THE NUTRITION REPORT

2004
SUMMARY

GERMAN NUTRITION SOCIETY

The Nutrition Report 2004

Summary

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Preface

In 1968 the government of the Federal Republic of Germany (FRG) commissioned the German Nutrition Society (DGE) to prepare a report concerning the nutritional status of the German population. This Nutrition Report was well received when it was submitted in June 1969 because it was for the first time that an overview of a wide range of nutritional data available in the Federal Republic was presented. As a result government decided to commission the DGE to prepare a comparable report every 4 years.

The following Nutrition Reports provide most recent statistical data of the nutritional situation in Germany which are supplemented by overviews, analyses and reviews of studies on present nutritional problems including evaluations.

The 1969 Nutrition Report dealt with the following subjects on 140 pages:
- Production and consumption in the light of nutritional physiology
- Relation between production and consumption of food produced in Germany
- Population and consumer structure according to economic sectors
- Relation between physiological consumer requirements and food prices
- Food consumption and nutrient intake
- Changes in nutrition in an industrial society
- Evaluation according to nutritional physiology
- Conclusions and future trends

In addition to an analysis of the nutritional situation in the Federal Republic of Germany the Reports of 1972 to 2004 also contain reviews of studies on nutritional problems.

The following subjects were dealt with in 1972:
- Nutritional behaviour in the Federal Republic of Germany
- Nutritional significance of processed food
- Changes in food quality during storage, processing and packaging
- Nutrition education at school
- Nutrition science and nutrition research

In 1976 detailed information was presented in the following fields:
- Food consumption and nutrient supply in the Federal Republic of Germany
- The influence of nutrition on the health situation in the Federal Republic of Germany
- Hygienic-toxicological and microbiological aspects of food
- Communal feeding in the Federal Republic of Germany
- Analysis of some selected samples of the influence of advertising on the nutritional behaviour
- Psychological causes of poor nutritional behaviour

The 1980 Nutrition Report dealt with:
- Development of the nutritional situation in the Federal Republic of Germany
- Nutritional behaviour in the Federal Republic of Germany
- Eating away from home (problem analysis with special regard to the main meal)
- Relationship between nutrition research and health policy

The 1984 Nutrition Report discussed the following topics:
- Development of the nutritional situation in the Federal Republic of Germany
- Chemical-toxicological and hygienic-microbiological aspects of food

- Psychosocial evaluation of nutrition in families with children
- Development of the food demand in the Federal Republic of Germany
- Critical evaluation of alternative diets

The 1988 Nutrition Report dealt with:
- Development of the nutritional situation in the Federal Republic of Germany
- Toxicological and microbiological aspects of nutrition
- Documentation Chernobyl
- Food allergies and food intolerance reactions
- Influence of federal measures on the nutritional behaviour
- Influences on human food intake
- Meals eaten away from home
- Recommendations to meet nutrient and dietary energy requirements
- Nutritional research in the Federal Republic of Germany

The 1992 Report dealt with:
- Development of the nutritional situation in Germany
- Toxicological and microbiological aspects of nutrition
- Selected socio-cultural influences on the nutritional behaviour
- Food allergies and food intolerance reactions
- Tumorigenesis – inhibiting and promoting effects of nutritional factors
- Iodine supply and iodine deficiency prophylaxis in Germany

The Nutrition Report 1996 dealt with:
- The nutritional situation in Germany
- Institutional feeding in the new Federal Länder (former German Democratic Republic)
- Iodine deficiency prophylaxis in Germany
- Toxicological aspects of nutrition
- Microbiological aspects of nutrition
- Tumorigenesis – inhibiting and promoting effects of nutritional factors
- Significance of phytochemicals for health
- Malnutrition of geriatric patients
- Novel food
- Information provided on food labels as a factor influencing food choice

The Nutrition Report 2000 dealt with:
- The nutritional situation in the Federal Republic of Germany
- Breastfeeding and infant nutrition in Germany
- Nutritional situation in day-care centres: Study of the Nutritional Situation in Day-Care Centres
- Eating habits and nutritional situation of children and adolescents
- Nutrition of the elderly
- Toxicological aspects of nutrition
- Microbiological aspects of nutrition
- Technological aspects of food processing
- Nutritional influence on the intestinal flora
- Prevention of diseases by wholesome diets

The Nutrition Reports provoked considerable interest both within and outside Germany.
From 1984 on, summaries of the Nutrition Reports have therefore been translated into English.

NUTRITION REPORT 2004

Chapter 1: Nutritional situation in Germany

Chapter 1 deals with the nutritional situation of the German population. Special attention is paid to possible differences between the old (former territory of the FRG) and the new (former GDR) Federal Länder, a comparison of nutritional behaviour and scientific recommendations, trends towards desirable and undesirable changes in nutritional behaviour in the light of health policy, and the need for public preventive measures in some essential fields.

Food consumption and nutrient supply

The nutritional situation is described on the basis of the *Food Balance Sheet* and the *Income and Consumption Survey (EVS).* EVS published every five years contains income and expenditure data of private households over a period of 3 months. The present Nutrition Report is based on EVS data of 1998 and on data of the Food Balance Sheet extending up to 2002. As EVS provides data of food purchases by private households, some conversions, especially of quantities purchased into quantities actually consumed, and of quantities related to households into those related to individuals are necessary. These conversions were made by use of corrective factors and appropriate econometric methods of assessment.

For studies of changes in nutrient supply, EVS data of 1988, 1993 and 1998 were used. Data of nutrient intake were calculated from EVS consumption data using the German Food Code and Nutrient Data Base (Bundeslebensmittelschlüssel, BLS) version II.3. A comparison of these data from the old and new Federal Länder yielded statistically significant differences for the majority of nutrients.

The Nutrition Report 2004, as the preceding Report of 2000, shows higher *food consumption* data for the new Federal Länder (former GDR), compared to the old, for meat, sausages and meat products, fish, butter, margarine, inland fresh fruit, fresh exotic fruit, vegetable products, bread and pastries, honey, jam and marmalade, coffee and tea as well as alcoholic drinks. In the old Federal Länder (former territory of the FRG), vice versa, higher consumption data than in the new were recorded for milk, cheese and curds, other edible fats and oils, processed foodstuff, chocolate and sweets as well as for non-alcoholic drinks. Because of their higher energy intake, men, on the average, eat larger amounts of many food categories than women; women, however, generally eat more dairy products, cheese and curds, fresh exotic fruit and fresh vegetables.

As far as *food of animal origin* is concerned, the increased consumption of poultry meat and of fish, and the trend towards less red meat, are regarded positive. This also applies to the relative constant consumption of dairy products made of fresh milk and to the higher consumption of yoghurt. The increasing consumption of cheese enhances the supply of calcium and other minerals, but involves the risk of more fat and of saturated fatty acids in particular. Altogether, too much fat is still consumed, and there is no indication of a downward trend. Vegetable oils and vegetable fats meanwhile account for more than half of the fat consumed; this and the decreasing consumption of butter are regarded as positive.

Of vegetable food, less potatoes, but more fruit and vegetables are consumed. In terms of absolute figures, however, fruit and vegetable consumption continues to be insufficient. The nutritional goal of at least 400 g fruit and vegetables per day set by WHO is failed by nearly any group except for those over 51 years of age. Younger individuals especially in the old Federal Länder should be advised to eat more fruit and vegetables. The lasting downward trend in alcohol consumption is good news.

Figure 1: Consumption of fresh fruit and citrus fruit (1995–2002)

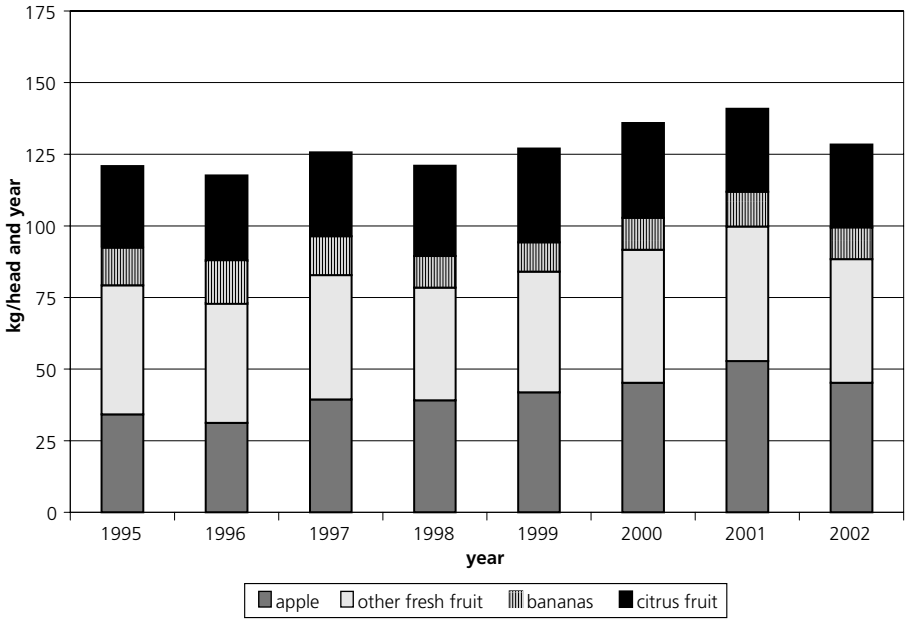
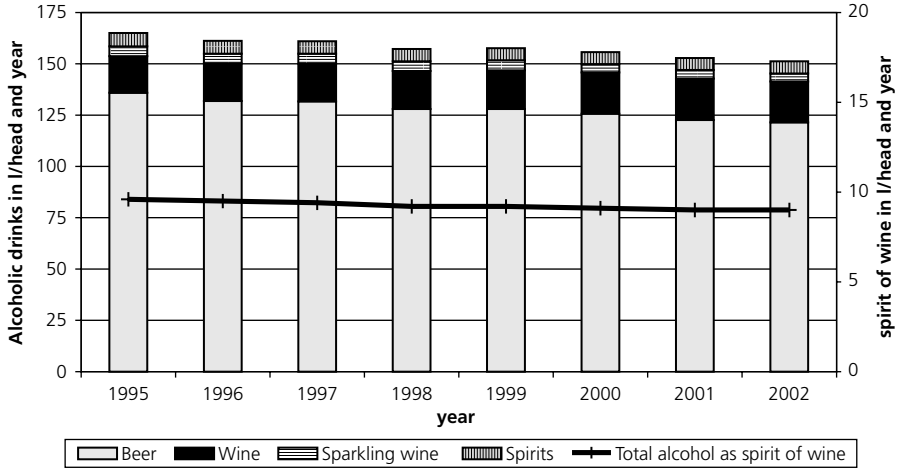


Figure 2: Consumption of alcoholic drinks (1995–2002)



More than two thirds of dietary energy is provided by vegetable products. The recommendation to predominantly live on vegetable food is hence followed by an average of all groups of the population.

