TRADITIONAL FOOD -

ENVIRONMENTAL AND

HEALTH CONCERNS

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1. Introduction

In every human society food is a way of creating and expressing the relationships between people. These relationships may be between individuals, and between the members of social, religious and ethnic groups. Therefore food is more than just a source of nutrition, it is an essential part of the way that any society organises itself and the way it views the world that it inhabits (Helman 2000).

An area of growing importance is the globalisation of the human diet. Social and economic changes have an impact on nutrition and health, especially in those communities that are undergoing urbanisation, industrialisation and westernization. These societies enter the different stages of what have been called the nutrition transition (Lang 1999, Drewnowski & Popkin 1997).

This means that global diet is in a constant state of flux and the cultural- and health implications of this are only now beginning to emerge. Most endangered in this process are the indigenous minorities of the world, as these cultures are vulnerable to social and economic changes of modern life, partly because of the rapid technological development leading to changes in basic living conditions, but also because contaminants spread through the food-chain pose a potential threat to the survival of Indigenous Peoples and their cultures. In several societies this contributes to a non-directed dietary change away from nutritious traditional food towards a non-balanced westernised diet.

It is beyond the scope of this review to go into a discussion of the diseases suffered by Indigenous Peoples in cultural transition and how dietary change is interfaced with other lifestyle changes such as smoking, disintegration of social networks, decreasing physical activity, and increased stress. However, the major trends that appear in the literature relate to obesity, diabetes, cancer and cardiovascular diseases (Kuhnlein and Receveur 1996).
Catching wild animals such as marine mammals, fish, land, mammals and fowl has always been a natural part of the Indigenous Peoples existence.

As part of the world community the Indigenous Peoples claim their rights to live and benefit from the natural resources, but in recent years the traditional lifestyle has been under attack from some parts of the world community. Animal rights activists, animal welfare organisations and some environmentalists have, based on emotional viewpoint, tried to criminalize the killing and utilisation of wild living resources, especially marine mammals, whales and seals. Especially the Indigenous peoples of the Arctic have claimed their rights to utilise renewable resources to maintain their traditional way of life.

An often used argument to make Indigenous Peoples refrain from eating meat and organs from seals and first of all from whales which are of the highest priority for the protectionists are the health consequences attributed the levels of contaminants such as Persistant Organic Pollutants (POPs) and toxic heavy metals (mercury). In this way emotional animal welfare concern is confused with public health concern.

It is a known fact that contaminants are bio-accumulated and bio-magnified in the marine food-chain and that some cultural groups i.e. the Inuits as top predators are exposed to levels of contaminants which are of concern from a public health point of view (AMAP 1998). However, the Human Health Expert
Group under the Arctic Monitoring and Assessment Programme (AMAP) in its conclusions and recommendations stated that:

Weighing the well-known benefits of breast-milk and traditional food against the suspected but to yet fully understood effects of contaminants it is recommended that:

- Consumption of traditional food continues with recognition that there is a need for dietary advice to Arctic peoples so they can make informed choices concerning the food they eat.

- Breast-feeding should continue to be promoted.

These recommendations have been maintained in the recent interim report to the ministers, prepared by the AMAP human health expert group.

2. Effects of contaminants in whales and humans

Effects in whales

The population of beluga whales in a polluted area of the St. Lawrence River, Canada has been investigated through the last two decennia. From 1983 to 1986 thirteen carcasses of stranded whales were necropsied. High concentrations of organochlorine compounds were detected in tissues of the animals and also multisystemic lesions and tumours were observed suggesting an important role of industrial contaminants in the observed decrease of this population (Martineau et al. 1988).

Further investigations from this area have confirmed a high prevalence of tumours which suggests an influence of contaminants through direct carcinogenic effect and/or a decreased resistance to the development of tumours in this population (DeGuise et al. 1994, 1995).

Later *in vitro* tests on beluga peripheral blood leukocytes and splenocytes with mixtures of organochlorine at concentrations in the range of those observed in tissues of the St. Lawrence belugas have supported the hypothesis that contaminants induce immune-suppression in these animals (De Guise et al 1998) thus making them susceptible to infectious and development of malignancies.

Estimates of toxic equivalents (TEQs) based on the occurrence of four PCB congeners (118, 183, 153, 180) reported in whales are high for St. Lawrence beluga and Faeroe Islands long-finned pilot whales and at a level which has been associated with adverse health effects in other aquatic species. (Colborn and Smolen 1996).

