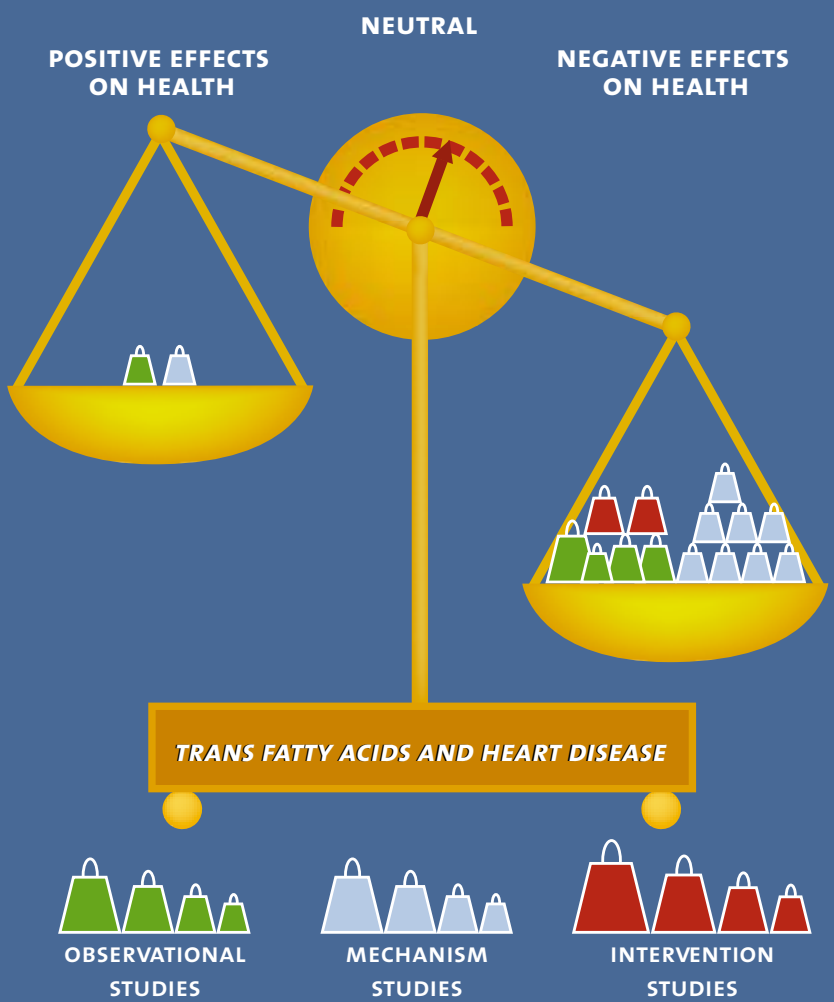
Ernæringsrådet

The influence of *trans* fatty acids on health

Fourth edition



The influence of *trans* fatty acids on health

Fourth edition

A report from the
Danish Nutrition Council

by
Steen Stender and Jørn Dyerberg

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Illustration on cover:
The various scientific studies are weighted according to the type and quality of the study concerned.
The sum of the weighted studies that indicate a harmful effect on health is compared with the sum of the weighted studies that indicate a positive or neutral effect on health. This weighting method is fundamental to the elaboration of reports by the Danish Nutrition Council.

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Table of contents

Foreword

A debate on the phasing-out of industrially produced *trans* fatty acids in food products has been initiated over the last few years in the EU, and particularly in the USA. In Denmark, this debate started in 1994 following the publication of the Danish Nutrition Council's first report, which actually dealt with *trans* fatty acids and contributed to a significant fall in the consumption of these fatty acids by Danes.

On March 11, 2003 the Danish government decided to phase out the use of industrially produced *trans* fatty acids in food before the end of 2003.

We hope that this report can provide a useful tool in work on eliminating these fatty acids, which are harmful to health, from food products, also in countries outside Denmark.

The present report is an English updated edition of the Danish Nutrition Council's third version of its report on *trans* fatty acids.

Bjørn Richelsen
Chairman of the Danish Nutrition Council

Summary

The report 'The influence of *trans* fatty acids on health' published in 1994 by the Danish Nutrition Council concluded that *trans* fatty acids in the diet promote arteriosclerosis at least as much as equivalent amounts of saturated fats and probably more, and that there are justified suspicions that a high *trans* fatty acid intake may have adverse effects on foetal growth. It was therefore recommended that a declaration of *trans* fatty acid levels in foodstuffs be dealt with by the EU. An agreement was also concluded with the Danish margarine industry to reduce the *trans* fatty acid content of margarines produced in Denmark.

Since 1994, the influence of a high intake of industrially produced *trans* fatty acids in promoting the development of heart disease has been further documented by, among other things, the presentation of four major prospective population studies. The studies indicate that, gram for gram, the intake of *trans* fatty acids as compared with saturated fatty acids is associated with an approximately 10-fold higher risk increment for the development of heart disease. The suspicion of an adverse effect of *trans* fatty acids early in life has been further confirmed. The possible effect of *trans* fatty acids on the development of cancer is still unclarified. Data from both epidemiological and mechanism studies gives rise to the justified suspicion that *trans* fatty acids increase the risk of type 2 diabetes. Studies have also been presented justifying further studies concerning the possible effect of *trans* fatty acids in promoting allergic diseases in children and concerning the possible influence of *trans* fatty acids on body fat distribution and insulin sensitivity.

There is very little information on the effect of *trans* fatty acids from ruminants on the above-mentioned aspects. Available data suggests, however, that ruminant *trans* fatty acids, especially so far as the effect on heart disease is concerned, do not have the same unfavourable effects as industrially produced *trans* fatty acids. Levels of *trans* fatty acids in industrially hydrogenated fats may account for up to 60% of the fatty acid content. The equivalent figure for beef and milk products is 2-5%.

The average daily intake of industrially produced *trans* fatty acids in Denmark was in 1994 approximately 2.5 grams per person, and has since fallen primarily as a result of a reduction in the *trans* fatty acid content of table margarines produced in Denmark. The current average daily intake is estimated at 1-2 grams. In the light of the results from a random survey conducted in November 2000 with subsequent analysis of the *trans* fatty acid content of the products collected, it is, however, likely that population groups with eating habits including frequent consumption of fast food, French fries, microwave popcorn, chocolate bars and the like have daily intakes of industrially produced *trans* fatty acids well above average levels in the general population. This is due partly to the import of products with a high content of partially hydrogenated fats and partly to the fact that bakery and industrial margarines may, despite technical potential for producing products with a low *trans* fatty acid content, still have a high content of industrially produced *trans* fatty acids.

The Danish Nutrition Council recommends that the use of industrially produced *trans* fatty acids in foodstuffs be ceased as soon as possible.

Mandate

In September 2002, the Danish Nutrition Council set up a working group with the following mandate:

To carry out an assessment of the knowledge relating to the influence of *trans* fatty acids on health and suggest a recommendation for intake of *trans* fatty acids.

The working group concluded its work on the Danish edition of the report in the autumn of 2003.

