The composition of the Eskimo food in north western Greenland[1, 2]

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ABSTRACT In the winter of 1976 an examination of the composition of Eskimo food was carried out in north western Greenland. Duplicate specimens of diets collected from 50 adults, equal numbers of males and females, were analyzed for water, ash, protein, fat, individual fatty acids, cholesterol, and carbohydrate. The results are compared with those of typical Danish diets. Seal and fish are predominant Eskimo food. Marked differences between Eskimo and Danish food were found. The Eskimo diets were richer in polyunsaturated fatty acids, the ratio to saturated fatty acids was 0.84 as compared with 0.24 in Danes. The polyunsaturated fatty acids were predominantly of the linolenic class (n-3) in Eskimos and the linoleic class (n-6) in Danes. Monoenes other than palmitoleic and oleic acids were high in Eskimo diets, but negligible in Danish. The results are related to previous examinations of the plasma lipids in Eskimos. The rarity of ischemic heart disease in Greenland Eskimos may partly be explained by the antithrombotic effect of the long-chained polyunsaturated fatty acids, especially eicosapentaenoic acid prevalent in diets rich in marine oils. *Am. J. Clin. Nutr.* 33: 2657–2661, 1980.

Death from ischemic heart diseases (IHD) constitutes only 3.5% of all deaths in Greenland Eskimos (1) despite a life span of more than 60 years (2).

In 1970 the serum lipids in 130 Greenland west-coast Eskimos were examined in an attempt to find the explanation of this (3, 5). Decreased levels of blood cholesterol, triglycerides, low-density and very low-density lipoproteins, and in males increased level of high-density lipoproteins were found. The fatty acid pattern of the serum lipids was very dissimilar to that of Danish controls. One of the most marked differences was that the polyunsaturated fatty acids belonging to the n-6 family were in Eskimos replaced by those belonging to the n-3 family. This was especially obvious when comparing arachidonic acid (C 20:4, n-6) with eicosapentaenoic acid (C 20:5, n-3) (6). As the serum lipid pattern in Eskimos living in Denmark was found to be similar to that of Danes, it was concluded that the differences found were of exogenous, presumably dietary origin (3, 7).

Consequently and examination of the composition of Eskimo food was carried out during late winter of 1976 in the settlement of Idglorssuit in the UmanaK district of north western Greenland at latitude 71 N.

Materials and Methods

From 50 Greenlanders, 25 males and 25 females, all hunters and/or fishermen and their wives, aged from 20 to 76 years, were collected 178 samples of the daily food during 3 to 7 consecutive days, using the double-portion technique as used by Keys and Kimura (8). The participants in the study all received payment for their food specimens. After the collection, the food samples were weighed, homogenized and aliquots were removed and kept frozen at −15 to −20 C until analyzed in Denmark. The food collection was carried out in the month of April when winter conditions are still prevailing. Seal hunting is predominant, mostly from the border between open sea and the ice.

The following analyses were carried out: water content after freeze-drying and weighing of the residue, protein content by the Kjeldahl method, fat content after extraction after Folch et al. (9), and weighing and mineral content after burning by weighing the ashes. The carbohydrate content was calculated as the difference between dry weight and the sum of protein, fat, and minerals. The energy values were calculated by means of Atwater's factors (protein and carbohydrate 4, fat 9 kcal/g). In the fat extracts the cholesterol content was determined by the method of Abell et al. (10). The fatty acids were analysed on fat extracts from the frozen but

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not freeze-dried food aliquots by means of gas-liquid chromatography (GLC), after hydrolysis and methylation, with a Hewlett-Packard gas chromatograph equipped with a 200 cm glass column of 3 mm i.d. The supporting medium was chromosorb WAW mesh 80 to 100 with 15% w/w diethylene glycol succinate as the stationary phase. The injection temperature was 250 C and the column temperature was increased from 150 to 200 C during the run with a column flow of 30 ml nitrogen/min. A hydrogen flame ionization detector was used at 250 C. The signals were electronically integrated and compared with those of assays on mixtures of pure fatty acids supplied by Nu-Check Prep. Elysian, Minnesota. Analytical grade chloroform was used as solvent and checked for impurities by GLC. Comparison with average Danish food was made with data given by Helms (11).

Results

The average amounts of protein, fat, and carbohydrate in calories percent in the food samples from Greenland are listed in **Table 1** together with those of average Danish food.

We found a nearly double intake of proteins in Eskimos as compared to Danes, compensated by a reduction in carbohydrates.

The average daily intake of cholesterol was found to be 264 mg/1000 kcal (SEM 11) against an average Danish intake of 138 mg/1000 kcal (11). In **Table 2** is shown the average composition of fatty acids in the 178 food samples. For comparison figures are given for common Danish food (11).