White et al (1994) have reported that in Canadian Arctic beluga whales concentrations of PCB's correlate with expression of the xenobiotic metabolising enzyme CYP-1A and suggest measurement of this enzymes a biomarker of exposure.

A correlation between organochlorine contaminants (PCBs and DDTs) and mixed function oxidases, benzo(a) pyrene monooxidase activity (BPMO) in skin-biopsis from Mediterranean fin whales (Balenoptera physalus) is reported by Marsili et al. (1998).

The literature on contaminants and their possible effects on baleen whales are more sparse than on toothed whales. However, existing literature show that concentration of DDT and PCB's in baleen whales appears to be higher in the northern hemisphere than in the southern oceans, perhaps due to greater contamination of northern ecosystems. In general the concentration levels are lower in tissues of baleen whales than in other marine mammal species, both on global and local scales, which is predictable based on the trophic levels of baleen whales. O'Shea and Brownell (1994) have reviewed laboratory studies on the effects of selected organochlorine contaminants on direct mortality and impaired reproduction in other mammals, and critically examined observations attempting to link organochlorines to reproductive and population effects in marine mammals. They found that here is no firm basis to conclude that the contaminants have affected baleen whale populations.

As recently demonstrated the baleen whales are influenced by contaminants as increased enzyme expression have been found and related to the exposure. Consequently there is concern also for the baleen whales. The unique strategy of periods of intense feeding followed by long periods of fasting places the embryonic and nursing calves in a vulnerable position, because under both situations maternal blood levels are elevated as a result of absorption from food intake or as a result of mobilisation as fat is metabolised (Colborn and Somlen 1996).

This call for research and management actions with focus on reducing man made contaminants in the oceans to increase habitats carrying capacity for these species.

3. Effects in Humans

In the AMAP report (AMAP 1998) it is concluded that existing epidemiological evidence on the adverse effects of Persistent organic pollutants POPs and methyl mercury in humans is inconclusive and needs to be replicated due to the specific context in the Arctic, in which there are differences in genetics, climate, food consumption patterns, and lifestyle among population groups.

For POPs there are both scientific and public concern about the possible adverse effects and pregnancy outcome, fetal development, child development, reproduction, male and female fertility and the immune system. Several of these effects may be mediated through endocrine disrupting properties of some POPs. The high exposure of some Arctic peoples to methyl mercury is a matter of concern because of its neurotoxic effect on the fetus.

Several studies have indicated effects on fetuses and children following long term exposure to environmental contaminants via food. However as food contains a great number of known and suspected anthropogenic toxicants making it difficult to determine which contaminant is responsible for the observed effect. Further more contaminants may interact in additive-, antagonistic- or synergistic effects. This is known *in vitro* to occur among POPs, e.g. between individual PCB congeners, but also between PCBs and methyl mercury (Bemis & Seegal, 1999). The synergistic effects between contaminants suggest that future revisions of consumption guidelines should consider contaminant interactions. To understand the potential effects it is necessary to study the combined effects of the actual mixtures of exposures. The best approach to this will be, parallel to continued monitoring, to use biomarkers of effect at the molecular level. This type of investigations has high priority in the AMAP phase II programme.

The developing foetus and breast fed infants are likely to be more sensitive to the effects of POPs and metals than individual adults and are the age groups at greatest risk. PCBs bear a striking structural resemblance to the active thyroid hormones and can, depending upon the species, dosage and congener used, act as agonists, antagonists and partial agonists to thyroid hormones (Porterfield and Hendry, 1998).

Thyroid hormones regulate neuronal poliferation, migration, process outgrowth, synoptic development, and myelin formation in specific brain regions during fetal development, therefore in appropriate levels of thyroid hormones can produce permanent damage to the developing brain. As a consequence most studies on PCBs have concentrated on neurological effects and function of thyroid in children.

There are several studies linking lack of optimal neurological function in infants and children with high background levels of exposure to polychlorinated biphenyls (PCBs), but it is unclear if the effects are caused by thyroid disruption *in utero* or direct neurotoxicity (Brucker-Davis, 1998). Developmental neurotoxicity of PCBs on children have been reported in several studies. In USA by Jacobson et al. (1990) and Jacobson and Jacobson (1996), in Germany by Winneke et al (1998), in the Netherlands by Patandin et al. (1999). From these studies it is concluded that the exposure *in utero* is the most important period.