Composition of the working group:
Professor, Head Physician, Dr.Med.Sci. Steen Stender
Professor, Head Physician, Dr.Med.Sci. Jørn Dyerberg

Chapter 3. Legislation relating to the level of industrially produced *trans* fatty acids in food has been drafted in consultation with scientific adviser Bente Koch and legal adviser Tereza Gabriel, the Danish Veterinary and Food Administration.

The section on *trans* fatty acids and excess weight in Chapter 1 has been drawn up in collaboration with Thomas Meinert Larsen of the Department of Human Nutrition, the Royal Veterinary and Agricultural University, Denmark.

Introduction

Trans fatty acids are fatty acids containing at least one *trans* double bond. A *trans* double bond is a double bond in fatty acids between two carbon atoms that have changed geometry relative to the *cis* double bonds found most commonly in nature. The hydrogen atoms in the double bond in the *trans* form are located on either side of the carbon atoms, whereas those in the cis form are located on the same side (Figure 1).

Despite being unsaturated, the chemical structure of *trans* fatty acids is therefore consequently similar to that of saturated fatty acids. There is, however, a difference in the geometry of the carbon chain (Figure 2). The question is whether this difference between the *trans* fatty acid and the corresponding saturated fatty acid also results in a difference in the biological effect of these fatty acids.

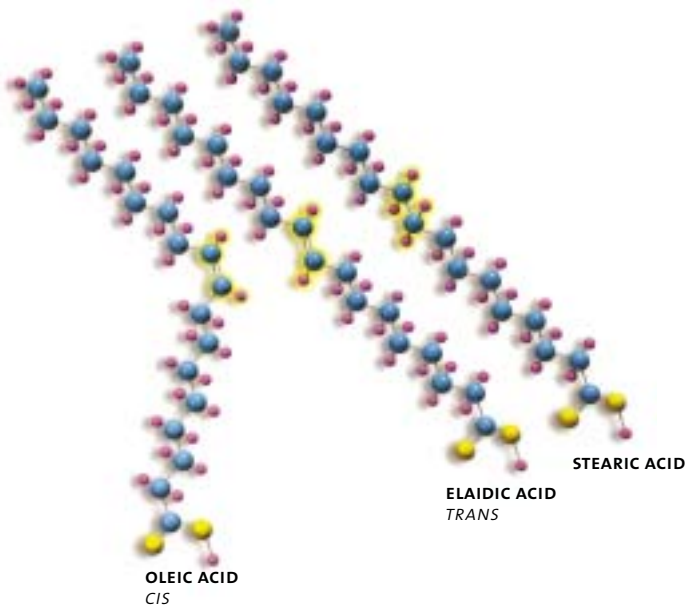

Figure 1
The chemical structure of the *cis*-unsaturated fatty acid (oleic acid), the corresponding *trans*-unsaturated fatty acid (elaidic acid) and the corresponding saturated fatty acid (stearic acid). (From J Amer Diet Assoc 2002; no. 1 - David Zweirz).

Dietary fatty acids with *trans* double bonds come primarily from two different sources: industrial, partial hydrogenation of edible oils containing unsaturated fatty acids, and bacterial transformation of unsaturated fatty acids in the rumen of ruminants. The first type is referred to in this report as industrially produced *trans* fatty acids, and the second as *trans* fatty acids from ruminants. When the term *trans* fatty acids is used in this report without any indication of source, this is due to a lack of information on this or on possible differences in effect between the two types.

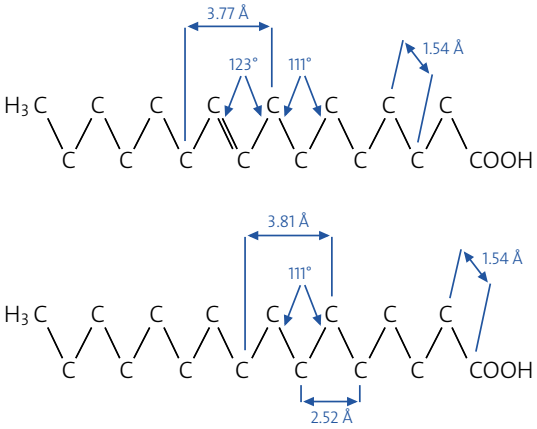

Figure 2
The molecular structure of a *trans* fatty acid (top) and the corresponding saturated fatty acid.

In industrial production designed to give a fat mixture a number of technical characteristics, such as storability in solid form (stable in storage) at room temperature, principally monounsaturated *trans* fatty acids are formed (e.g. elaidic acid 9*trans*-18:1), though also a wide range of chemical variants (1). Small quantities of so-called conjugated *trans* fatty acids, known as CLAs, are also formed in industrial hydrogenation (2).

In the rumen of ruminants, principally *trans* vaccenic acid (11*trans*-18:1) is formed, which accounts for over 60% of the *trans* fatty acid content of butterfat from cows (2). In addition, a relatively small quantity of CLA is formed (e.g. 9*cis*, 11*trans*-18:2 and 10*trans*, and 12*cis*-18:2).

It is largely the same *trans* fatty acids that are present in industrially produced *trans* fatty acids and *trans* fatty acids from ruminants, but there is a very considerable difference in the amount of the individual *trans* fatty acids in the industrially produced *trans* fatty acids and in *trans* fatty acids from ruminants (Figure 3). There is therefore a basis for differences in their influence on biochemical processes in the body as this influence may be related to specific *trans* fatty acids. Based on the said quantitative differences, information can be obtained by chemical analysis on the extent to which *trans* fatty acids originate from the industrial process and from ruminant fat.

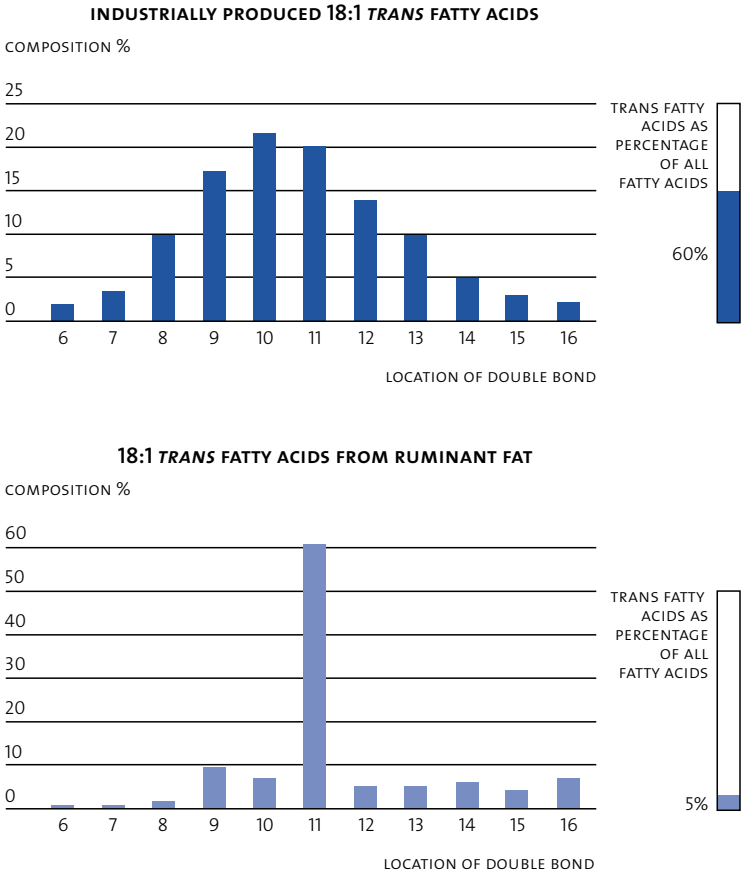

Figure 3
The distribution of *trans* fatty acids in industrially hydrogenated vegetable oil and in *trans* fatty acids from ruminant fat.