The main findings in Eskimos were a reduction in saturated fatty acids, compensated by a marked increase in monounsaturated and a less but still substantial increase in polyunsaturated fatty acids. The polyunsaturated fatty acids were dominated by the linolenic class in contrast to the dominance of the linoleic class in Danish food.

In **Table 3** a more detailed distribution of the dietary fats is given, as well according to the degree of saturation as to the fatty acid classes.

TABLE 1
Average percentage amounts of energy from protein, fat and carbohydrate of all the Eskimo food samples as compared with average Danish data (11)

	Eskimos		Danes
	mean	*SEM*	*mean*
Protein	23	0.61	11
Fat	39	0.90	42
Carbohydrate	38	1.09	47

TABLE 2
Average content of fatty acids as percentage of total fatty acids in Eskimo food as compared with Danish food (11)

	Eskimos		Danes
	mean	*SEM*	*mean*
12:0		1.1	0.08	5.9
14:0		3.7	0.06	7.5
16:0		13.6	0.26	25.5
16:1		9.8	0.25	3.8
16:2	(C 17:0)	0.4	0.04	
18:0		4.0	0.15	9.5
18:1		24.6	0.22	29.2
18:2		5.0	0.28	10.0
18:3		0.6	0.04	2.0
20:0		0.1	0.02	4.3
20:1		14.7	0.37	0.4
20:2		0	0.01	
20:4		0.4	0.04	0
20:5		4.6	0.15	0.5
22:0		0.1	0.02	0
22:1		8.0	0.23	1.2
22:5		2.6	0.10	0
22:6		5.9	0.16	0.3
24:0		0	0.01	0
24:1		0.1	0.02	0

TABLE 3
Dietary fats in Eskimo and Danish food divided in fat types

	Eskimos	Danes
Saturated (% of total fatty acids)	22.8	52.7
Monounsaturated (% of total fatty acids)	57.3	34.6
Polyunsaturated (% of total fatty acids)	19.2	12.7
P/S ratio	0.84	0.24
Linoleic class (n-6) (g/day/3000 kcal)	5.4	10.0
Linolenic class (n-3) (g/day/3000 kcal)	13.7	2.8
Monounsaturated, except 16:1 and 18:1 (g/day/3000 kcal)	29.6	2.1

The average daily energy intake as calculated from the food samples was 1541 kcal with a range from 117 to 9407 kcal. The fat consumption averaged 69.9 g/day ranging from 3.9 to 603 g/day.

Discussion

In 1972 we carried out an examination of Eskimo food in north western Greenland. As the amount of food aliquots collected was rather scarce, we consider this examination a pilot study only. However, our results in 1972 were in all essentials comparable to those of the present study (7).

Since 1950 most Eskimos, particularly in Alaska and Canada, have been on diets rich in "Western" food. The settlement of Idglorssuit started in 1859. The first shop was opened in 1918 and in 1966 a new shop was built. The sale of sugar is high constituting approximately 175 g/person per day equivalent to approximately 700 kcal while white bread with bisquits and rye flour provided 335, rice 112 and potatoes 37 kcal/person per day. Whereas whale and seal meat was eaten almost every day, on the average about 400 g/person per day, sugar was eaten about five times and bread twice daily.

The traditional Eskimo diet, however, contained no sugar or cereals. One of us calculated that the true adult Eskimo diet in 1855, with a little food obtained from white traders, provided daily about 377 g protein, 59 g carbohydrate, and 162 g fat; but obviously without Western contact the Eskimos were totally carnivorous and their food was almost free of carbohydrate, except for a few berries, roots, and leaves in summer (12). Therefore, the Idglorssuit Eskimos we have studied do not eat the traditional high fat and protein diet, but their dietary fat is rich in long-chained fatty acids of the linolenic class (n-3) with little of the linoleic class (n-6) (Table 3) and this is reflected in the composition of their plasma lipids (6). That the Eskimo pattern of eating habits, however, is maintained is obvious. Energy and fat intake is depending on working circumstances and accessibility of food can vary enormously; fat intake may exceed 600 g/day and energy 9000 kcal/day. This variation is *not* reflected in the fatty acid pattern of the dietary lipid which was found rather constant, independent of caloric intake (Table 2).

The rather low total energy intake calculated from the food samples is in our opinion a result of a certain hesitation in delivering food aliquots representing the total daily food for an examination as the present. Even if this is true, we believe—and this was confirmed by the daily interviews concerning the composition of the food as carried out by a dietician—that the food samples qualitatively were representative for the composition of the daily food, even if they are not so quantitatively.

