal aspects of labelling and fibre-related claims.

This book is based upon the different lectures presented at the symposium. We should like to thank all the speakers, chairmen, the organising societies as well as the local organisers from the Department of Food Science of the SFIT and the participants for making it such a successful meeting. We should particularly like to thank Dr. Conrad Guettler and Miss Gina Fullerlove, of Academic Press London, for all their help and advice in the preparation of these proceedings for publication. Finally, we would like to express our gratitude to the responsables of Academic Press, London, for giving us the opportunity to publish this volume.

Zurich and Vevey, Autumn 1986

Renato Amadò  
Thomas F. Schweizer

**A. Epidemiologische und chemische Grundlagen**  
**Epidemiology and Chemistry**

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# EPIDEMIOLOGY OF DIETARY FIBRE, DIVERTICULAR DISEASE, AND LARGE BOWEL CANCER

SHEILA BINGHAM

## ABSTRACT

A number of large bowel disorders, including cancer, and other diseases are common in 'Western' countries such as Europe, USA, Australia and New Zealand, but rare in countries such as Africa, Asia, India and Japan. Lack of dietary fibre has been proposed as being important in the aetiology of these diseases, and studies in Britain and other westernised countries show that dietary fibre intakes are low when compared with rural Africa. However, recent studies have also shown that intakes in Japan are no greater than in the west. Fibre cannot therefore be the reason for low rates of, for example, large bowel cancer and diverticular disease seen in Japan. Limited studies in Britain and Scandinavia however suggest that fibre might be protective against colon cancer in populations otherwise seen to be at risk from other aspects of the westernised type of diet.

## INTRODUCTION

The controversy over the nutritional properties of 'whole' versus 'refined' food has existed for centuries. The publication in 1969 however of the 'dietary fibre hypothesis' (ref.1) has prompted radical change in current concepts of the nutritional value of western diets and in medical practice, particularly perhaps in the past decade. The treatment of many large bowel disorders is very different from that of 20 years ago, and the majority of expert committees have advocated changes in national diets in order to avoid diseases which dietary fibre is thought to protect against (ref.2,3).

Table 1 lists those disorders stated to be caused by lack of fibre in western societies currently under investigation and which were discussed in the latest textbook on dietary fibre (ref.4). The basis for the fibre hypothesis is largely epidemiological; these diseases are said to be rare in areas where much dietary fibre is consumed, particularly rural Africa (ref.1). However, there is a marked lack of good epidemiological data both on fibre consumption and prevalences of many of these disorders. This paper will concentrate on the epidemiology of just two of these disorders, diverticular disease and large bowel cancer, for which some data on their

TABLE 1. Diseases Associated with Lack of Dietary Fibre (ref.4)

---

|                      |                      |
|----------------------|----------------------|
| Constipation         | Obesity              |
| Diverticular disease | Diabetes             |
| Colorectal cancer    | Gallstones           |
| Appendicitis         | Heart disease        |
| Crohn's disease      | Varicose veins       |
| Ulcerative colitis   | Haemorrhoids         |
| Irritable bowel      | Deep-vein thrombosis |
| Duodenal ulcer       | Renal stone          |
| Hiatal hernia        |                      |

---

occurrence is available. It must be emphasised however that the causative agents involved in both these diseases are unknown, consequently the manner in which dietary fibre may protect against them remains a matter for conjecture. Due to both inadequate epidemiological data and lack of experimental confirmation, the almost universal acceptance of the fibre hypothesis at the present time is somewhat surprising.

#### EPIDEMIOLOGY

##### The nature of diverticular disease

Diverticular disease is a condition of the colon in which the mucosal lining herniates through the muscular wall to form pouches or diverticula. Most people are asymptomatic, and the presence of diverticula alone is known as diverticulosis. However, other patients suffer from abdominal pain, nausea, vomiting, heartburn and flatulence. In some patients, inflammation (diverticulitis) occurs, resulting in peritonitis, abscesses and fistulae which are life-threatening and require major surgery. Present-day routine treatment of diverticulosis is with an increase of fibre in the diet, usually bran (ref.5). This however does not constitute evidence that lack of fibre is the cause of diverticular disease.

##### Prevalence

Diverticular disease is said to be 'extremely rare' in rural Africa (ref.6) whereas it is very common in western populations, where it primarily occurs in older people, and in the left (descending) colon. For this

reason, rates should be age-standardised but this is rarely done, so that comparisons between different countries is difficult. In one study in Britain the prevalence in Oxford in 1979 was about 34%, with 65% of the population over 70 years affected (ref.7). In 1959 in Salt Lake City, USA, the prevalence was 21% overall, and 36% in patients over 70 years old (ref.8). Rates in Poland and India are lower, about 7% and 1% respectively, with the majority of diverticula occurring in elderly patients and in the left colon in India (refs.9,10).