Human intake of *trans* fatty acids therefore originates from foods containing industrially produced, partially hydrogenated fat, and from beef, mutton, lamb and dairy fat.

The *trans* fatty acid content of industrially hydrogenated fats varies widely and may account for up to 60% of the fatty acid content, whereas the *trans* fatty acid content of beef and dairy products is considerably lower and accounts for 2-5% of the fatty acid content (2) (Figure 3). In the case of special dietary choices, this allows for a daily intake of up to 10 times more industrially produced *trans* fatty acids than *trans* fatty acids from ruminants.

The Danish Nutrition Council's report, The influence of *trans* fatty acids on health, which was published in 1994 (3, 4), aroused considerable attention both nationally and internationally as a result of its distinctive stance. The report concluded that industrially produced *trans* fatty acids in the diet promote arteriosclerosis at least as much as equivalent amounts of saturated fatty acids and probably more, and that there are justified suspicions that a high intake of *trans* fatty acids may have adverse effects on foetal growth.

The Danish Nutrition Council therefore considered it reasonable that the intake of industrially produced *trans* fatty acids should be reduced as much as possible as there was no evidence that they have beneficial effects on health as compared with saturated, monounsaturated or polyunsaturated fatty acids and were therefore being used in various food products chiefly on economic and production grounds.

The report led to an agreement with the Association of Danish Margarine Manufacturers on a strategy designed to reduce the *trans* fatty acid content of a number of margarine products over a number of years.

The Danish Nutrition Council's report was sent to the EU Commission in 1996 with a view to securing the Commission's agreement to implement national regulations on the labelling of foodstuffs with details of *trans* fatty acid content. The Danish request was rejected by the EU Commission, partly on the grounds of a lack of scientific consensus within EU Member States concerning the potential harmful effect of industrially produced *trans* fatty acids on health.

Since then, a number of studies have been published concerning the influence of *trans* fatty acids on health. These studies have on many points not only confirmed but also supplemented the Danish Nutrition Council's conclusions. On the basis hereof, the Danish Veterinary and Food Administration asked the Danish Nutrition Council to update the scientific background with a view to taking initiatives at EU level again to regulate levels of industrially produced *trans* fatty acids in foodstuffs. This happened in 2001 with the publication of a new *trans* fatty acid report (5).

1:

Trans fatty acids in the diet and disease

1.1 *Trans* fatty acids and heart disease

1.1.1 Epidemiological studies

Trans fatty acid intake and heart disease in various countries

Studies of the link between the intake of *trans* fatty acids and the occurrence of heart disease in the form of arteriosclerotic diseases are hampered by the fact that, among other things, an assessment of a person's intake of *trans* fatty acids over a number of years is associated with considerable uncertainty. This is due partly to the general uncertainty associated with dietary studies and partly to considerable uncertainty about the *trans* fatty acid content of food products, which can vary from one brand to another and indeed within the same brand over time. Lastly, the technical aspects of analysis also give rise to uncertainty about the *trans* fatty acid content of foodstuffs.

As *trans* fatty acids from the diet, like other fatty acids, are deposited in adipose tissue, the *trans* fatty acid content of adipose tissue reflects to a certain extent the intake of *trans* fatty acids over the previous period (several months to 1 year). The *trans* fatty acid content of adipose tissue is analysed by determining the fatty acids present in a biopsy. The *trans* fatty acid content of blood and blood cells can be determined similarly. These measure-ments reflect the intake of *trans* fatty acids in recent days, weeks and months.

Studies using the composition of *trans* fatty acids in tissue or blood as a marker for *trans* fatty acid intake and its relationship with the occurrence of heart disease have yielded conflicting results. Most studies have been too small to determine the existence of an association. The results of the biggest study to date, the EURAMIC study, which included 671 men with cardiac infarcts from 9 European countries, were not conclusive either (7).

All in all, there was no association between the above-mentioned markers for intake of *trans* fatty acids and the risk of myocardial infarcts. However, an analysis excluding centres with little intracentre variation and very low *trans* fatty acid intake shows that, among the remaining centres, there was a positive association between the intake of *trans* fatty acids and the occurrence of heart disease. The results of the study are, however, also considered difficult to interpret for methodological reasons (8).

A small (n = 66) case control study from Britain did not find an association between the *trans* fatty acid content of adipose tissue and the risk of sudden cardiac death (9) either, though see also page 26.

A case control study from Norway (10), covering 100 patients with a first myocardial infarction and 98 controls without heart disease, showed, on the other hand, that the concentration of industrially produced *trans* fatty acids in adipose tissue was significantly higher in patients than in controls. The risk of myocardial infarctions in the heart, corrected for age and sex, was 2.8 (95% confidence interval: 1.16-6.84) in the highest quintile compared with the lowest quintile for the *trans* fatty acid content of adipose tissue.

Prospective studies

The strongest epidemiological evidence relating levels of *trans* fatty acids in the diet to the risk of heart disease comes from three major prospective studies covering about 150,000 subjects monitored for 6-14 years: The Health Professionals Follow-up study, USA 1996 (11), the Alpha-Tocopherol Beta-Carotene Cancer Prevention Study, Finland 1997 (12), and the Nurses' Health Study, USA 1997 (13), which is a follow-up of the original study (6) after 14 years' observations, and from the Zutphen Elderly Study, Holland 2001 (14), which covers 667 men over an observation period of 10 years. These studies assessed the intake of *trans* fatty acids with the aid of a detailed questionnaire on the composition of the diet. The validity of the self-reported dietary composition was supported by random comparison between the fatty acid composition calculated on the basis of the completed questionnaire and the fatty acid composition measured in adipose tissue. These four studies all find a positive association between the intake of *trans* fatty acids and the risk of heart disease. The relative risk of heart disease, associated with an

absolute increase of 2 per cent energy in the intake of *trans* fatty acids, was, following statistical correction for a large number of known risk factors for heart disease, 1.36 (95% confidence interval 1.03-1.81) in the Health Professionals Follow-up Study; 1.14 (0.96-1.35) in the Alpha-Tocopherol Beta-Carotene Cancer Prevention Study; 1.93 (1.43-2.61) in the Nurses' Health Study and 1.28 (1.01-1.61) in the Zutphen Elderly Study. All in all, the relative risk of heart disease associated with an increase in the *trans* fatty intake of 2 per cent energy in the 4 studies referred to above is 1.25 (1.11-1.40) (14). See Figure 4. It should be pointed out that the relative risk values used in Figure 4 are directly comparable. In the case of two of the studies, these risk figures differ from those mentioned above, which are based on special corrections.