Energy and nutrient supply: In men and women of all age groups up to 51 years mean energy supply is below the guiding values of D-A-CH[1]; it should be noted, however, that the guiding values for mean energy supply presuppose adequate physical activity with PAL values between 1.6 and 1.75. As the physical activity of the majority of individuals in Germany is below the desirable level, however, energy supply is too high.

In all groups of persons, *dietary protein* accounts for 12 % to 14 % of dietary energy; this is above the D-A-CH reference values of 8 % to 10 % of dietary energy recommended to adequately meet protein requirements.

The share of *fat* in the total dietary energy supply amounting to 33 % to 38 % is still too high. In individuals with corresponding physical activity, fat supply may also account for as much as 35 % of dietary energy; the average physical activity of the population, however, does not correspond to the recommended PAL values of 1.6 to 1.75. Diets supplying too much fat include the risk for obesity, cardiovascular diseases and certain types of cancer. Meta-analyses of intervention studies have shown that, on a long-term basis, a low fat supply also prevents overweight.

[1] German Nutrition Society, Austrian Nutrition Society, Swiss Society for Nutrition Research, Swiss Nutrition Association (D-A-CH): Reference Values for Nutrient Intake, 1st edition, German Nutrition Society (2000)

In all groups of persons, supply of *saturated fatty acids* is more or less distinctly above the guiding value of not more than 10 % of the total dietary energy supply. In groups of persons over 51 years of age, the mean cholesterol intake is above the guiding value of 300 mg per day as both cholesterol and saturated fatty acids are frequently present in the same food. The supply of *polyunsaturated fatty acids* nearly corresponds to the guiding value of 7 % of dietary energy listed in the D-A-CH reference values; however, their composition is still not optimal: in Germany the mean ratio of linoleic acid (n-6) and α-linolenic acid (n-3) in the daily diets is above 7:1 while a ratio of 5:1 is recommended. The supply of very long-chain n-3 fatty acids (fish oil fatty acids) averages about 250 mg/d in men and about 150 mg/d in women. It is somewhat higher in higher age groups of men and women. In combination with an endogenous synthesis of long-chain n-3 fatty acids from α-linolenic acid these quantities seem to be sufficient.

The *carbohydrate supply* of all groups of persons averages less than 50 % of dietary energy. Although polysaccharides prevail, their share in the total dietary energy accounts for less than 30 % in all groups of persons. Mono- and disaccharides, accordingly, have a greater share in the total dietary energy than the 10 % recommended by WHO for sugars added. In view of this great share of mono- and disaccharides it is not surprising that the intake of dietary fibre averages less than the D-A-CH reference value of minimum 30 g per day. This applies to nearly all groups of persons. In view of convincing evidence for a protective effect of a high-dietary fibre diet it is recommended to further increase the share of high-dietary fibre vegetable food such as whole-grain products, potatoes, fruit and vegetables in the daily diet.

In all age groups over 25 years, *alcohol* has been found to supply a considerable share averaging 7 % of the total dietary energy, meaning that in part of the population alcohol supplies a distinctly higher share of the daily dietary energy. In view of the risk for alcohol-related damage to health, measures of health education are urgently needed in this field.

Table 1: Mean supply of energy and nutrients (4 up to > 65 years)

Energy and nutrients	Unit	Average		Average	
		Men		Women	
		Old Länder*	New Länder**	Old Länder*	New Länder**
Energy	MJ	9.9	10.5	9.0	9.3
Protein	g	78	82	72	73
Fat	g	95	105	85	93
Cholesterol	mg	283	319	268	297
Carbohydrates	g	270	273	256	254
Dietary fibre	g	23	23	23	23
Alcohol	g	15	18	7	9

* old Länder = former Federal territory

** new Länder = former German Democratic Republic

Comparing mean energy and nutrient supplies reported in the present and in the preceding Nutrition Report of 2000 with the D-A-CH reference values one finds that supply has not much changed during the past 4 years and that it is sufficient for the majority of nutrients. Some comment, however, is needed for the following.

In men and women over 51 years *sodium supply* is relatively high on the average and exceeds the guiding value of 6 g dietary salt per day. Persons with higher intakes, i.e. values in the upper range of variation, and with a corresponding genetic predisposition are at risk for hypertension.

In children, adolescents and other age groups *calcium supply* is inadequate. People should from their early years be motivated to eat more high-calcium, low-fat dairy products and more high-calcium vegetables, such as e.g. certain cabbage species, and drink mineral waters to prevent osteoporosis.

In girls and adolescents from 10 to under 15 years and in young women from 15 to under 25 years *iron supply* has been found to be inadequate. In women who, according to age, are capable of child bearing adequate iron supply according to requirement is of great importance. The daily diets of this age group should contain lean meat and low-fat meat products.

Altogether, *iodine supply* is still insuffient, even though the data presented in this report do not adequately allow for the use of iodized salt in private households and iodized salt contained in commercial food. The general use of iodized salt is urgently advised.

Vitamin supply is satisfactory, except for *vitamin D* and folate. During the phase of growth and at advanced age, adequate vitamin D supply is essential for the bones. Inadequate vitamin D supply in children and adolescents presents problems mainly because the modern ways children and adolescents presently spend their leisure time do not guarantee sufficient UV exposure for endogenous vitamin D synthesis. At advanced age, endogenous synthesis of vitamin D is also reduced by an age-related reduced activity of the enzymes involved. Enhanced dietary intake of vitamin D, e.g. with salt-water fish, and sufficient outdoor activities are needed to meet the increased requirement for protection against osteoporosis. In individuals under 25 years, *folate supply* is distinctly below the D-A-CH reference values. Because this vitamin is of importance in preventive medicine, it is recommended to eat more vegetables and whole-grain products.

Table 2: Nutrient supply in Germany (Average values per day; 4 up to > 65 years)

Energy and nutrients	Unit	Average		Average	
		Men		Women	
		Old Länder*	New Länder**	Old Länder*	New Länder**
Sodium	g	3.1	3.5	2.5	2.7
Potassium	g	3.1	3.2	3.2	3.1
Calcium	mg	873.0	837.0	876.0	811.0
Magnesium	mg	372.0	366.0	371.0	350.0
Iron	mg	13.4	13.7	13.4	13.5
Zinc	mg	10.8	11.1	10.0	10.1
Vitamin A (RE)***	mg	1.1	1.3	1.3	1.5
ß-Carotene	mg	2.2	2.3	3.1	3.3
Vitamin D ****	µg	3.2	4.0	2.4	2.9
Vitamin E (TE)***	mg	14.7	15.2	12.4	13.0
Vitamin K	µg	279.0	281.0	304.0	297.0
Thiamine	mg	1.3	1.4	1.2	1.3
Riboflavin	mg	1.5	1.6	1.4	1.5
Niacin (NE)***	mg	30.0	31.0	28.0	28.0
Vitamin B_6	mg	1.7	1.8	1.6	1.6
Folate (FE)***	µg	210.0	216.0	215.0	215.0
Pantothenic acid	mg	4.9	5.2	4.5	4.7
Biotin	µg	40.0	42.0	40.0	40.0
Vitamin B_{12}	µg	5.7	6.4	4.7	5.2
Vitamin C	mg	101.0	110.0	121.0	131.0

* old Länder = former Federal territory

** new Länder = former German Democratic Republic

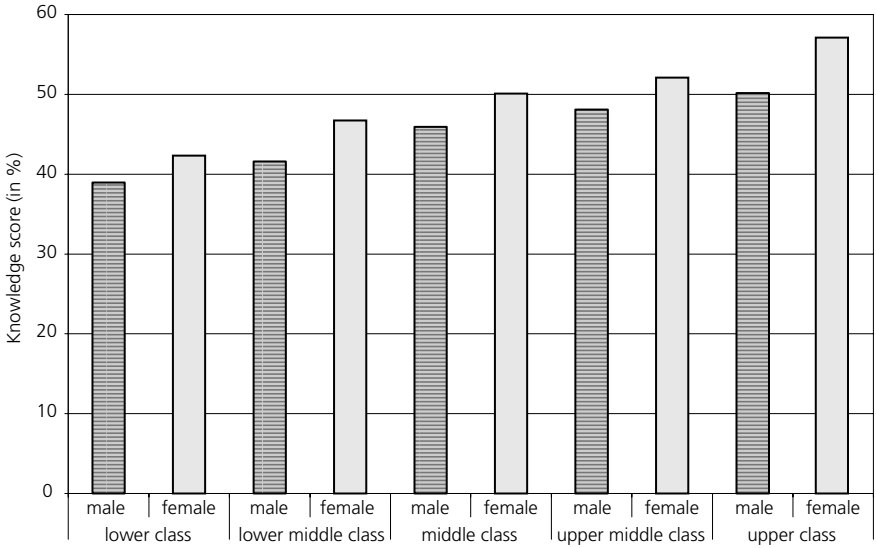
*** RE = Retinol Equivalents; TE = Tocopherol Equivalents; NE = Niacin Equivalents; FE = Folate Equivalents

**** The non-assessable physiological vitamin D synthesis in the skin is not taken into account.

Relation between nutritional knowledge and nutritional behaviour

The 2nd Bavarian Consumption Study (BVS II) conducted from September 2002 to July 2003 has shown relations to exist between nutritional knowledge and nutritional behaviour. The interview data have shown women to have a significant better nutritional knowledge than men. Members of the higher social classes, furthermore, have a significant better nutritional knowledge than those of the lower social classes.

Figure 3: Mean score of knowledge according to gender and social layer



Time budget, meal patterns and nutritional styles

The Nutrition Reports so far documented the nutritional situation in Germany under physiological and economic aspects, while less attention was paid to social, cultural and psychic dimensions and to aspects of time. To fill this gap, this chapter is devoted to the extent and use of time spent on nutrition-related activities, to meal patterns and nutritional styles which are studied in greater detail. An analysis of the time budget of individuals provides an excellent basis for such studies as the time resource – 24 hours per day – , in contrast to money, is equally available to any person.