More interesting from the point of view of fibre intake (see below) is that prevalence rates are very low in China, Korea and Japan (refs.11,12, 13). Two large scale studies in China and Korea have recorded rates of 0.4% or less, and present levels in Japan are around 6-7%, higher in Tokyo (10-12%) and possibly increasing in the country as a whole. In these three populations with low prevalence, the majority of diverticula are located in the right colon. The reason for this anatomical difference is unexplained.

#### Incidence of large bowel cancer

The incidence of large bowel cancer is very much better documented with established cancer registries in many areas of the world (ref.14). These show that there are consistent geographical variations in the incidence of colon cancer worldwide. Large bowel cancer increases markedly with age, like diverticular disease, and worldwide comparisons are usually age-standardised and truncated to the 35-64 years age group. These show that it is true to say that large bowel cancer is very rare in rural Africa, whereas it is very common in affluent western societies, such as New Zealand, the USA, the UK and Switzerland (Table 2). In these westernised countries, large bowel cancer is one of the most important cancers, second only to lung in men and breast in women. Rates are low in other developing countries, such as Colombia and India but note also that rates are low in Japan, which is a contrasting urban, comparatively affluent, society. No incidence rates are available for China.

#### Migrant studies

Migrant studies show that these geographical variations in cancer incidence are due to environmental influences, rather than genetic ones. As

TABLE 2. Colon Cancer Incidence (ref.14)

Age standardised truncated rates per 100000 men

---

|                    |      |
|--------------------|------|
| New Zealand whites | 36.1 |
| Connecticut, USA   | 35.8 |
| Switzerland        | 24.1 |
| United Kingdom     | 20.4 |
| Denmark            | 18.9 |
| Germany            | 16.6 |
| Finland            | 9.7  |
| Japan              | 7.6  |
| Colombia           | 5.8  |
| India, Bombay      | 5.7  |
| Nigeria            | 3.4  |

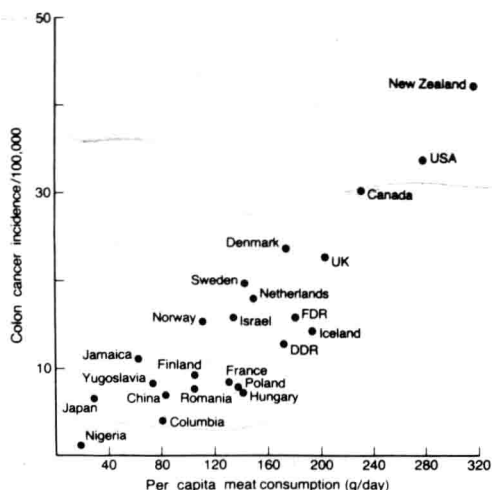
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already stated, rates for both diverticular disease and large bowel cancer are low in Japan, but high in the USA. Rates for large bowel cancer however in migrants to Japan change to those of the USA population in Hawaii within one generation (ref.15). An autopsy study of diverticular disease shows that in Japanese Hawaiian migrants, the low rates found in Japan have changed to the high rates found in the USA population (ref.16).

#### Dietary influences

Whilst there are many other differences in life-style between rural African and western societies, one strong contender to account for geographical variations in diverticular disease and large bowel cancer incidence is diet. There are very many aspects of westernisation of food habits and a simplistic view is probably unwise. However, in the case of large bowel cancer there is a very strong worldwide association between meat consumption and large bowel cancer incidence, rates being highest in the areas with the highest meat consumption (Fig.1). Total fat consumption is also related (ref.17) but to a lesser extent. Fat increases bile acid excretion and this may be important in the promotion of large bowel tumours (ref.18,19). Recent studies have also shown that carcinogenic heterocyclic amines present in cooked meat have induced tumours in the large intestine of experimental animals (ref.20). Ammonia alters the susceptibility of cells to virus-induced tumour changes, and increases cell turnover, thus increasing the possibility of genetic damage occurring (ref.21). Ammonia

FIGURE 1. Relationship between meat consumption in various countries and the risk in those countries of developing colon cancer (ref.17)



concentration is greater in the faeces of subjects maintained on high meat diets compared with low meat ones (ref.21). Fat and animal protein intakes in Hawaiian Japanese are almost twice those of indigenous Japanese (ref.22).

With regard to diverticular disease, no dietary factors other than dietary fibre (see below) have been associated with altered risk consistently.

## DIETARY FIBRE

### Mechanisms

On feeding fibre, stool weight is increased, transit time decreased, and the consistency of the stool is softened (ref.21). Painter and Burkitt (ref.6) suggested that diverticula were formed as a result of increased pressure in the colon, due to the small hard faeces formed from a fibre-deficient diet. They proposed that with increased fibre 'the swiftly passed soft stool subjects the sigmoid to less strain and does not favour the