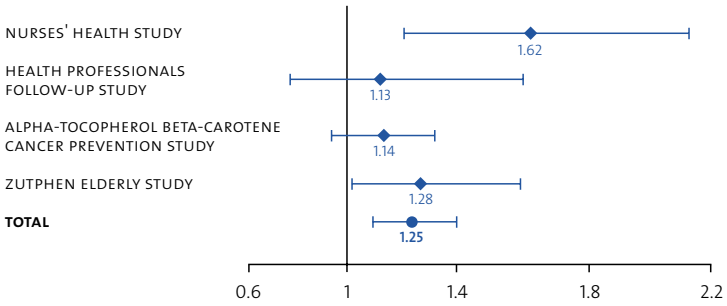

Figure 4
Fully adjusted relative risks for the development of heart disease in the case of an increase of 2 per cent energy in the intake of trans fatty acids at baseline and the total variance-weighted relative risk. The blue lines indicate the 95% confidence interval. Printed with the permission of Elsevier Science (14).

The greater relative risk in the Nurses' Health Study can probably be ascribed to the fact that there were 4 dietary studies in the follow-up period, which reduced the uncertainty in the assessment of *trans* fatty acid intake.

In three of the prospective studies, the association between the intake of *trans* fatty acids and the risk of heart disease was stronger than a corresponding association between the intake of saturated

fatty acids and the risk of heart disease. In the Zutphen Elderly Study, this association was not investigated.

Studies like those referred to above have been criticised for their uncertainty in assessing the *trans* fatty acid intake of the subjects involved. However, random errors in the measurement of intake will result in an underestimation of a possible association between the risk of heart disease and the intake of *trans* fatty acids. It should also be pointed out that observational studies like those mentioned do not necessarily demonstrate a direct causal relationship.

The associations observed apply in principle only to the groups observed. The four studies cover such different populations, however, that the results very probably hold true for the populations as a whole.

Even bearing in mind these fundamental reservations, the prospective studies cited therefore essentially support the hypothesis that *trans* fatty acids in the diet increase the risk of heart disease.

It should be pointed out in this connection that at the same time as a fall in the daily intake of industrially produced *trans* fatty acids in Denmark from 6 grams in 1976 to 1-2 g today, there has been a 50% fall in mortality from heart disease (3, 15). See Figure 5. Although many lifestyle changes have occurred in the last 80 years, it is tempting to see the rise until 1970-1980 and the subsequent fall in mortality from heart disease in the West in the context of the same rise and fall in the intake of industrially produced *trans* fatty acids over this period (15). It is in the same way tempting to relate the rise in mortality from heart disease in eastern Europe observed in recent decades to the increase in the intake of *trans* fatty acids (16). However, the suggested relations merit much deeper analysis.

AGE-STANDARDISED MORTALITY FROM HEART DISEASE AS A MAIN DIAGNOSIS, AND INTAKE OF *TRANS* FATTY ACIDS IN DENMARK OVER THE PERIOD 1977-1996

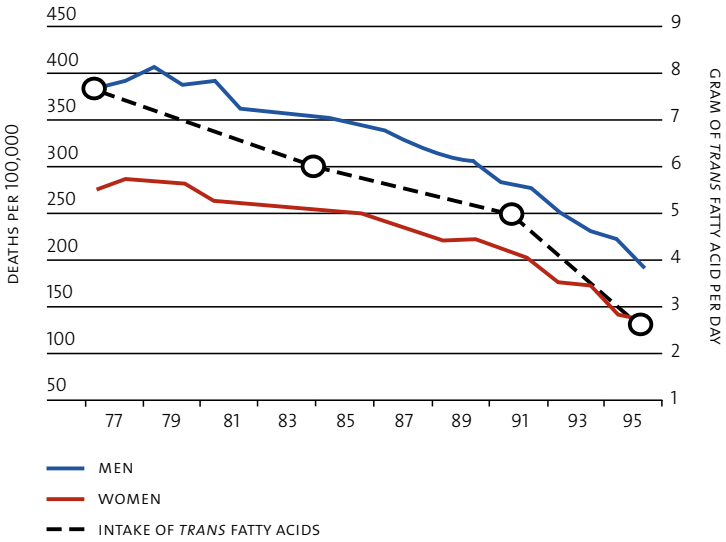

Figure 5
Changes in mortality from heart disease and changes in the intake of trans fatty acids.

1.1.2 *Trans* fatty acids and blood lipoproteins

Convincing evidence of an adverse effect on plasma lipids and lipoproteins in connection with increased intake of industrially produced *trans* fatty acids has been published in a review by Ascherio *et al* (17). The results are partly based on two major studies (18, 19). The article summarises the randomised studies, which compare the influence of isocaloric levels of saturated fatty acids and industrially produced *trans* fatty acids on plasma HDL and LDL concentrations. HDL and LDL levels in the plasma are well-documented risk markers for the development of heart disease. High LDL levels are associated with an increased incidence of ischaemic heart disease, whereas high HDL levels are associated with a reduced incidence of ischaemic heart disease. For this reason, the ratio between LDL and HDL is often used as a combined risk marker for these two components in relation to the development of heart disease. The higher this ratio, the higher the risk.

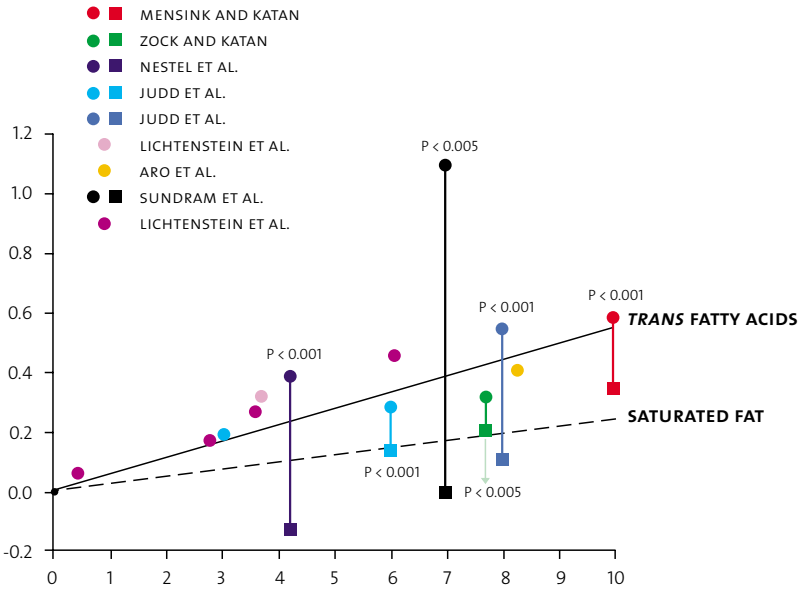

Figure 6
Results of randomised studies of the influence of industrially produced *trans* fatty acids (circles) and saturated fat (squares) on the LDL cholesterol/HDL cholesterol ratio (y-axis). A diet with isocaloric levels of unsaturated fatty acids was used as a comparative basis (17). The x-axis indicates in per cent energy a replacement of unsaturated fat with either saturated fatty acids or industrially produced *trans* fatty acids.