The content of the fatty acids in the food examined may be summarized as follows. The Eskimo food was found to contain much more of the monoenes C 16:1, C 20:1, and C 22:1 than Danish food (Table 3). The high consumption of C 22:1 (cetoleic acid) by the Eskimo is interesting in view of the known toxicity of docosaenoic acids to all lower animals, reviewed by Beare-Rogers (13) and FAO/WHO (14). Cetoleic acid (C 22:1, n-11) is an isomer of erucic acid (C 22:1, n-9) which is an important fatty acid of rapeseed oil. Cetoleic acid is a significant constituent of marine oils, constituting about 12% of the fatty acids of herring oil, 15% of capelin oil, 4% of Greenland halibut and seal oils. In certain species (13) it causes cardiac fibroses because the muscle mitochondria has difficulty in oxidizing the acid leading to accumulation of lipid droplets. But it is known that adaptation occurs to low doses and this may be the explanation of the apparent absence of harmful effect in seals and Eskimos. Further elucidation of this interesting problem, however, awaits the results of histological examination of Eskimo hearts.

Another essential difference between Eskimo and Danish food is that the Eskimo intake of linoleic (C 18:2, n-6) and α-linolenic (C 18:3, n-3) acids is much less than in Danes. The intake by Eskimos of linoleic acid is less than half that of Danes, whereas the consumption of α-linolenic acid is only one-fifth that of Danes. As linoleic acid is the precursor of arachidonic acid (C 20:4, n-6), the amount in the Eskimo food of only half of that in Danish food is notable. Also notable is the finding of the high intake by the Eskimos of the long-chained polyunsaturated fatty acids eicosapentaenoic (C 20:5, n-3), docosapentaenoic (C 22:5, n-3), and docosahexaenoic (C 22:6, n-3) acids as compared with that of Danes. The sum of these fatty acids is in Eskimos 13.1% of the total fatty acid intake against 0.8% in Danish food. This means that the polyunsaturated fatty acids in Eskimo food are highly dominated by acids of the n-3 family (the linolenic acid family) whereas the n-6 family (the linolenic acid family) dominates in Danish food. This is also reflected in the serum fatty acid pattern of the Eskimos (6).

Based on our findings and using the formula of Keys for calculating changes in the serum cholesterol level when going from one diet to another

$$\Delta chol = 2.7\ (\Delta S - \Delta ½P) + 1.5\ (\sqrt{C_2} - \sqrt{C_1})^3$$

we find that a change from Danish food (11) to Eskimo food, assuming an unchanged energy intake, would cause the serum cholesterol to decrease with 0.67 mmole/liter whereas the actual difference was found to be 1.15 mmole/liter (5). This stresses that calculations of the influence of dietary alterations on serum cholesterol levels are only valid when these are not substantially influenced by major alterations in the food composition.

In vitro experiments (15, 16) have shown that the low level of arachidonic acid and high level of eicosapentaenoic acid may be of importance for the aggregability of the thrombocytes in vivo. The basis for this is that eicosapentaenoic acid inhibits platelet aggregation and maybe in the vessel wall can be converted to a potent antiaggregatory prostaglandin namely PGI_3. This is in contrast to the biologically active prostaglandins of the 2-class coming from arachidonic acid, from which as well a potent proaggregatory substance (TXA_2) as a potent antiaggregatory substance (PGI_2) can be formed (17, 18).

We have recently shown that an increase in plasma and platelet content of eicosapentaenoic acid in Eskimos leads to a decreased platelet aggregability and a prolongation of the bleeding time (19). This circumstance may diminish the tendency to thrombus formation in Eskimos as the aggregation of thrombocytes has been shown to be the initial stage of any thrombotic process. Even if the cause of ischemic heart diseases is not to be found exclusively in the composition of the dietary and consequently the plasma lipids, our examinations of Greenland Eskimos have helped substantially to clarify the reason for the rarity of IHD in these people. This seems to include at least the following factors. *1*) Favorable plasma lipid and lipoprotein levels, i.e., low levels of cholesterol, low-density lipoproteins, triglycerides and very low-density lipoproteins, and increased high-density lipoproteins, placing Eskimos in a low risk group for developing atherosclerosis. *2*) High serum concentration of eicosapentaenoic acid, leading to a balance of platelet active prostaglandins displaced toward the antiaggregatory side, i.e., a low thrombus formation tendency.

It may be added (concerning the accepted ordinary risk factors for IHD) that the Eskimos are seldom obese, that hypertension is uncommon and diabetes mellitus unknown, whereas most Eskimos are heavy cigarette smokers.

The essential basis for the favorable factors mentioned seems to be found in the composition of the Eskimo food. The results of our investigation of the composition of Eskimo food thus offers a possible way of prophylaxis to people in communities with a high incidence of IHD.

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[3] Δchol, is the difference in mg/dl in serum cholesterol; ΔS and ΔP are the differences in caloric percentage of saturated and polyunsaturated fatty acids, respectively; C_2 and C_1 are mg cholesterol/1000 kcal in the two diets to be compared.

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