Although people are under increasing pressure of time in their every-day and occupational life, Germans in 2001/2002 spent 1 h and 43 min on their meals, i.e. an average of 21 min more than 10 years ago. Of these, most (13 min) was spent on meals at home while the time spent on eating away from home only increased by an average of 8 min. During the period under review, nutrition

has gained in importance regardless of the daily occupational stress, social duties and personal leisure-time activities. This applies to men and women. A comparison between working days and weekends has shown that in the period under review both men and women took more time – about 24 min on the average – for meals at weekends when more time is available than on working days.

26 % of the population over 12 years, compared to 18 % 10 years ago, have at least one meal per day away from home in canteens and other communal feeding institutions. Despite the increasing importance of food consumption outside home, meals at home still dominate. A disintegration or replacement of conventional meal patterns by food consumption around the clock has not been observed; during the period under review, i.e. 2001/2002, meals were still taken at certain fixed times.

In private households, all matters relating to food and meals are predominantly cared for by women. They are part of women's daily routine work, no matter whether and to what extent women contribute to the family income.

Mortality of nutritional chronic diseases

In Germany, cardiovascular diseases and malignant tumors continue to be the most frequent causes of death. Disregarding death caused by smoking, these partly nutritional chronic diseases account for 68 % of deaths in Germany. The part nutrition plays in the development of chronic diseases is evident.

A first glance at the causes of death classified according to diseases reveals a picture typical of industrial societies which has not or only little changed in recent years. The incidence of cardiovascular diseases has somewhat decreased while that of malignant tumors has increased.

At closer inspection of the most frequent individual causes of death some differences between men and women in priority and percent of diseases related to total mortality become obvious. They refer to the ranking and percentage of individual diseases in the total mortality. There is a distinct increase of deaths of pulmonary cancer in women who had been smokers[2].

In Germany the trend towards increasing life expectancy is continuing. Gender-specific differences in life expentancy are decreasing. Compared to life expectancies in other European countries Germany is in a medium place. In a worldwide comparison, men in Island (78.2 years) and women in Japan (84.7 years) are in first place. The general trend towards a higher life expectancy is reflected in a delayed occurrence of partly nutritional chronic diseases such as e.g. ischemic cardiac diseases.

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[2] For detailed information on cardiovascular diseases, obesity, diabetes mellitus, malignant tumors of digestive organs, respiratory organs, prostate and mammary gland and on osteoporosis see text and tables of the Nutrition Report 2004.

Chapter 2: Toxicological aspects of nutrition

Residues may remain in food of vegetable or animal origin after the purposeful use of pesticides or animal drugs while environmental pollutants such as e.g. dioxins are unintentionally transferred from the environment. The present chapter, in continuation of previous Nutrition Reports, deals with residues and contaminants. Reporting on fungal toxins (mycotoxins) has been resumed, data on environmental pollutants in breast milk have been updated while acrylamide in food is dealt with for the first time.

Residues of pesticides and protectants of stored food

According to the food surveillance authorities, the frequency of identifiable residues has been increasing during the period under review. This applies to food samples of foreign origin in particular. More fruit and more vegetables of foreign origin were contaminated by excessive concentrations of residues.

Data on residues detected in fruit and vegetables during the years from 1989 to 2001 are represented within the frame-work of the *Monitoring Programme.* Accordingly, considerable concentrations of residues have been found in imported dessert grapes and strawberries while the contamination of apples decreased. A remarkably high number of drupe samples was contamined by concentrations above the maximum allowed levels.

A coordinated surveillance programme comparable to the Monitoring Programme was also initiated by the European Commission. Every year several products are checked by the member states for compounds for which maximum allowable concentrations were fixed. In 2000, 80 % of the samples of peas, cucumbers, cabbage and rice were free of identifiable residues while 17 % contained residues below and about 3 % above the harmonized maximum concentrations allowed. Looking at the combined data from 1996 to 2000 one finds a constant proportion of 60 % to 61 % of samples without identifiable residues. However, cases in which the maximum concentrations allowed had been exceeded increased from 3.0 % in 1996 to 4.5 % in 2000. This is attributed to different surveillance programmes, improved methods of analysis and a reduction of maximum permissible concentrations.

In food of animal origin residues of legally allowed pesticides are insignificant. Pesticides ingested with fodder are within short converted by the animal organism into water-soluble compounds and excreted. Residues of persistent organochlorine insecticides and contaminants with chlorine-containing industrial chemicals have also become insignificant. Their use had already been prohibited or strictly limited in the seventies. Concentrations in food of animal origin are in the majority of cases within the limits of analytical detection. Somewhat higher concentrations found in fish mainly depend on age and fat content of the animals. The share of samples of dairy products, eggs, meat, poultry meat and the products of these without identifiable residues of organochlorine compounds is growing.

To sum it up it can be said that advanced analytical techniques have extended the routinely detectable spectrum of compounds and increased the capability of detecting even smallest traces. The data presented have shown that the official system of food controls for consumer health protection is functioning. The figures available give no reason to assume a danger to consumer health.

Residues of compounds with pharmacological action and of contaminants in food of animal origin

In Germany a control system was established which comprises the whole chain from food production to food sale to consumers, i. e. a system ensuring controls from stable to table. It includes checks according to the national residue-control plan and surveillance by the Federal Länder as part of the offical food-control programme. The system does not aim at obtaining statistical data of the residue load in food of animal origin; it is intended to detect prohibited compounds or violations of maximum concentration limits.

Because of their effect on growth and gain in meat, compounds with hormonal action offer a great potential for misuse as illegal fattening aids. They comprise such different compounds as estrogens, androgens, stilbenes, thyreostatics and gestagens. During the period under review no detections of illegal use were recorded. This is good news showing that the use of hormonal compounds is irrelevant in Germany.

In addition to these sampling inspections of flocks and in slaughterhouses official food surveillance authorities have also arranged for various checks in individual links of the commercial food chain. The principle of mutual acknowledgement of controls among trading partners and the assurance of qualities by certificates attesting a product's suitability for human consumption as basis of worldwide trade still requires, so experience has shown, some official control by sampling to ensure health-related and economic consumer protection. According to the results obtained during the period under review (1999 – 2001) consumers in Germany can be sure that food of animal origin supplied in the market does not contain any residues which are dangerous to health. Measures to protect consumer health have also been effective in that an acute danger has not emerged. Individual cases in which chloramphenicol was detected have shown, however, that a mere prohibition of a compound without subsequent controls does not guarantee the absence of residues in food. It must also be ensured that the use of antibiotics is confined to strict indications and that waiting times are properly observed.

Fungal toxins (mycotoxins) in food

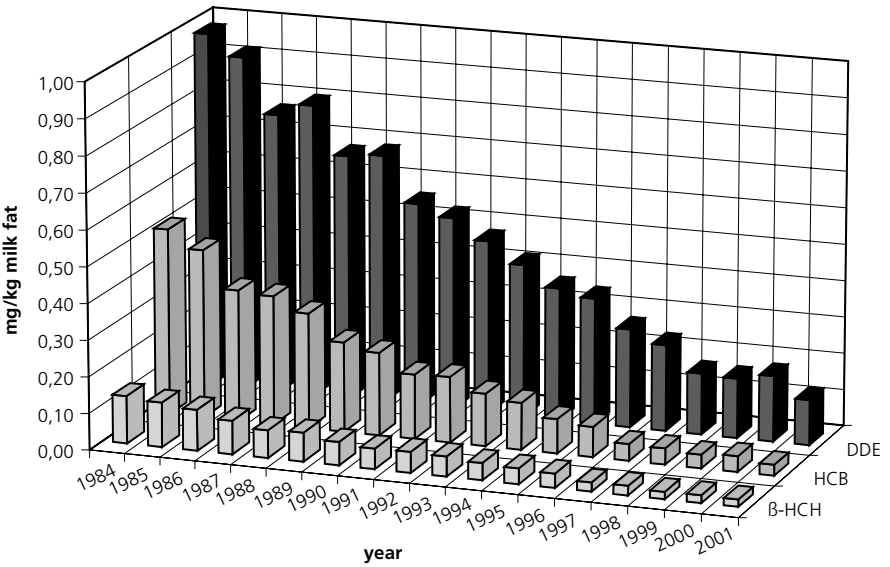
Mycotoxins may even form on agricultural produce before harvest and, under certain conditions, grow on the harvested produce. Food may also be contaminated during storage. As the possibilities to recognize and prevent natural mycotoxin contamination are limited, there can be no absolute guarantee of mycotoxin-free food. Shell fruit (pistachios, Brazil nuts, almonds, hazelnuts and peanuts) and spices are the produce most contaminated by aflatoxin B_1. In shell fruit 6 % of samples were loaded with concentrations above the maximum permissible limit, 22 % of samples were

contaminated. In spices, 10 % of samples were loaded with concentrations above the maximum permissible limit, 42 % of samples were contaminated. Other mycotoxins routinely controlled by food surveillance authorities are ochratoxin A, deoxynivalenol, fumonisins, zearalenon and patulin.

Environmental pollutants in breast milk

Extensive evaluations of studies of breast milk conducted up to the mid nineties have then shown that the concentrations of the majority of persistent organochlorine compounds had substantially decreased in the course of some years. In 1995 the national commission for breastfeeding referred to these results as a basis for a re-evaluation of the health risk associated with breastfeeding. The commission then regarded and still regards present residue concentrations in breast milk as no health risk for babies and recommends that mothers fully breastfeed their children up to the time of transition to infant food (4 – 6 months); nor does the commission see a health risk for the infant if the child is also fed breast milk after this time – in addition to supplementary food and infant formula.

Figure 4: Time course of the average contamination of breast milk from North Rhine-Westphalia with organochlorine pesticides 1984–2001 (contents in mg/kg milk fat)*



* Source: Chemisches Landes- und Staatliches Veterinäruntersuchungsamt Münster

Since the early nineties a permanent decrease of polychlorinated biphenyls in breast milk has been recorded. Compared to the figures of 1979 to 1981 concentrations of organochlorine pesticides decreased by more than 90 % and those of the polychlorinated biphenyls by 80 %. Cases of exceeded reference values are only occasionally observed, usually in mothers who immigrated from Third World countries or in women who lived in such countries for longer periods of time.