The above-mentioned review shows the adverse effect of an increased intake of industrially produced *trans* fatty acids on the ratio between LDL and HDL cholesterol (Figure 6). This effect is greater than the influence of a corresponding increase in the intake of saturated fatty acids. A possible explanation for this has appeared in *in vitro* studies with human liver cells, in which industrially produced *trans* fatty acids, compared with saturated fatty acids, increased the formation of cholesterol-rich LDL particles (20). The meta-analysis shows that an absolute increase of 2 per cent energy in the intake of industrially produced *trans* fatty acids increases the ratio between LDL and HDL by 0.1. A corresponding increase in this ratio, as a function of dietary levels of saturated fat, requires an increase of 5 per cent energy. An increase of 0.1 in the ratio between LDL and HDL cholesterol corresponds to about a 5% increased risk of developing heart disease.

Besides increasing the ratio between LDL cholesterol and HDL cholesterol, the level of lipoprotein Lp(a) is also increased when industrially produced *trans* fatty acids replace saturated fat (21). The link between a high Lp(a) and the risk of heart disease is, however, still uncertain.

Recently it has been shown that consumption of dietary industrially produced *trans* fatty acids produces a deleterious increase in small, dense LDL (22). An increase in small LDL-subfractions is associated with a marked increased in the risk of heart disease even in the presence of relatively normal LDL-cholesterol concentrations.

A high intake of industrially produced *trans* fatty acids increases triglyceride concentrations in the blood (17). High plasma triglyceride levels have proven to be an independent risk factor for heart disease (23, 24).

It should be pointed out that results from similar studies concerning blood lipids and the intake of *trans* fatty acids from ruminants have still not been published.

1.1.3 *Trans* fatty acids and other risk factors for heart disease

The 5% increased risk of heart disease, which can be attributed to the fact that 2 per cent energy from industrially produced *trans* fatty acids adversely affects the ratio between LDL and HDL cholesterol, is – albeit of crucial significance – considerably less than the increased risk of 25%, which the above-mentioned prospective studies find to be associated with the same intake of *trans* fatty acids. Compared with saturated fatty acids, *trans* fatty acids therefore have, gram for gram, a more than 10-fold higher association with the risk of heart disease, as 2 per cent energy from saturated fat is associated with an increased risk of heart disease of about 2% (25) (Table 1). This marked difference in increased risk may be due to effects of *trans* fatty acid intake on blood levels of triglycerides and Lp(a) as well as on other mechanisms important for the development of heart disease that are not mediated via the ratio between LDL and HDL cholesterol.

Table 1
Increased risk of heart disease in persons with a comparable absolute increase in intake of saturated fat and *trans* fat.

	INTAKE GRAMS/DAY	RISK INCREASE BASED ON INCREASED LDL/HDL RATIO	OBSERVED RISK INCREASE IN THE PROSPECTIVE POPULATION STUDIES
Saturated fat	5 (2 E%)	2%	2%
Trans fat	5 (2 E%)	5%	25%

E%: Per cent energy

There is a possibility that a high *trans* fatty acid intake results in the incorporation of these fatty acids in heart muscle cells and the conduction system and that this lowers the threshold for cardiac arrhythmias, which may be life-threatening in connection with acute myocardial infarction in the heart. In animal experiments, saturated fatty acids promote susceptibility to malignant cardiac arrhythmias (26). Support of this arrhythmia hypothesis concerning *trans* fatty acids is that fatty acids of another type, namely what are known as n-3 fatty acids in fish oils, both in animal experiments (26) and in human trials with a daily intake of 1-2 grams, apparently have the opposite effect (27, 28). It is this rhythm stabilising effect that best explains the effect of fish oils on extending the lives of patients who have previously had acute myocardial infarction (29, 30).

The possibility that *trans* fatty acids lower the threshold for cardiac arrhythmias has been supported by the results from a more recent case control study of the risk of sudden cardiac death. When levels of *trans* fatty acids in red blood cells as a marker for *trans* fatty acid intake were compared in 179 cases of sudden cardiac death with 285 controls, it was found that dietary levels of *trans* fatty acids were associated with a moderately increased risk and that levels of *trans* linoleic acids were associated with a markedly increased risk of sudden cardiac death (31). The mechanism behind this finding can theoretically be related to changes in the fatty acid composition of muscle cell membranes (32). This affects the function of the ion channels, which are important for the formation and propagation of the electrical impulses in the cells, see Figure 7.

It has also turned out that industrially produced *trans* fatty acids in the diet, in comparison with saturated fat, lower plasma HDL cholesterol and reduce endothelial function in the vascular wall (33). The endothelium is the innermost cell layer in the vessels in direct contact with the blood. Its function is among other things to provide protection against thrombosis and to regulate the blood supply to the tissue. Endothelial dysfunctions are probably the first stage in the development of cardiac arteriosclerosis.

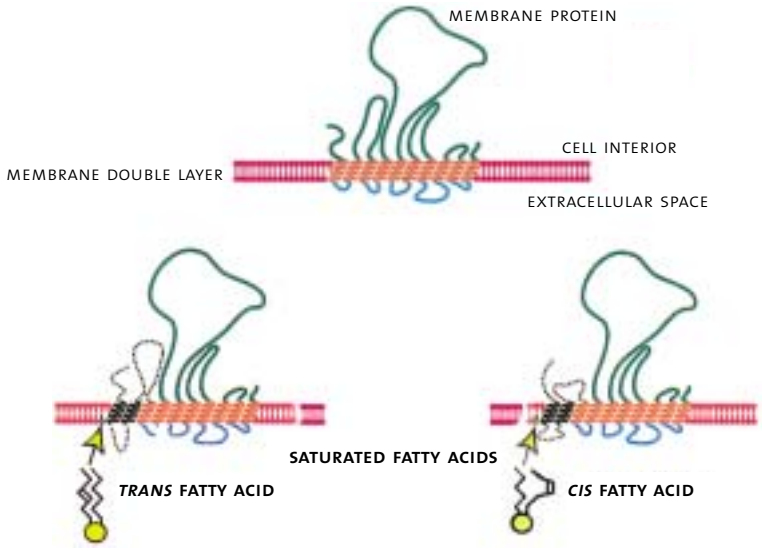

Figure 7
The drawing illustrates how *trans* and *cis* unsaturated fatty acids in the cell membrane change the configuration of the ion channel protein, indicated by changes in the dotted black line. Such changes may be important for major cell functions. Modified in accordance with (32).