Studies on thyroid function have shown that TEQ level in breast milk significantly and negatively correlated with the levels of triiodothyronine (T_3) and thyroxine (T_4) in the blood of Japanese breast-fed babies (Nagayama et al. 1998). However, in a study conducted in USA Longnecker et al. (2000) conclude that within the range of background level exposure in the United States *in utero* PCB exposure is only slightly related to serum concentration of total thyroxine, free thyroxine and thyroid stimulating hormone at birth.

The susceptibility of fetuses and neonates is underlined by the reported lack of negative effects on thyroid functions in adults at background level of exposure to POPs (Brucker-Davis, 1998).

Conclusion on effects

There exists increasing evidence to show that both wildlife and man at the present level of exposure are negatively influenced by environmental contaminants.

Except under extreme exposure situations the effects are subtle and the causal relationship is difficult to establish due to lack of specificity of epidemiological methods, which limit their ability to detect subtle associations including possible links between exposure to low levels of environmental contaminants and disease.

However, present knowledge from animal experimental studies combined with the epidemiological evidence, even if it is inconclusive, have given rise to concern and indicate the need for reduction of environmental contaminants in order to improve living conditions for man and animals.

4. Guidelines

A guideline indicates which, from a public health point of view, is an acceptable exposure limit and not a limit beyond with intoxication will occur. As a consequence they should be regarded as an administrative tool to regulate exposure to chemicals of potential hazard.

Most guidelines are based on animal experiments in single compound studies and do not take into account possible interactions. Extrapolation from animals to man also include some serious uncertainties.

To overcome these obstacles a factor of safety is used, often a factor of 100, meaning that if rats do not show any effects at a life long exposure to e.g. 1 mg/kg of a compound 0.01 mg/kg is supposed to be safe for man as a tolerable daily intake (TDI). Table 1 shows TDIs for some of the most important contaminants.

Table 1.

Tolerable daily intake (TDI) of some contaminants

Compound	TDI	Origin
ΣDDT	20 μg/kg bw/day	Canada, Sweden
ΣPCBs	1 μg/kg bw/day	Canada
ΣToxaphene	0.2μg/kg bw/day	Canada
TEQ	1-4pg/kg bw/day	WHO
	5 pg/kg bw/day	Scandinavia
Methyl mercury	0.47 μg/t bw /day	WHO
Total mercury	0.71 μg/t bw /day	WHO

bw= bodyweight

Dioxins/furans (PCDD/F) and some PCB congeners exert the toxic effect via the same mechanisms. The various congeners do, however, not possess the same toxic potential. To be able to express a total effect potential of a mixture of congeners toxic equivalent factors have been developed (TEF) for the different PCDD/F and dioxin-like PCB congeners where their individual toxicity is weighted against the most toxic dioxin congener (2.3, 7.8 TCDD). Using the TEF value and the individual congener concentrations, the total TCDD-equivalents (TEQ) can be calculated for a mixture. Risk assessment for PCBs can thus be made in two ways. The sum-PCB approach and the TEQ approach there are several advantages and limitations associated with each method (Giesy and Kannan 1998).

The TDI for TEQ was established by WHO in 1990 to 10 pg/kg b.w. (picogram = 10^{-12} gram). A later revision in 1998 lowered the TDI to be in the range 1-4 pg/kg b.w. (van Leeuwen et al. 2000).

Guidelines are not “scientific truth”, but express the state of current knowledge and will as such continuously be under revision. Future revisions of TDIs should be based on studies of interactions among individual contaminants present in foods and between contaminants and nutrients (AMAP 1998).

5. Contaminant levels in whales. Data compiled from the AMAP report

Table 2 shows the mercury levels in different whale species as reported by AMAP (AMAP 1998). It is clearly demonstrated as expected from the trophic levels, that the concentrations in baleen whales are much lower than in toothed whales. The table also indicates the highest daily consumption of meat according to the TDI. There are no problems in consumption of meat from baleen whales, while meat from toothed whales should only be taken as a main-course once a week.

Table 2.
Mercury in whale meat

(µg/g w.w. daily intake g/person/day)

Baleen	n	$\bar{x}$	range	*max daily
Bowhead and Minke whale	5	0,10	0.015-0.22	329
Toothed				
Beluga	74	0.88	0.15-3.01	37
Narwhal	19	0.61	0.08-1.22	54

*Assumption 70 kg body wright. Hg 100% as methylmercury

Table 3 shows levels of POPs also here, even if not so pronounced as for methyl mercury the differences between trophic levels are seen for both DDTs and PCBs.