In the early nineties a relatively strong decrease of the dioxin load in breast milk has been found, while during the time to follow mean concentrations stagnated. Although the down-trending of the dioxin load has delayed in the past years it is worth mentioning that the mean dioxin concentrations in breast milk have decreased by about 70 % since 1989.

Acrylamide in food

In April 2002 the Swedish authority for food safety published research results according to which very high concentrations of acrylamide – a compound which has been found to be cancerogenic in animal experiments – were detected in high-starch roasted, grilled, baked and fried food. In the European Union large quantities of acrylamide are needed for the production of polyacrylamide which is mainly used for drinking and wastewater treatment. There is unanimous agreement among experts that the exposure of consumers resulting from the technical use of polyacrylamide and to its acrylamide residues is irrelevant for health.

Studies conducted in many food items have shown maximum acrylamide concentrations in potato and cereal products which had been exposed to intense heat during roasting, grilling, baking or frying. Meanwhile it has been found out that most of the acrylamide is released from the amino acid asparagine which before entered into a condensation reaction with reducing sugars such as dextrose or fructose. Temperature, heating time, availability of water, selection of raw material and treatment, as well as the use or non-use of certain additives are the most important factors influencing the extent to which acrylamide is formed. Measures to minimize acrylamide formation score a limited success, however, as the contents of natural components leading to acrylamide formation depend on many parameters which can only partly be influenced by manufacturers or consumers in their kitchens. It should be kept in mind that smoking produces a stronger load than food intake.

At present, the risk for cancer in humans caused by acrylamide in food – if there is one – cannot reliably be quantified. To reduce the basic risk for cancer is much more important than to avoid acrylamide-containing food, however. The risk for cancer is primarily reduced by non-smoking, temperate consumption of alcohol and a mixed diet rich in fruit and vegetables (wholesome nutrition according to the 10 rules of the DGE[3]) in combination with adequate physical activity.

[3] See appendix

Chapter 3: Microbiological aspects of nutrition

In acute foodborne infections and intoxications which primarily lead to health disorders in the gastrointestinal range, the difficulty to obtain precise figures of pertinent cases and of the food involved lies in the differentiation between food-related diseases and other infections of the gastrointestinal tract transmitted from one person to another e.g. by the lack of hygiene (smear infection). Milder courses of the disease escape exact diagnosis because those who have fallen ill do not go to see the doctor.

These are some of the reasons for measures intended to ensure more efficiency in some fields including the registration of the number of diseases, the practice of reporting food contamination rates by surveillance authorities in recent years, the identification and explanation of the causes of microbial foodborne diseases and the recognition of what some events have in common which were previously regarded as inconspicuous individual cases. The Infection Protection Act of 2001 has been helpful in this respect.

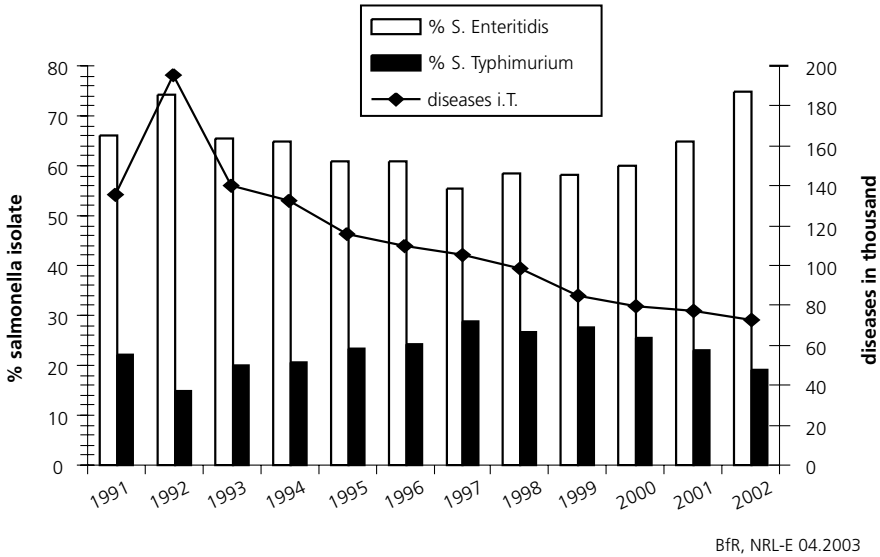
Food infections and food intoxications

Salmonellosis was also the most important bacterial infectious disease in humans during the period of review (1999 – 2002). Most salmonelloses take the course of diarrhoea; in individual cases, however, severe general infections and even fatality were observed. After the incidence of salmonellosis had culminated in 195 378 cases in 1992 it has been continuously decreasing since 1993 down to 63 044 in 2003. Since 2001, infectious diseases are notifiable according to the Infection Protection Act. The extended duty of notification provided in this Act has also shed light on the increasing significance of other agents causing enteritis such as campylobacter in particular.

As in the previous period (1991 – 1998) and again from 1999 to 2002, *poultry meat, among raw food of animal origin,* was most (15 %) infested with salmonella. Problematic agents among salmonella species are *Salmonella* enteritidis, *Salmonella* typhimurium and *Salmonella* paratyphi B. *Salmonella* typhimurium DT 104 presents problems in those cases in particular in which, because of the agent's frequent resistance to antibiotics, a serious systemic disease develops which requires antibiotic therapy.

Salmonella will continue to play an essential part as pathogenic agent causing food infections. To prevent salmonellosis, perishable food such as dishes and creams containing eggs, minced meat, delicatessen and sauces of any kind should be cooled down immediately after purchase or shortly after preparation, resp. To consumers – independent of legal regulations for manufacturers and trade – kitchen hygiene is the essential means of protection against salmonella infections. Kitchen hygiene also comprises careful handling of deep-frozen poultry. Salmonella are destroyed by heating food for at least 10 min to not less than 70° C. Acidification (marinating) of food inhibitis the growth of salmonella.

Figure 5: Development of salmonelloses in humans 1991–2002*



* Source: Robert Koch Institute; serovar numbers up to 2000 acc. to information from the new Federal Länder (former GDR) and Berlin, from 2001 on acc. to the Infection Protection Act.

Campylobacter is the second most frequent causer of food infections in Germany. Poultry meat and raw milk are predominantly infested. Specific measures against campylobacter are rather exceptional; the agent is widely spread in living animals and a correlation between contaminated food and outbreak of the disease can only rarely be established.

Among *Escherichia coli* bacteria, the group of *Enterohemorrhagic Escherichia coli (EHEC)* is extremely pathogenic. EHEC-related diseases may take the course of a mild case of diarrhoea but may also involve renal damage and even renal failure *(Hemolytic-Uremic Syndrome – HUS)*. These serious complications occur primarily in small children and individuals of advanced age. The number of cases notified was 1 018 in 2001, 1 249 in 2002 and 1 216 in 2003. The bacteria are transmitted from animals to humans and vice versa. Ruminants and products of ruminants such as raw meat and raw milk are considered to be the main reservoir. The legislator responded to this danger in 1997 by interdicting the sale of raw milk in communal feeding institutions. The bacteria are transmitted by food, by contact to animals e.g. in zoos and at farms but also from human to human.

In 2002, 216 cases of *listeriosis* in humans (agent: *Listeria monocytogenes*) were notified. Those primarily infected were newborn children whose mothers had been infected during pregnancy but had either not fallen ill or only shown weak, influenza-like symptoms while the children were stillborn or had listeriosis. Individuals who suffer from a previous disease or persons of advanced age are also at

a specific risk for listeriosis. The severity of the infectious disease (about 10 % – 30 % of infections end fatally) is reason for utmost attention. The diseases are predominantly due to the consumption of contaminated food. Pregnant women are advised to avoid certain food such as e.g. soft cheese made of raw milk which is very frequently contaminated by listeria. Other ready-to-eat products should be consumed fresh or be stored in the refrigerator at temperatures of less than 6° C for a time not exceeding the best-before-use date. This applies to vacuum- or otherwise packaged fresh meat products (e.g. slices of boiled ham, scalded sausages) and smoked fish. In contrast to many other microbial agents causing food infections and intoxications, listeria may also grow in coldstored food. Food kept in the refrigerator hence is not sufficiently protected against listeria growth.

Diarrhoea occasionally complicated by reactive inflammations of joints is typical of *yersiniosis* caused by *Yersinia enterocolitica.* In 2003, 6 571 cases were notified. Accordingly, yersinia is the third most frequent causer of food-related infections. Main reservoir of Yersinia is food of animal origin, mainly pork and pork products.

Bovine spongiform encephalopathy (BSE)

BSE as a new disease in cattle was first described in the United Kingdom in 1987. BSE belongs to the group of transmissible spongiform encephalopaties (TSE). British researchers were the first to assume a correlation to exist between BSE and a new variant of the *Creutzfeldt-Jakob* disease in 1996; the disease so far mainly affected younger persons. Epidemiological studies, microbial studies in mouse models and other scientific investigations confirmed this assumption. About 150 cases of the disease were notified worldwide up to August 2004; they all, except for a few, appeared in the United Kingdom.

The agent causing bovine spongiform encephalopathy (BSE) resists conventional measures of disinfection and is not destroyed by food preparation processes. All measures must, therefore, aim at keeping the agent away from the food chain.

In late November 2000 BSE was for the first time diagnosed in Germany in an animal which had been born, raised and slaughtered in this country. In 2001, 125 BSE-infected animals were detected, in 2003 only 52. The EU decree 999/2001 makes it obligatory for all member-states to take certain precautions against BSE. In Germany precautionary measures partly exceed those prescribed by the EU. These measures are supposed to largely close down sources of infection. A strict observance of rapid tests for BSE and elimination of certain organs such as e.g. brain, spinal marrow and intestine which have been identified as potentially infectious 'specified risk material' are supposed to be efficient countermeasures.

The identity of animals is further ensured from slaughtering over cutting up to the retail trade by the obligatory labelling of beef. Details printed on the package or shown on notice boards in retail shops and supermarkets inform consumers on the provenience of the animal providing the meat. The letters D/D/D e.g. on prepackaged meat signify that the animal was born, fattened and slaughtered in Germany.