1.1.4 Industrially produced *trans* fatty acids versus *trans* fatty acids from ruminants

The epidemiological studies published to date do not permit any definite conclusions about differences in the associations between the risk of heart disease and the intake of industrially produced *trans* fatty acids and *trans* fatty acids from ruminants. However, the largest epidemiological study, the Nurses' Health Study, showed a significant, positive association with the intake of industrially produced

trans fatty acids and a non-significant, inverse association between the intake of *trans* fatty acids from ruminants and the risk of heart disease (6). The same pattern was found in the Finnish Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study, in which the increased risk of cardiac death was found to be positively associated with total *trans* fatty acids as well as elaidic acid and *trans* fatty acids from hydrogenated vegetable fat, but not with *trans* fatty acids from ruminants, in connection with which a slightly insignificant, negative association was found (12).

In the much smaller Zutphen Elderly Study, there was no difference in the associations between the risk of heart disease and either *trans* fatty acids from ruminants or industrially produced *trans* fatty acids (14), while this was not clarified in the American Health Professionals Follow-up Study (11).

In a substudy of the so-called Framingham study comprising 832 men who were free of heart disease at the start of the study and who were followed up for 21 years, a significant, moderate, increased risk of heart disease associated with margarine intake was found. Over the last 10 years of the study period, a 10% increased risk of heart disease was found for every extra daily teaspoonful of margarine consumed by the participants. The risk for those eating most margarine was virtually twice that in those who did not consume any (34).

Since 1994, epidemiological and mechanism studies have provided further evidence that industrially produced *trans* fatty acids in the diet increase the risk of heart disease. This finding is in line with the conclusion of a comprehensive report published by the National Academy of Science, Institute of Medicine in July 2002, recommending that the intake of *trans* fatty acids should be as low as possible (35). This report does not differentiate between industrially produced *trans* fatty acids and *trans* fatty acids from ruminants.

1.2 *Trans* fatty acids early in life

Based on results from animal studies, it was previously assumed that *trans* fatty acids do not cross the placenta, and that the foetus is therefore protected against *trans* fatty acids (3). More recent studies on humans have shown, however, that *trans* fatty acids are transferred

to the foetus, as they were found in the same levels in the blood of newborn infants as in that of mothers (36, 37).

Both the foetus and the breast-fed baby are consequently exposed to *trans* fatty acids corresponding to the mother's intake. Dietary *trans* fatty acids can in part compete with essential polyunsaturated fatty acids in the body. In animal experiments, a high intake of industrially produced *trans* fatty acids inhibits the formation of long-chain polyunsaturated fatty acids (LCPUFAs) from their precursors (38). In theory, something similar may apply in humans (39). LCPUFAs are important for both growth and the development of vision and the central nervous system early in life.

The amount of *trans* fatty acids that must be supplied before the synthesis of LCPUFAs is affected is, however, unknown.

In 1992, a study of premature babies was published which found a negative correlation between birth weight and *trans* fatty acid levels in plasma 4 days after birth (39). In a study published in 2001, Elias and Innis showed that *trans* fatty acid levels including CLA in the umbilical blood of 84 neonates reflected the mother's levels of *trans* fatty acids in the blood and thus the mother's *trans* fatty acid intake. At the same time, the pregnancy period was found to be shorter in mothers the higher the *trans* fatty acid level in the infant's blood (37). The authors further showed that there was an inverse relationship in the infants' blood between *trans* fatty acids and polyunsaturated fatty acids, which is also shown in other studies (40).

n-3 fatty acids from fish oils prolong pregnancy (41), while *trans* fatty acids appear to shorten it. This might take place by the same mechanism as described for the heart's tendency for arrhythmia. n-3 fatty acids inhibit the contraction in uterine cells by virtue of an effect on the ion channels of these cells, thus prolonging pregnancy. *Trans* fatty acids may have the opposite effect.

In a study by Hornstra published in 2000, it was concluded that since the mother's intake of *trans* fatty acids is negatively associated with levels of polyunsaturated fatty acids in the blood of newborn infants, it is advisable to minimise the intake of *trans* fatty acids during pregnancy (42). The same conclusion is not reached in a

review by MC Craig-Schmidt (43) dating from 2001, which recommends a number of studies of the possible harmful effect of industrially produced *trans* fatty acids on infants before deciding whether to offer advice on the intake of *trans* fatty acids by pregnant women. The Danish Nutrition Council is of the opinion that a justified suspicion of harmful effects of this kind is an adequate basis for advice.

A surprising observation from 1998 is the finding of an association between a high intake of *trans* fatty acids and the risk of preeclampsia (44). In this study, *trans* fatty acid intake was estimated via the *trans* fatty acid content of the cell walls of red blood cells. Women who developed preeclampsia had approximately 30% higher *trans* fatty acid levels in red blood cells than women who did not develop this disorder.

All in all, it is still uncertain whether *trans* fatty acids have negative consequences early in life, but there is a justified suspicion that this may be the case.

1.3 *Trans* fatty acids and cancer

In the so-called EURAMIC study dating from 1997, the association between *trans* fatty acid levels in adipose tissue and the incidence of cancer of the breast, prostate and large intestine was investigated in European populations with wide differences in dietary levels of *trans* fatty acids. A positive association was found between *trans* fatty acid intake and the incidence of cancer of the breast and large intestine (45, 46).

A smaller study concerning the association between the prognosis for breast cancer and adipose tissue levels of *trans* fatty acids showed a negative association between *trans* fatty acids and the incidence of lymph node metastasis (47), but the study did not reveal an association between *trans* fatty acids and survival.

In a case control study of polyps in the large intestine and *trans* fatty acid intake conducted in about 500 index subjects and 500 controls, no association was found between self-reported intake of *trans* fatty acids and the incidence of this condition, which predisposes to intestinal cancer (48).

In another case control study investigating the association between *trans* fatty acids and cancer of the large intestine in 2000 patients and 2000 controls, signs of an increased risk of cancer related to the intake of *trans* fatty acids in subgroups of these patients were found (49).

In the Netherlands Cohort Study on Diet and Cancer, which comprised 941 cases of breast cancer, a weak, positive relationship between CLA intake and incidence of breast cancer was found from the use of data from the TRANSFAIR study (50).

In the Danish Nutrition Council's report from 1994, it was concluded that there was no evidence that dietary levels of *trans* fatty acids had any carcinogenic effect. Studies published since 1994 do not warrant revising this conclusion, but provide a basis for continued watchfulness of this possibility.

1.4 *Trans* fatty acids and allergy

The increased incidence of hay fever, atopic disorders and asthma in Europe is associated with the spread of the Western lifestyle (51). In an international study of asthma and allergies in childhood (ISSAC) from 1998, the incidence of asthma, allergic cold and asthmatic eczema in children aged 13-14 years was investigated in 155 centres around the world. A positive association was found between the intake of *trans* fatty acids and these diseases. Such an association was not observed for the intake of monounsaturated and polyunsaturated fatty acids (52, 53).

The above-mentioned results do not allow any conclusion concerning recommendations for dietary levels of *trans* fatty acids in relation to the incidence of allergic diseases, but provide a basis for further studies.