Table 3.

POPs in whaleblubber μg/g w. w.
(AMAP 1998)

	Beluga			Narwhal			Minke whale		
	n	$\bar{x}$	range	n	$\bar{x}$	range	n	$\bar{x}$	range
ΣDDT	9	2.24	0.60-3,44	1	3.23		4	1.75	1.20-2.30
ΣPCBs	9	3.55	2.71-5.01	1	3.20		4	2.11	1.00-2.70
ΣToxaphene	9	5.00	2.57-7.71	1	7.93		No data		
TEQ*	4	16.9	7.5-25.0	3	15.2	9.8-18.6	No data		

w.w. = wet weight

TEQ: CB77, 126 and 169

In table 4 the calculated daily intake, according to TDIs (cf. table 1) are given. It appears that DDTs and PCBs do not represent any problems while the Toxaphene and TEQ there seems to be problems if whale meat is consumed on a regular basis.

Table 4.
Maximal daily intake of whale meat, grams

(Assumption 1 person, 70 kg b.w. lipidcontent in meat ≈ 10%

	DDT	PCB	TOX	TQE
Beluga	625	197	14	4-16
Mink Whale		331	-	

b.w. = birth weight

It should be noted that the mean values given in the tables are based on a small number of animals, and can as such not be regarded as representative for whales in a global perspective. This also means that the calculated daily maximum intakes of meat are not general recommendations, but only an indication of a possible exposure level and areas of potential problems. Further more it should be taken into account that in most cases also other ocean living organisms such as seals, fowl and fish are consumed together with whales and that these species also contain contaminants. The total human exposure thus depends on the relative importance of individual species in the local diet.

6. Temporal trends

One major question in the phase II of AMAP will be whether concentrations of environmental contaminants are increasing or decreasing in the Arctic environment. With the information available in 1996 it was difficult to assess temporal trends as most measurements were recent. In the first phase assessment of POPs (AMAP 1998) it was concluded that the results of a number of temporal trends studies of Arctic biota indicated that PCB and DDT levels in the Arctic have declined in the past 20 to 25 years since the first controls on DDT and open use of PCBs began. In humans exposure assessments within the past decade have revealed that in the case of breast milk samples concentrations of PCDDs/Fs and PCB have shown a continued decline in certain countries (Brouwer et al. 1998). These estimates are, however, uncertain as there is a considerable intraspecies variability and a small numbers of sampling times which make it difficult to observe statistically significant trends.

At present a decline in global contaminant levels is indicated, showing that regulations already enacted have been effective. However, some populations and animal species are still exposed at a level giving rise to concern. This warrants a strengthening of the international effort to control man made contaminants.