Communal feeding

In the range of communal feeding, the registration of food infections and intoxications has considerably improved since 2001 when the *Infection Protection Act* came into force. In communal feeding mainly *Bacillus cereus, Clostridium perfringens* and *Staphylococcus aureus* present problems. The share of salmonellosis which had prevailed during the periods from 1985 to 1989 and from 1990 to 1993 has meanwhile decreased down to 22 %, obviously also as a consequence of the decree governing hen eggs which provides against inadequate thermal treatment and which distinctly reduced the risk of salmonellosis. This applies to communal feeding in particular.

In the period under review (1998 – 2001), *Bacillus cereus* caused 62 % of individual diseases and 67 % of outbreaks. The influence of heat during cooking prompts its nearly ubiquitous heat-resistant spores to germinate and to grow once a maximum temperature of 55° C is reached. To be on the safe side, one should make sure that the temperature of held meals does not fall below 65° C. Growth of *Bacillus cereus* during cooling of meals is only prevented if the temperature range between 55° C and 7° C is passed as fast as possible. Food preparations which are first heated and then cooled down such as e.g. puddings, especially those made of semolina, and other desserts as well as potato and noodle salads are at great risk for contamination with *Bacillus cereus.*

It is a fact known for decades that the majority of food infections and intoxications is provoked by inadequate thermal treatment. To avoid risk-increasing temperature ranges it is necessary to continuously control temperature (during coldstorage, heating and reheating, holding, cooling). Short cooling times in particular are frequently not observed. In view of the enormous food quantities handled in kitchens of large-scale catering establishments, short cooling times require adequate cooling units and capacity and thin layers of the food to be cooled.

Chapter 4: Vitamin and mineral content of vegetable food

Promotional campaigns and product information give the impression that today commercial food of vegetable origin contains less nutrients than in the past suggesting that nutrient supply especially of vitamins and minerals is no longer guaranteed by a balanced diet. Statements of this kind are not scientifically substantiated. The present chapter, on the one hand, describes factors influencing the nutrient content of vegetable food in greater detail and, on the other, shows developments in the content of these essential food components in the course of the past decades.

Factors influencing the nutrient content

Plants, too, need essential nutrients for growth, development and reproduction. A deficiency or surplus of nutrients produce characteristic recognizeable changes in the plant. Deficiency or lack of these compounds would strongly affect plant metabolism or result in its breakdown; growth and reproduction would consequently be inhibited or prevented.

The contents of minerals and vitamins in plants depend on several (internal and external) factors. Internal factors include cultivar (genetics) and the ripening degree of fruit and vegetables at the time of harvest. During ripening mineral and vitamin concentrations change in a quite different way. In ripening papaya and paprika fruit e.g. carotinoid concentrations increase with the development of colour. Vitamin C concentrations increase in some fruit and decrease in others.

Table 3: Changes in concentrations of vitamin C during ripening of different fruit and vegetables

Concentration decrease	Concentration increase
West Indian cherry	Tomato
Kiwi fruit	Paprika
See buckthorn berry	Red peppers
Orange	Peach
Grapefruit	Apricot
Tangerine	Papaya
Apple	
Mango	
Banana	

External factors influencing plant development are *climate, soil, transport* and *storage.* The *general influence of climate* comprises the quantity of light, the time-related distribution of light incidence, heat incidence and water supply; the latter includes rainfall, soil and air humidity and the extent of evaporation. Soil, a natural substrate for plants, stores and provides plant nutrients whose availabil-

ity to the plant also depends on chemical bonds. Temperature, enzymatic or chemical oxidation, light and oxygen, fading or drying during *transport* and *storage* are responsible for changes in the vitamin content which may be more or less pronounced. Of all vitamins present in vegetable raw material vitamin C is most susceptible. Differences in mineral concentration are exclusively due to changes in the water content of vegetable food.

Representation and evaluation of nutrient data

Discussing nutrient data from different sources one must not only allow for numerous internal and external influencing factors, but also for analytical advances, quality parameters and the kind of data representation. As far the analysis of food components and of vitamins in particular is concerned, tremendous advances have been made in the past decades. Older spectrophotometric, colourimetric and polarimetric methods have been replaced by more sensitive methods of high pressure liquid chromotography (HPLC) allowing individual vitamins to be quantified. More specific methods of HPLC have also replaced older microbiological methods to determine water-soluble vitamins.

Table 4: Total folate concentrations in vegetables determined by different analytical methods [µg/100 g fresh weight] from different literature sources[4]

	SIDA*	HPLC-FD**	Microbiologic Assay
Carot	12.6 – 15.7	16	14 – 28
Spinach	96.1 – 159	100	150 – 338
Broccoli	27.2 – 41.9	114	71; 90 – 102

* Stable Isotope Dilution Assay; ** High pressure liquid chromatography with fluorescence detection

Changes in the contents of nutritive components in food of vegetable origin should not be discussed without reference to the ranges of variation and the corrresponding influencing parameters.

Development of concentrations of selected food components – a comparison

Two data from different sources can only be compared if all parameters of the samples, analytical methods applied and representation of the data are identical. Such data allowing a comparison on an international level are not available. For this reason it is not possible to infer changing concen-

[4] Freisleben A, Schieberle P, Rychlik M: Syntheses of labeled vitamers of folic acid to be used as internal standards in stable isotope dilution assays. Journal of Agricultural and Food Chemistry 50 (2002) 4760–4768

trations of vegetable food components or to present a list of constant data. However, to still give an impression of the course of vitamin and mineral concentrations in vegetable food over a longer period of time, vitamin and mineral concentrations of eight selected vegetable foods listed in ten international nutrient tables of the past 50 years were compiled.

Totalling the mineral contents of the eight food items analyzed one finds constant values within a narrow range of variation. Of individual minerals, sodium and magnesium only show somewhat wider ranges of variation. Altogether, however, mineral values are nearly completely in the range of variation listed in the databank most referred to in Germany (databank by Souci, Fachmann and Kraut: DFKDB 2000). Vitamin concentrations in the food selected are, except for a few, also within this range of variation. During the period under survey, trends towards decreasing or increasing nutrient concentrations of the food selected were not obvious.

Chapter 5: Tumorigenesis – inhibiting and promoting nutritional factors

In an ageing society, malignant diseases are statistically the second most frequent cause of death, and the trend is up. Limited therapeutic success at increasing cost has brought primary prevention to the focus of attention.

A systematic analysis of the results of studies presently available and insight into biological fundamentals provide evidence for relations between nutritional factors and cancer, allowing to derive some preventive potential. Further indication of a risk-lowering potential of nutritional factors is supplied by case-control studies which, however, because of their retrospective design, may not be taken as a basis for preventive recommendations. Recommendations for prevention should in principle be developed on the basis of the highest possible evidence for a risk-reducing effect and include all methodological approaches. In the present chapter, the degree of evidence is rated according to criteria of the World Health Organization (WHO) which also provide the basis of the DGE guidelines for prevention of chronic diseases: *convincing* evidence, *probable* evidence, *possible* evidence and *insufficient* evidence for a risk-modifying effect. In this way it is possible to adopt the ratings of international expert groups such as WHO, World Cancer Research Fund (WCRF) or International Agency for Research on Cancer (IARC) for evaluation of a risk-modifying effect of different groups of food and of selected nutrients.

Representations concentrate on overviews and meta-analyses of the period from 1999 to 2003. In addition, results of some individual most recent studies have been included which have so far neither appeared in overviews nor in meta-analyses or for which overviews and/or meta-analyses have not been available so far.

Selected groups of food and the influence of these on the risk for cancer

The following table shows the evidence for the influence of (groups of) food on the risk for cancer at the time when this Nutrition Report was published.

Table 5: Nutrition and cancer prevention – Evidence

	Rating by WCRF in 1997		*Present rating by expert groups or by the authors of the present chapter*	
	Risk	*Evidence*	*Risk*	*Evidence*
Fruit & vegetables Totally	↓ Mouth, pharynx, stomach, esophagus, lungs	••••	↓ Esophagus	♦♦♦
	↓ Larynx, *pancreas,* breast, bladder	•••	↓ Larynx, mouth, pharynx kidney	♦♦
	↓ Ovaries, *endometrium, cervix, thyroid gland*	••		
			↓ Lungs, stomach	♦♦♦
Fruit consumption			↓ Bladder, colon, rectum	♦♦
Veget. consumption	↓ Colon, rectum	••••	↓ Colon, rectum	♦♦♦
	↓ Kidney, *liver, prostate*	••	↓ Lungs, ovaries, stomach	♦♦
Meat Totally	↑ Breast, *pancreas, prostate, kidney*	••	↑ Breast	♦♦
Meat, red	↑ Colon, rectum	•••	↑ Colon, rectum	♦♦
Meat, processed	↑ Colon, rectum	••	↑ Colon, rectum	♦♦♦
Fish	– Colon, rectum	••	↓ Colon, rectum	♦♦
Milk & Dairy products	↑ Prostate, *kidney*	••	↑ Prostate	♦♦
			↓ Colon, rectum	♦♦
Eggs	↑ Colon, rectum	••	↑ Breast	♦♦
Fat Totally	↑ Lungs, colon, rectum, breast, prostate	••		
Saturated fatty acids	↑ Lungs, colon, rectum, breast, prostate, *endometrium*	••	↑ Breast	♦♦
Carbohydrates and Dietary fibre	↓ Colon, rectum, breast, *pancreas*	••	↓ Colon, rectum	♦♦
Glycemic index	↑ Colon, rectum	••		
Alcohol	↑ Upper digestive organs, liver	••••	↑ Upper digestive organs, liver, breast	♦♦♦♦
	↑ Colon, rectum, breast	•••	↑ Colon, rectum, stomach	♦♦♦
	↑ Lungs	••		
Overweight	↑ endometrium	••••	↑ endometrium	♦♦♦♦
	↑ Breast (postmenopausal), kidney (renal cells)	•••	↑ Breast (postmenopausal), renal cells, colon, esophagus (adenocarcinoma)	♦♦♦♦
	↑ Colon, *bile*	••		
Physical activity	↓ Colon	••••	↓ Colon, breast	♦♦♦♦
	↓ Breast, lungs	••	↓ Prostate, endometrium	♦♦

↓ reduced risk
↑ increased risk
– no relationship

•••• convincing
••• probable
•• possible

♦♦♦♦ convincing for a risk-modifying effect
♦♦♦ probable evidence for a risk-modifying effect
♦♦ possible evidence for risk-modifying effect

Cancer localizations printed in italics were not re-evaluated by the authors as neither recent meta-analyses nor overviews were available at the time when this chapter was prepared. For cancer localizations not appearing in the column 'Evaluation by experts or authors' there is, according to the view of expert groups and authors, insufficient evidence for a risk-modifying effect.