1.5 *Trans* fatty acids and diabetes

Analysis of the Nurses' Health Study after 14 years' observation showed that the risk of the development of type 2 diabetes was associated with *trans* fatty acid intake (54). The authors concluded that as the intake of industrially produced *trans* fatty acids in the USA

is on average 3 per cent energy, a reduction in *trans* fatty acid intake of 2 per cent energy could reduce the incidence of type 2 diabetes by 40% if the fats containing the *trans* fatty acids were consumed in their original unhydrogenated form. It was not possible, however, to find such an association in either the Iowa Women Study (55) or the Health Professionals' Study (56).

The administration of a high-fat meal of variable fatty acid composition, elaidic acid (9*trans*-18:1) compared with oleic acid (9*cis*-18:1) gave rise to higher insulin levels in the blood at the same blood sugar level, which indicates that elaidic acid produces increased insulin resistance (57). That *trans* fatty acids in *in vivo* and *in vitro* studies affect insulin sensitivity and secretion – see also below under CLA – supports the hypothesis of a diabetes-promoting effect of *trans* fatty acids (58, 59). The mechanism underlying this effect may be of the same nature as the previously mentioned effect of *trans* fatty acids on cell membrane ion channels.

The Nurses' Health Study is of much greater strength than the two prospective studies referred to above, and so the observed association between the intake of *trans* fatty acids and the development of type 2 diabetes compared with the mechanism studies described leads to a justified suspicion that a high intake of *trans* fatty acids increases the risk of the development of type 2 diabetes.

1.6 *Trans* fatty acids and excess weight

Industrially produced *trans* fatty acids and *trans* fatty acids from ruminants contain calories in the same quantities as other edible fats. On the face of it, there is therefore no reason why *trans* fatty acid should have a special effect on excess weight.

A special group of *trans* fatty acids, known as conjugated linolic acids (CLAs), which is linolic acid with conjugated double bonds, one of which is in a *cis* and the other in a *trans* configuration, constitutes less than 10% of *trans* fatty acids from ruminants, but they are also present in small levels in industrially produced, partially hydrogenated fat. The average daily intake of CLA in Denmark is of the order of 100-300 mg (60, 61). These fats have been the subject of a number of studies investigating their possible effect on the body's

distribution of fatty and fat-free mass. A review of 28 publications from 1999 to 2002, including animal and human studies, reveals conflicting results that do not allow for conclusions to be drawn about a positive impact on human body composition even with intakes of up to 7 grams CLA per day. A recent Swedish study indicates that certain CLA isomers that are present only in very low levels in ruminant fat increase the insulin resistance of men with abdominal obesity (62). This is again an example of marked effects on essential cellular functions exerted by the intake of a few grams of specific fatty acids that might be due to the influence on the configuration of the transport proteins and thus their function in the cell membranes.

2:

Trans fatty acid levels in the Danish diet

2.1 Average intake of *trans* fatty acids compared with other countries

In 1995 and 1996, the so-called TRANSFAIR Study Group collected up to 100 product samples in each of 14 European countries. The product samples were chosen in such a way that they could be used to calculate the population's intake of fat, including *trans* fatty acids. The product samples were analysed in the same laboratory, and *trans* fatty acid intake was accordingly calculated on the basis of dietary studies in the individual countries (63). Criticism was later levelled at the method adopted in this study for the analysis of *trans* fatty acids. The method was claimed to underestimate *trans* fatty acid intake substantially (64).

Table 2 shows that in Denmark there was an intake of 2.6 grams of *trans* fatty acids per day in adults, corresponding to the average for the 14 countries. This indicated that *trans* fatty acid intake in Denmark had halved in the period 1991-1996. According to the study, 10% of the population in Denmark consumed more than 3.9 grams of *trans* fatty acids daily based on the product samples included in the study. Based on data from Sweden, where the intake of *trans* fatty acids is of the same order as in Denmark, it is estimated that about half the average intake of 2.6 grams is accounted for by ruminant fat (65).

2.2 Margarine

The principal single source of *trans* fatty acids in the Danish diet was previously margarine, both table margarines and the so-called bakery and industrial margarines. In 1992, the Danish Veterinary and Food Administration established a programme for margarine monitoring, and in 1992, 1995, 1997 and 1999 it conducted a survey of the fatty acid content of margarines on the Danish market (66).

Table 2
Average daily intake of *trans* fatty acids in men and women in 14 European countries in 1996 (TRANSFAIR (62)) and corresponding results from previous periods.

		TRANS FATTY ACID	*TRANS* FATTY ACID	PREVIOUS *TRANS* FATTY ACID INTAKE	
COUNTRY	AGE	% ENERGY	GRAMS PER DAY	GRAMS PER DAY	PERIOD
Iceland	19-64	2.0	5.4		
Holland	19-64	1.6	4.3	10	1984-85
Belgium	18-63	1.4	4.1		
Norway	19-64	1.5	4.0	8	1984-91
United Kingdom	0-75 +	1.3	2.8	7	1982
Denmark	**19-64**	**1.0**	**2.6**	**5**	**1991**
Sweden	19-64	1.1	2.6	7	1984
France	19-64	1.2	2.3		
Germany	19-64	0.8	2.2	4	1991
Finland	25-64	0.9	2.1	3	1992
Spain	0-70 +	0.7	2.1	2	1988
Italy	1-80	0.5	1.6		
Portugal	38	0.6	1.6		
Greece	23-64	0.6	1.4		

The study from 1999 showed that levels of industrially produced *trans* fatty acids in table margarines have fallen considerably from levels found in the study conducted in 1995, in which only 42% of the samples were free of industrially produced *trans* fatty acids (i.e. less than 1%), whereas 88% were free of them in 1999 (66). The average level of industrially produced *trans* fatty acids in table margarines in 1999 was below 1%, while in 1996 it was around 3%. Only a very few table margarines had levels of industrially produced *trans* fatty acids exceeding 5% in 1999, with maximum levels of 9.7% being recorded (66).

On the other hand, the average level of industrially produced *trans* fatty acids in bakery and industrial margarines had not changed; however, 20% were free of *trans* fatty acids in 1999 as against none in the study conducted in 1995.

In the 1999 study, only one margarine had a low level of industrially produced *trans* fatty acids originating from hydrogenated fish oil.

In the 1996 study, levels of such *trans* fatty acids were found in 9 table margarines and 7 bakery margarines. *Trans* fatty acids formed by hydrogenation of fish oils may, owing to their greater chain length (20 and above), theoretically be expected to have more adverse effects than those based on vegetable oils (chain length of 18 and below). This configuration allows for effects on structural lipids in the central nervous system, where it is the long-chain fatty acids that dominate.

The results from the Danish Veterinary and Food Administration's studies (67, 68), compared with the results from the TRANSFAIR study (63), indicate, with the methodological reservations mentioned above (64), that the average intake of industrially produced *trans* fatty acids was back in 1995 low in the Danish population, namely 1-2 grams per person per day. With the attention that has been given to industrially produced *trans* fatty acids after the Danish Nutrition Council's reports (3, 4, 5), particularly in Denmark, it is likely that the average intake of industrially produced *trans* fatty acids has fallen further, see Figure 8.