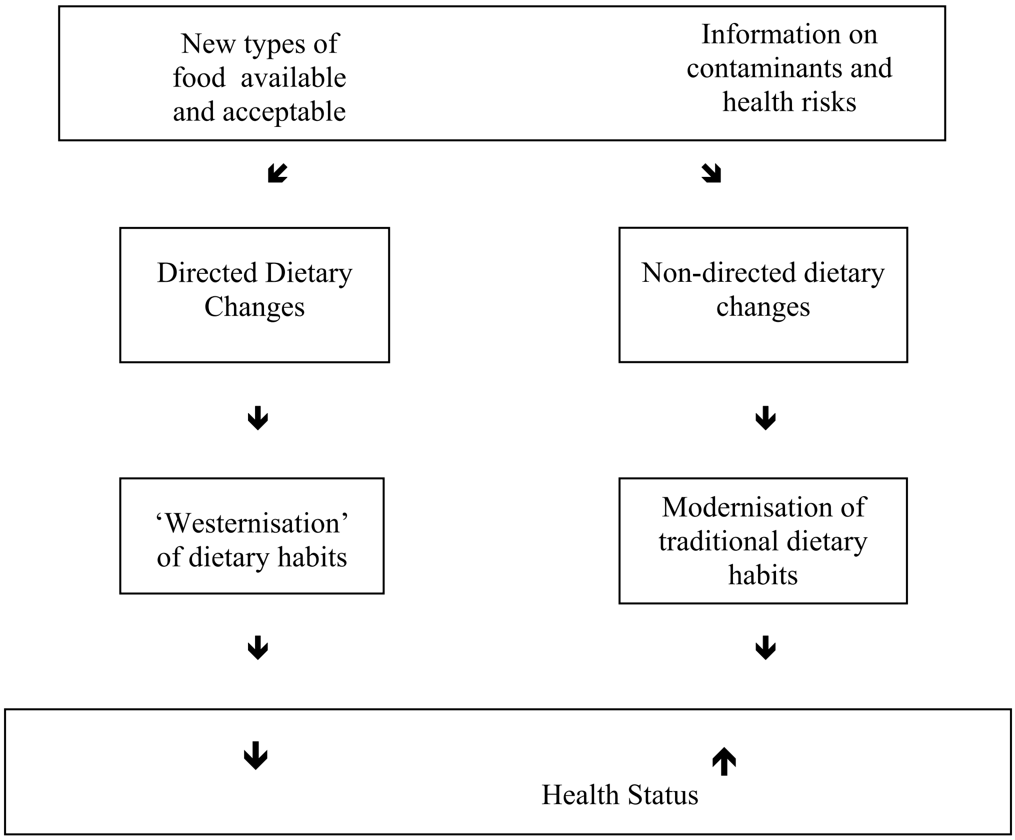
7. The Arctic dilemma

The traditional Inuit diet consists mainly of meat and organs from marine mammals and in addition birds and fish. This food is for this culture vital to maintaining dietary adequacy for many nutrients because market food that is available, purchased and consumed is of inferior nutritional quality (Kuhnlein et al. 1992).
Also outside the Arctic the Inuit diet has attracted attention as consumption of the n-3 fatty acids found in marine mammals and fish have been suggested as the components responsible for the lower incidence of cardiovascular disease in Alaska, Canada and Greenland.

The Inuit diet is very nutritious but at the same time it acts as a vehicle for environmental contaminants. The Arctic dilemma. The Inuit peoples are at present in a nutrition transition away from a traditional diet towards a westernisation. The two most important factors in this process are that 1) new types of food have become available and found acceptable and 2) that there is a growing concern for environmental contaminants in traditional food (cf. fig. 1.)

If this process goes on in non-directed way it may result in a fast-food dominated and unbalanced diet which may lead to a decrease in the general health status. To turn the development into a directed way it is important that cultural knowledge is transferred from the old to the young. This should be encouraged by local governments in their cultural policy, as dietary habits are an integrated part of the culture of a community. The traditional food patterns can in this way be adapted to present days requirements and follow the general, continuous development of the culture. The nutritional values of the traditional can thus be maintained and even improved by combination with imported food items such as fruit and vegetables for the benefit of health of the consumes (Fig. 1).

Figure 1. **Two directions for dietary changes**



Kuhnlein and Receveur (1996) have expressed their view on the qualities of traditional food in this way: "The major qualities of traditional food systems of indigenous peoples that require attention are the various species and species diversity that are accepted as food from the natural environment in divers climates and latitudes, the technologies developed to harvest and process the food and the sensory qualities and dietary structures developed for food selection."

These qualities determine the chemical composition of the indigenous food items and the nutritional content of the diets of indigenous peoples. In understanding these qualities, we gain a perspective on the vast diversity of food available and how many different dietary patterns can provide complete human nutrition'

8. Epilogue

Global contamination has reached a level where it is a threat to the environment especially to animals and man feeding at high trophic levels, and major international efforts to reduce the level of organochlorine compounds and other persistent contaminants have become a matter of urgent importance. Ideally environmentalism should serve the objectives to preserve nature including the diversity of human cultures, and devote the efforts towards a reduction of global contamination to create better living condition for all species. These years we experience that some groups, one-eyed, focus on specific animals groups e.g. the marine mammals. They use the contaminant issue to scare people, whose traditions have been based on harvesting marine mammals, from eating what they regard as their natural food with the purpose to promote legal implementation of bans against hunting. This is basically an unethical attitude as it is of limited benefit to the animals as they are, according to present scientific knowledge, threatened by the same contaminants and to the same degree as man are. The ideal solution to the question of animal-welfare is thus to reduce or eliminate the global contamination at the sources and hereby create a better environment for the animals leading to healthier animals with better capacity of reproduction. As a consequence this would allow sustainable and equitable harvest for the benefit of populations with traditions for subsistence whaling. This is the way to restore the balance between Nature and Man and prevent extinction of their culture.

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