A daily diet rich in fruit and vegetables is assumed to lower the risk for certain tumors. Evidence for a risk-modifying effect, independent of the type of cancer, is rated possible or probable. Biological plausability of the protective effects of fruit and vegetables is derived from the results of animal experiments, in which reduced cell-proliferation rates, increased phase II enzyme activities and a decrease of DNA damage were observed.

In the food category *meat* it should be differentiated among meat in general, red meat (mutton, lamb, beef, pork) and processed meat products such as e.g. sausages, ham, salt meat. Consumption of meat products is associated with the highest increase of the risk for colorectal tumors. Biological plausability is derived from the influence of certain preparation techniques for meat including exposure to intense heat (frying and grilling) during which cancerogenic compounds such as polycyclic aromatic hydrocarbons and heterocyclic amines form. In animal models, N-nitroso compounds contained in meat products also show cancerogenic action.

White meat (fish and poultry) has no risk-increasing potential. More fish, especially fat fish in the daily diet lowers the risk for tumors of endometrium, prostate and thyroid gland. Biological plausability of this favourable effect of fish is derived from eicosapentaenic acid and docosahexaenic acid which inhibit tumor growth *in vitro* and in animal models. *n-3 fatty acids,* furthermore, are assumed to influence the expression of certain oncogens, signal-transduction cascades and the differentiation of tumor cells.

Biological plausability of the effects of milk and dairy products is derived from very high calcium concentrations and from vitamin D. Calcium is assumed to precipitate bile acids and oxidized fatty acids and thus to protect the intestinal wall against these potentially cytotoxic compounds. A connection is also assumed to exist between lactose, conjugated linoleic acids, whey proteins, lactic acid bacteria and malignant tumors.

Selected food components and the influence of these on the risk for cancer

Besides groups of food, some selected food components were also checked for a potential risk for cancer. Special attention was paid to the effect of specific fatty acids. Increased concentrations of short-chain fatty acids and n-3 fatty acids are assumed to protect against cancer while medium-chain fatty acids and arachidonic acid are suspected of promoting cancerogenesis. The authors of this chapter also accord possible evidence for an increased risk for breast cancer to saturated acids. Monounsaturated fatty acids delay menarche and thus possibly lower the risk for breast cancer. Findings regarding the effect of n-6 fatty acids are inconsistent while it is undisputed that a high consumption of fish which means increased supply of n-3 fatty acids may reduce the risk for breast cancer. A high total fat consumption is associated with an early menarche and extended exposure to estrogen which is suspected of promoting the risk for breast cancer. A correlation has not been found to exist between the risk for pulmonary carcinoma and the quantity and quality of fat consumed nor between carcinoma of the bladder and fat consumed. High total fat consumption and high intake of saturated fatty acids increase the risk for prostate carcinoma. There has been no evidence for an association between the risk for ovarian carcinoma and the quantity of fat consumed or the fatty-acid pattern. The biological plausability of the influence of fat on the risk for cancer is,

on the one hand, derived from the increasing energy supply associated with increased fat intake and, on the other, from the different effects of saturated, n-6 and n-3 fatty acids.

For a long time *dietary fibre* has been assumed to protect against colorectal cancer. Meanwhile, studies aiming at a reduction of the rate of relapses of colorectal adenoma were reason to re-evaluate the effects of dietary fibre. Considering it all including most recent findings of the EPIC study, however, the authors of this chapter see a possible evidence that dietary fibre lowers the risk for colon cancer.

In recent years the *glycemic index (GI)* has frequently been associated with cardiovascular and cancer diseases. There have also been data suggesting an increased risk for colon cancer with increasing intake of food with a high GI. It should be noted, however, that the GI of a food greatly changes from person to person and in dependence upon food preparation and some other factors. It also changes in a combination of different food in meals compared to the GI of an individual food. Some recent findings also suggest a conncection between GI and the risk for breast cancer. Altogether, however, these findings are insufficient to postulate a risk-increasing effect of a high GI for the types of carcinoma mentioned before.

Alcohol has been discussed as the cause of malignant tumors for many years. At present a threshold value for tumorigenesis in the digestive tract caused by alcohol consumption cannot be scientifically substantiated. There is convincing evidence that alcohol increases the risk for liver cancer and breast cancer. Alcohol is also responsible for cancer of mouth, throat and esophagus. There is no convincing evidence for a relationship between alcohol consumption and malignant pulmonary and ovarian tumors, while an association with prostate tumors seems only to exist in excessive alcohol intake.

Biological plausibility of the cancer-promoting effect of alcohol is derived from the cancerogenic action of acetaldehyde and an ethanol-dependent enzyme induction with an increased reactivity of cancerogenic and mutagenic compounds, and, furthermore from elevated estrogen concentrations and increased cell proliferation under the influence of alcohol. Experimental studies of cancerogenesis altogether speak against an initiating action of alcohol, but rather for a promoting effect on the process of malignant tumor formation.

Weight and physical activity and the influence of these on the risk for cancer

Obesity is associated with an increased risk for cancer. Overweight postmenopausal women are at a higher risk for breast cancer. The risk for malignant tumors of the endometrium is also increased in obese women. Overweight men and women are at a higher risk for colon carcinoma, renal cell carcinoma and adenomatous carcinoma of the esophagus.

Recently the protective effect of *physical activity* against cancer has shifted to the foreground of discussions. An expert group of the WHO International Centre of Cancer Research in Lyon regarded the risk-lowering effect of physical activitiy in malignant colorectal tumors as convincing. In the majority of epidemiological studies a dose-effect relationship has even become obvious. There is also con-

vincing evidence that physical activity reduces the risk for breast cancer by 20 % to 40 % while the evidence for a risk-lowering effect of physical activity in tumors of endometrium, prostate and lungs is rated possible. Biological plausibility of a relationship among increased body weight, physical inactivity and development of malignant tumors is associated with the insulin metabolism, sexual hormones and the insulin-like growth factor (IGF) in particular.

Functional food and food supplements

Functional food have been defined as modified food providing additional benefits. With regard to cancerogenesis, mainly pro- and prebiotics have so far been discussed. At present there is no direct experimental evidence for a cancer-preventing effect of probiotics. Anticancerogenic action of prebiotics was observed in animal experiments. It may be due to a stimulating effect on bacterial growth and to the cell-proliferating and -differentiating action of butyrate, a fermentation product of the bacterial metabolism in the colon. The question whether or not these findings are relevant to humans needs to be settled by intervention studies.

Among *vitamin* and *mineral supplements,* calcium and selenium in particular seem to be potentially capable of preventive action. This has been shown in case-control and cohort studies. However, intervention studies in humans have not furnished convincing evidence for a cancer-preventing action of antioxidative vitamins or of the minerals mentioned before.

The effect of exposure-related factors may be modified by *gene-nutrient interaction,* depending on the individual genetic disposition. For this reason different individuals, despite equal exposure, are at different risk for malignant tumors and other diseases.

Due to many interactions among the various food components the influence of nutrition on the risk for cancer is very complex. Causal relations which take this fact into account hence are difficult to derive. One means of establishing causal relations is by *nutritional patterns:* The nutritional pattern of a certain population which is identified by multivariate statistical analysis is associated with the target diseases to be investigated. Protective effects against cardiovascular diseases could be attributed to a prudent-diet pattern (many fruit and vegetables, whole-grain products and white meat) but not to a western-diet pattern (many fine-ground cereal products, saturated fat, red meat).

The connection between nutritional patterns and cancer diseases is little consistent. An analysis of the Nurses' Health Study has shown the western-diet pattern to be significantly associated with the risk for colon cancer. For the prudent-diet pattern an inverse, but not significant relation was obtained. Such findings can only be interpreted in consideration of the fact that they were exclusively derived from the population investigated and that they are not transferable to other groups. In a prospective study conducted in Finland, the Netherlands and Italy over a period of 20 years lower mortality in men has been found to be associated with a nutritional pattern based on the WHO guidelines for healthy nutrition. Application of the Healthy Eating Index (HEI), a score derived from the US American food pyramid and the Dietary Guidelines for Americans, to the Nurses' Health Study has shown that a high HEI was not associated with a reduced risk for cancer. In the Health

Professionals Follow-up Study increasing HEI was associated with a reduced risk for coronary heart diseases but not for cancer. A similar rating instrument, the Recommended Food Score, was associated with a reduced total mortality of cancer.

Conclusion

The development of recent years has shown that the preventive potential of some nutritional factors has been overrated, while that of others has been underrated – a fact illustrating the dynamics of research in this field. From the present point of view the preventive potential of nutritional factors seems to be lower than WCRF assumed it to be in 1997. Changes in lifestyle would certainly involve some preventive potential to reduce the risk for cancer. Its use would help to counterbalance the increasing incidence of cancer diseases associated with a growing life expectancy. Evaluating the nutritional factors which influence the risk for tumors one arrives at two conclusions: first, there is need for nutritional guidelines for cancer prevention reflecting the present state of knowledge. These guidelines which should be observed by the population, include non-smoking, more fruit and vegetables in the daily diets, regular weight controls and physical activity. Secondly, academy's efforts towards extending our knowledge should be supported in any possible way.

Chapter 6: Nutritional influence on the intestinal flora

Given constant conditions of life, an established intestinal flora is relatively resistant against the growth of new and especially pathogenic microorganisms. Digestible food components which were already digested and absorbed in the upper ranges of the digestive tract, especially in the ileum, are not available to the microbial colon flora. Colonic microorganisms are dependent on undigestible food components such as dietary fibre. Dietary fibres which are supposed to promote the growth of protective bacteria are called *prebiotics,* of which inulin and oligofructose are the best known. Bifidobacteria and other lactic acid bacteria are supposed to have protective effects on the host organism. Strains of bifidobacteria and lactic acid bacteria for which such health-promoting action has been verified, are called *probiotics.* The strains presently added to food have been shown to survive the passage of stomach and small intestine and to colonize the colon in active form and significant number. There is presently no definite answer to the question whether the presence of a new bacterial strain in the intestinal flora influences the share of other bacteria in the total flora. Drastic changes in the composition of the dominant flora can be excluded.

Table 6: Bacterial species, strains of which are used as probiotics in food (modified*)

Lactobacillus species	Bifidobacterium species
L. acidophilus	B. adolescentis
L. casei	B. animalis
L. gasseri	B. bifidum
L. johnsonii	B. breve
L. paracasei	B. longum
L. plantarum	
L. reuteri	
L. rhamnosus	

* modified according to: Holzapfel WH, Haberer P, Snel J, Schillinger U, Huis in't Veld JHJ: Overview of gut flora and probiotics. Int J Food Microbiol 41 (1998) 85–101

The health-promoting effects of *probiotic bacteria* are directly or indirectly related to the gastrointestinal system. Many probiotic strains are capable of preventing pathogenic microorganisms from colonizing the intestine and spreading through the intestinal wall into the blood and in other organs. Several beneficial effects of probiotics are hence observed in diseases of the gastrointestinal tract. *Diarrhoea* caused by rotaviruses e.g. in hospitalized children may be shortened or prevented by probiotics. Some studies have also shown probiotic strains to reduce duration and/or frequency of traveller's diarrhoea. Probiotics were also helpful in cases of diarrhoea caused by a massive disorder of the intestinal flora after administration of antibiotics. Irradiation or chemotherapy frequently lead to massive disorders of the immune system and intestinal flora, to diarrhoea and heavy growth of moulds. These undesirable side-effects could be reduced by administration of probiotics. Complaints

associated with *lactose intolerance* are reduced by probiotic bacteria. Some beneficial effects of probiotics in cases of *inflammable diseases* and irritations of the gastrointestinal tract are promising and justify further studies in humans.

A few, but well designed studies have shown probiotics to alleviate symptoms and reduce the risk for disease in food allergies and atopic dermatitis.

By ad- and absorption, metabolizing or influencing of the intestinal flora lactic acid bacteria are capable of reducing intestinal concentrations of cancerogenic, mutagenic and genotoxic compounds and of cancer-promoting enzymes. The question, however, whether probiotics may reduce the frequency of *cancer*, e.g. of colon carcinoma, in humans needs to be settled by further research.

Some strains of lactobacilli and bifidobacteria which are capable of deconjugating bile acids and/or binding cholesterol, may reduce total plasma cholesterol or *LDL-cholesterol concentrations* by increase of fecal sterol excretion and reduction of enterohepatic re-circulation; HDL-cholesterol is not influenced. There is presently no indication that this action may persistently decrease LDL-cholesterol concentrations or even reduce the risk for arteriosclerosis.

In animal and human studies *prebiotics* have been shown to have some health-related effects. *Inulin* and its hydrolysis product *oligofructose* are fermented by the colonic flora. These prebiotic carbohydrates hence increase biomass as well as weight and frequency of stool, alleviate *obstipation* and promote the health of the intestinal mucosa. They also specifically influence some favourable intestinal bacteria, especially bifidobacteria. By inhibiting individual bacterial strains with pathogenic potential such as e.g. clostridia prebiotic carbohydrates also reduce the risk for diarrhoea.

In various animal models even chemically induced precancerous lesions and, in extended studies, the frequency of colonic *tumors* were reduced by a diet containing 5 % to 15 % inulin and oligofructose. This effect could still be intensified by synbiotic combinations of pre- and probiotics.

Lowering of the pH by prebiotics increases the solubility of calcium, iron and magnesium and thus promotes absorption of these in the colon. This could have a protective effect e.g. against osteoporosis. Inulin and oligofructose may also indirectly, i.e. by influence on the intestinal flora, modulate various parameters of the immune system such as NK-cell activity, secretion of IL-10 and interferon, and lymphocyte proliferation.

Chapter 7: Influence of phytochemicals on health

Phytochemicals have a variety of health-related effects which are being intensively studied in national and international research institutions. This chapter resuming a subject which was last discussed in the Nutrition Report 1996 deals with the most recent scientific knowledge in this field.

Meanwhile, information about some phytochemicals in food is available in official databanks. These data should be critically regarded, however. Concentrations of phytochemicals in food vary for genetic and ecological reasons. Additional differences in prepared food are caused by storage and processing and by food preparation in household kitchens. Reliable data of daily intake are, therefore, only available for a few phytochemicals. The bioavailability of phytochemicals has also been found to vary considerably, depending on their chemical structure but also on the activity of the human intestinal flora.

Table 7: Main groups of phytochemicals

Group	Number of different structures
Carotinoids	> 700
Saponins	not known
Phytosterols	> 100
Glucosinolates	> 120
Flavonoids	> 6 500
Phenolic acids	not known
Protease inhibitors	not known
Phytoestrogens	
⇒ Isoflavonoids	> 870
⇒ Lignans	not known
Monoterpenes	not known
Sulfides	not known

Information about the health-promoting effects of phytochemicals in humans is presently based on the results of epidemiological studies; for many phytochemicals, the chemical structure of the potentially effective compounds is not yet known.

Epidemiological studies of a potential *anticancerogenic* action of several phytochemicals provided interesting insight into the relationship between lycopene, glucosinolates, phytoestrogens and prostate carcinoma, breast cancer and other types of tumor. Except for some positive statistical associations, there has so far been no evidence for a verified protective action.

An antioxidative effect of phytochemicals has been verified *in vitro*. This was reason to assume an increased dietary intake to provide some protection against certain diseases. However, supplementation of ß-carotene did not enhance protection against lipid peroxidation or oxidative DNA damage while increased intake of high-carotinoid fruit and vegetables enhanced protection against lipid peroxidation and oxidative DNA damage. While many *in vitro* studies have shown a clear protective action of flavonoids against lipid peroxidation, *in vivo* studies after oral intake of flavonoids, e.g. with onions, only yielded inconsistent results.

Immunomodulatory effects of phytochemicals have been found e.g. for ß-carotene and lycopene. It is still open whether these effects are specific to individual carotinoids and relevant for prevention e.g. of infectious diseases. Many *in vitro* studies and *in vivo* observations suggest an immunomodulatory action of flavonoids. Because of the expression of estrogen receptors on various immune-cell types, the immune system may also be modulated by phytoestrogens. Such effects have been shown for various representatives of this group of phytochemicals.

A *plasma cholesterol lowering* effect of phytosterols is due to an inhibition of the absorption of dietary cholesterol and of cholesterol excreted by the gallbladder. Whether reduced blood cholesterol concentrations after intake of high-phytosterol margarine lead to a significant reduction of cardiovascular diseases is a question not yet answered by intervention studies in humans.

Antibiotic action has been documented for various phytochemicals. Certain flavonoids such as e.g. procyanidines are capable of inhibiting bacterial growth. An intervention study revealed that women who regularly consumed a concentrate of cranberries and billberries which contain phytochemicals are at lower risk for inflammations of the urinary tract. Sulfides *in vitro* inhibit the growth of staphylococci and other bacteria. Further studies in humans are necessary before these findings can be definitely evaluated.

The inverse relation of flavonoid intake and the risk for mortality of cardiovascular diseases found in epidemiological studies is attributed to the *antithrombotic action* of flavonoids. Flavonoids *in vitro* inhibit thrombocyte aggregation. At present it is still open, however, whether the reduced risk for mortality of cardiovascular diseases shown in epidemiological studies is in a causal relation with the antithrombotic effect of flavonoids.

Carotinoids, furthermore, have been supposed to protect against eye diseases (macular degeneration and cataract). Certain carotinoids (lutein and zeaxanthin) have been assumed to protect retina and lense against free radicals. These assumptions are based on epidemiological studies. Phytoestrogens may possibly increase bone density and prevent osteoporosis. Intervention studies on osteoporosis prevention by increased intake of soybean and isoflavone did not yield consistent results. The data presently available do not provide sufficient evidence for protective action of isoflavones against osteoporosis.

To sum up it can be said that the intake of protective compounds in fruit and vegetables is associated with a lower risk for diseases. Several most recent prospective cohort studies have shown an inverse relation to exist between the consumption of fruit and vegetables and the risk for cardiovascular diseases. In some studies a high intake of flavonol and flavone was associated with a lower

risk for cardiovascular diseases and pulmonary carcinoma. Other studies also suggest a lower risk for cancer and cardiovascular diseases by dietary intake of carotinoids.

In vitro and *ex vivo* studies with isolated compounds of phytochemicals provide more or less convincing indication of an effectiveness confirming the observations made in the epidemiological studies. These findings should still be treated with reserve, however. A recent meta-analysis of the effect of ß-carotene supplements (15 mg – 50 mg per day) in more than 100 000 individuals[5] has shown that this supplementation led to a slight, but statistically significant increase of total mortality and an increased risk for cardiovasculary diseases. These exemplary studies suggest caution in using phytochemicals and advise against an intake of isolated compounds. So far, specific protective action of an individual isolated phytochemical in humans has not been evidenced in any study.

Food supplements on the basis of phytochemicals or fruit and vegetable extracts, resp., are frequently propagated as an alternative to phytochemicals in fruit, vegetables and whole-grain products. Arguments in support of these products usually lack any scientific evidence for health-related effects and their harmlessness to health. Concentrates or extracts from fruit and vegetables are in principle no alternative to the daily intake of 5 portions of fruit and vegetables, either unheated or heated.

At the present time, recommendations for intake of individual phytochemicals cannot be made. A direct transfer of results obtained *in vitro* or in animal experiments to humans is not possible. Food plants, moreover, contain a mixture of hundreds of phytochemicals whose individual action cannot be separately evaluated in terms of quality or quantity. Nor is it known whether phytochemicals only develop their maximum protective effect in an interaction with essential nutritive and fibre compounds contained in fruit and vegetables.

[5] Vivekananthan DP, Penn MS, Sapp SK, Hsu A, Topol EJ: Use of antioxidant vitamins for the prevention of cardiovascular disease: meta-analysis of randomised trials. Lancet 361 (2003) 2017–2023

Chapter 8: Representation and effect of nutritional information on television

Mass media have so far been little used for nutritional education. Due to its enormous scope, the emphatic way information is represented, its topicality and its role in the daily life of a great many viewers television could be the most important conveyer of nutritional information. The present chapter deals with the representation of nutrition in TV programmes and the extent to which television is suitable for nutrition education.

The study comprises three components. An *analysis of the programme contents* (whole-day sampling, prime-time sampling from 19.00 to 23.00 o'clock) of the most important German TV broadcasting stations in terms of transmission areas provides a first indication of what image of nutrition is produced by the different TV companies. A *consumer poll* checks for possible relations between TV use in general and watching of nutrition-related programmes in particular and nutritional attitudes and nutritional behaviour. A *laboratory experiment* is to find out whether attitudes and behaviour may be attributed to the practical use of certain TV contents and whether, accordingly, TV may be regarded as an efficient mediating channel for information on healthy nutrition.

This multimethod study was based on two theories from communication science. The *cultivation approach* proceeds on the assumption that the image of social reality of viewers frequently watching TV resembles the world as presented on TV while that of viewers less frequently watching TV comes closer to reality. Cultivation research mainly deals with the influence of entertaining contents. The *framing approach* primarily refers to information-oriented contents and proceeds on the assumption that journalists place a subject to be dealt with into certain frames of interpretation. These frames which are strictly adhered to help viewers to comprehend and interprete the message as certain aspects are shifted to the foreground while others are neglected. There are risk frames, lifestyle frames, political frames, economic frames, service frames. Private TV companies prefer risk and lifestyle frames while service, political and economic frames prevail in the broadcastings of companies under public law.

The *extent* of nutrition-related broadcasts is considerable. Of totally 3 123 programme elements of the whole-day sample about two thirds convey nutritional information. In certain types of broadcasts such as e.g. advertising nearly one third may be devoted to nutritional information. Measuring the significance of nutrition-related programme elements in terms of time, one finds that more than one tenth of the total broadcasting time is devoted to nutrition. As far the intensity of representations is concerned it has been shown that nearly half of the nutrition-related information (about 49 %) of the whole-day sample deals with nutrition only casually as a side issue while in 51 % nutrition is the main issue. The representation of nutrition is altogether given much room in the whole-day sample. Similar findings have also been obtained for prime-time samples.

An overall view of the *image of nutrition on TV* shows nutrition to be extensively represented, although some of it is rather casual. The German TV programmes largely represent food and nutrition in a way that is not in correspondence with the recommendations by the German Nutrition Society. This is reason for some criticism. Consumer-related subjects such as purchase, preparation,

consumption and aftertreatment of food prevail. It is quite obvious, however, that the potential of television as an educational medium in matters of healthy nutrition is still not adequately used.

Notice of *nutritional magazines and advice* is clearly related to TV use itself. Here is some potential for nutrition education as these broadcasts are mainly watched by younger people of all social classes – even by viewers who actually take no interest in nutritional subjects. This is a chance for nutritional education institutions to address an audience otherwise not reached. With increasing time spent on watching TV and with a preferential use of certain types of broadcasts or broadcasting companies, however, the audience's attitudes have been found to turn more negative. This may possibly be explained by the fact that healthy diets are rarely made the exclusive topic but also by the – frequently casual – presentation of food which is detrimental to health.

The experimental results have shown that the nutritional behaviour may in principle be influenced by TV even if watching of a single nutritional contribution does not persistently change attitudes. TV accordingly is suitable for nutrition education. It is worthwhile carefully placing and extending its educational potential for a comprehensive and purposive representation of nutrition.

Educational institutions such as the German Nutrition Society could be helpful in this respect: by optimizing public relations, also by including television, and by drawing attention to themselves by launching of entertaining and animating educational messages and by presenting personalities who are experts in nutritional education. Opening to private broadcasting companies with their competence in questions of entertainment and their audience is also advisable. Certain target groups among the TV audience can also be selectively addressed. Finally, designing of brief, easily remembered and concise educational spots on eating and drinking seems promising.

Chapter 9: Enrichment of food and new products

Food supplements, functional food, health food, wellness products, designer food etc. are new in the food market. They have been the subject of intensive scientific and public discussion also with regard to the fact that legal regulations exist for food supplements, but not for enriched food.

Consumers find it difficult to judge the practical use of the products. Whatever the benefits beyond nutrition may be which are claimed in promotional statements – there is usually not more to this than a combination of several compounds added, mostly vitamins and minerals. Consumption figures for the new products are trending up. Consumption data of enriched conventional food in particular are rare, however. Enriched conventional food, furthermore, is not listed in the usual nutrient tables; overdosage hence cannot be excluded. Studies have shown that even vitamins (e.g. ß-carotene) which were for a long time regarded as completely harmless, or minerals may be overdosed.

Meanwhile various groups of experts have been concerned with scientifically substantiated limit doses for vitamins and minerals. Data of enriched products and information on nutrients, whose supply could come close to a critical limit are urgently needed. The present chapter also presents a sort of first inventory.

Food is primarily *enriched* with vitamins (nearly 40 %), minerals (nearly 20 %) and trace elements (nearly 10 % of products). Products enriched with other compounds (e.g. amino acids, carnitine, taurine, nucleotides) account for less than 3 % each and for somewhat more than 8 % altogether. New products may also contain other compounds (e.g. creatine, salmon oil), mixtures of compounds, dried food (e.g. dried powderized garlic) or extracts.

The great many innovations and completely new product groups in the dynamically growing German food market are difficult to systematize. One distinguishes between *separate products* (especially food supplements) and *other food.* The distinction is in accordance with the recent harmonized EU definition of food supplements. The legal provisions governing these products stipulate dosable administration forms (tablets, capsules, compressed drugs).

The group of *other food* comprises usual food such as dairy products or breads and pastries to which vitamins and minerals were added, and some new groups (bars, energy drinks).

Regarding the *number of vitamins added* one finds that most products contain one or few vitamins while the complete spectrum of nutrients is rarely supplied. A certain pattern which can be made out shows that preference is given to the addition of either 1 (nearly 30 % of separate products), 3 (15 % of products) or 10 vitamins (more than 10 % of products). The same applies to minerals and trace elements, of which only one compound is preferably added.

Analyzing according to the *kind of vitamins and minerals added* one finds that in *monopreparations* the vitamin folic acid is preferentially added, followed by the vitamins E and C and, at some distance, by biotin and ß-carotene. Of the *minerals added,* magnesium is twice as frequent as calcium, of *trace elements* zinc and selenium are preferred.

In *multicomponent preparations,* vitamin E and C rank first (nearly 20 %). Water-soluble vitamins are evenly distributed to about 12 % of products. The fat-soluble vitamins A and D only account for one third of these frequencies; ß-carotene is added to about 8 % of products. In multicomponent preparations calcium and magnesium rank first, followed by iron in nearly 5 % of products. Selenium and zinc are the trace elements which are most frequently added.

As far as *enriched conventional food* is concerned, one finds a similar frequency distribution of the number of admixtures as in food supplements (separate products). Conventional food enriched by all vitamins is practically not available.

Nearly the same *sort of nutrient* – vitamin C, vitamin E and ß-carotene – are added to separate and conventional food. Trace elements are relatively rarely added to conventional food.

It is still open whether enriched food guarantees a higher nutrient intake. One does not yet know whether enriched food is consumed the same way as its non-enriched pendants. Some consumers may substitute a bar for a meal while others may eat bars in addition. New products may even replace completely different food preferred so far (e.g. specific drinks for breakfast instead of bread).

The data compiled give the impression that nutrient admixture is very arbitrary. Exact knowledge of food enrichment in Germany and actual nutrient intake by people is urgently needed. The findings reported make one feel tempted to call for regulations by law.

A healthy way of eating and drinking in compliance with the 10 dietary guidelines of the German Nutrition Society (DGE)

A well-balanced diet keeps one healthy and promotes efficiency and well-being. The German Nutrition Society has established 10 dietary guidelines based on most recent scientific knowledge which will help you to stick to a healthy diet and still enjoy food.

1. Choose from among a great many different foods

Enjoy the great variety of food. Selection from among a great many different foods, appropriate combination and adequate quantities of high-nutrient and low-energy food are characteristics of a well-balanced diet.

2. Plenty of cereal products – and potatoes

Bread, pasta, rice, grain flakes preferably made of whole grain, and potatoes contain nearly no fat, but plenty of vitamins, minerals, trace elements as well as dietary fibre and phytochemicals. Combine these products with low-fat food items.

3. Fruit and vegetables – take '5 a day'

Eat 5 portions of fruit and vegetables a day, if possible fresh, cooked for a short time only, or one serving in form of juice – ideally along with each main meal and also in between meals: That way you'll get plenty of vitamins, minerals, dietary fibre and phytochemicals (e.g. carotenoids, flavonoids). That's the best thing you can do for your health.

4. Milk and dairy products daily, fish once to twice a week; meat, sausages and eggs in moderation

These foods contain essential nutrients, e.g. calcium in milk, iodine, selenium and n-3 fatty acids in saltwater fish. Meat is favourable because of its high level of available iron and of the vitamins B_1, B_6 and B_{12}. However, 300 – 600 g of meat and sausages per week are sufficient. One should choose low-fat products; this applies to meat and dairy products in particular.

5. Moderate fat

Dietary fat provides essential fatty acids. Food containing fat also contains fat-soluble vitamins. Dietary fat is associated with high energy intake; too much dietary fat may hence promote overweight and possibly cancer. Too many saturated fatty acids promote, in the long run, the development of cardiovascular diseases. Use vegetable oils and fats (for instance, canola oil and soybean oil, and margarine containing these oils). Watch out for invisible fat usually contained in some meat products, dairy products, confectionery and sweets, in fast food and ready-to serve food. 70 – 90 g fat per day are sufficient.

6. Sugar and salt in moderation

Food and beverages containing various types of sugar (for instance, glucose syrup) should only occasionally be consumed. Be creative in using herbs and spices. Add little salt. At any rate use iodinized salt.

7. Plenty of liquid

Water is vitally necessary. Make sure your daily liquid ration is about 1 ½ litre. Prefer water – carbonated or non-carbonated – and other low-calorie drinks. Alcoholic drinks should only occasionally be consumed and if, in small amounts only.

8. Make sure your dishes are prepared gently and taste well

Cook food at low temperatures, if possible for a short time only, use little water and little fat. This will preserve the food's natural taste, protect nutrients and prevent formation of harmful compounds.

9. Take your time and enjoy eating

Eating consciously helps to eat healthy. Arrange dishes attractively. Take the time for eating. It's fun, makes you aware of the great freedom of choice and promotes the feeling of satiation.

10. Watch your weight and stay active

Both a balanced diet and enough physical activity and sports (30 – 60 minutes per day) are needed. Proper weight improves your well-being and promotes your health.