In the light of the Danish Nutrition Council's established focus on the problem – including not least the publicity that the issue has had in the media – we have managed to convince the company Hans Freitag that in future they should use only a vegetable fat with a low trans fatty acid content.

The analysis of the vegetable fat now used, which has just been received, is attached for your information.

If the Danish Nutrition Council so wishes, we would be happy to arrange for a sample of the "new" product to be sent direct from the plant in Germany for your further assessment.

For form's sake, we would point out that, owing to the previous importer's distribution, there are still packs of the "old" type on the market.

We would like to thank you for your efforts in this matter and trust that you will be happy with this development. We are of course available to respond to any additional questions or comments that the Danish Nutrition Council might have in this matter.

Yours faithfully,

Figure 8
Extract of a letter received by the Danish Nutrition Council from the manufacturer of the assorted wafers that had a *trans* fatty acid content of 18 grams per 100 grams of product, which was the highest among the products included in the Danish Nutrition Council's analysis.

It should be mentioned in this connection that a number of bakers have currently stopped using bakery margarines containing industrially produced *trans* fatty acids and market bakery products free of *trans* fatty acids.

Figure 9
From ISO's advertisement, week 6, 2002, advertising for *trans* fatty acid-free pastry products. ISO is a chain of supermarkets in Denmark.

2.3 Other sources of industrially produced *trans* fatty acids

2.3.1 Snacks, cakes and confectionery

In connection with the drafting of the Danish Nutrition Council's report in 2001, 49 snack, cake and confectionery products were purchased in November 2000 from 5 different supermarkets in the Greater Copenhagen area.

The collection exercise was purely random in nature, and the products were purchased if the list of ingredients (see below) included the following phrases:

"partially hydrogenated fat"
"hydrogenated vegetable oil"
"partially hydrogenated vegetable oil"
"hydrogenated vegetable fat"
"vegetable fat partially hydrogenated"
"vegetable oil and fat, partially hydrogenated"
"vegetable fat and hydrogenated vegetable oil"
"partially hydrogenated vegetable and animal fats".

The manufacturers or distributors whose names appeared on the products collected were then asked to answer a number of questions about the product purchased by the Danish Nutrition Council and to provide information on the *trans* fatty acid content of other products produced and/or distributed by the company. The Danish Nutrition Council also conducted an analysis of the *trans* fatty acid content of the products purchased. [1)]

Of 12 companies questioned, answers were received from 11. All in all, the 11 firms provided information on 145 products and indicated the *trans* fatty acid content of 119 products. Appendix 1 sets out the products with a quoted *trans* fatty acid content and the content found by the Danish Nutrition Council in the 49 products purchased.

The result of the analysis was as follows: 24 products contained less than 1 gram of industrially produced *trans* fatty acids per 100 grams of product, 11 had between 1 and 2 grams and 8 had more than 2 grams per 100 grams of product. Two of these 8 products had levels of 7.4 and 18 grams per 100 grams of product, respectively (Appendix 1). A partially hydrogenated fat with a *trans* fatty acid content of more than 50% was used for the product with the highest level of industrially produced *trans* fatty acids. The analysis demonstrates that a wide range of snack, cake and confectionery products contain industrially produced *trans* fatty acids, and that this content can vary considerably.

1) Analysis conducted by BioCentrum, Technical University of Denmark

No regulations existed before June 2003 governing information on levels of *trans* fatty acids in foodstuffs not claimed to be free of *trans* fatty acids. In 2001, the Danish Nutrition Council conducted an additional study of 31 food products purchased whose list of ingredients did not contain any of the terms referred to above for industrially hydrogenated fats, but only information on levels of vegetable fat. These food products also contained *trans* fatty acids in very variable amounts. Levels of *trans* fatty acids varied from 0 to 31 grams per 100 grams of fat in the products, i.e. well above what could originate from *trans* fatty acids from ruminants (Appendix 2)[2]).

As unconverted vegetable fat is often unsaturated, indications of levels of vegetable fat in food products may be interpreted by the consumer as a positive health message. Compared with saturated fat, the studies indicate that, gram for gram, industrially produced *trans* fatty acids increase the risk of heart disease considerably more (tenfold). This finding highlights the need for regulation of levels of industrially produced *trans* fatty acids in our food.

Only a few of the products analysed, which are indicated in Appendices 1-2, contain so much industrially produced *trans* fatty acid that normal consumption of the product in question may contribute significantly to total *trans* fatty acid intake. The presence of products with a high level of industrially produced *trans* fatty acids shows, however, that producers had the opportunity to change and thus significantly increase the *trans* fatty acid content of a particular product if this is financially attractive without the change being apparent from the labelling, which is the same whether the level is low or high.

2.3.2 Microwave popcorn

In a similar way as for snacks, cakes and confectionery, the Danish Nutrition Council has obtained information on the *trans* fatty acid content of microwave popcorn (popcorn intended for preparation in microwave ovens) from a number of manufacturers/distributors. The Danish Nutrition Council has also commissioned an analysis of the *trans* fatty acid content of a range of randomly selected products[2)].

2) Analysis conducted by BioCentrum, Technical University of Denmark

The results of these investigations are set out in Appendix 3.

This analysis shows that certain types of microwave popcorn have levels of industrially produced *trans* fatty acids accounting for up to 40% of the fat content. A bag containing 10-30 grams of fat (corresponding to one portion) may therefore contain about 10 grams of industrially produced *trans* fatty acids.

It is estimated that 20-30 million bags of microwave popcorn are sold annually in Denmark.

2.3.3 Fast food

The Danish Nutrition Council has become aware that deep-frying fat in some of the large fast food chains' products may contribute to a very high intake of industrially produced *trans* fatty acids as a number of these chains still use deep-frying fat with *trans* fatty acid levels higher than 10%. In February 2001, the Danish Consumer Council published a study of 24 different fast food products (69) and found these to include a number containing high levels of industrially produced *trans* fatty acids.

Following an inquiry by the Danish Nutrition Council to the McDonald's chain in Denmark, an agreement was concluded with the latter under which the chain would declare the level of *trans* fatty acids in various products in the form of tables in the so-called McDonald's Avis.

In addition, McDonald's, Denmark submitted a declaration of intent to reduce the *trans* fatty acid levels of the chain's products with a view to removing this type of fat completely over a number of years.

McDonald's USA stated in September 2002 that levels of industrially produced *trans* fatty acids in its deep-frying oil would be halved by February 2003. America's biggest producer of snack products (Frito-Lay) also stated in September 2002 that from 2003 they would be removing industrially produced *trans* fatty acids from their most popular products.

The Danish Veterinary and Food Administration has recently published the results of an analysis of 253 samples of cakes, choco-

late and confectionery, cookies, pommes frites and frozen potatoes, microwave popcorn and more plus 10 infant formulas and 8 baby food products. The products were found among Danish importers and producers. The investigation has taken place in the period of October, 2002 – May, 2003.

All 18 infant formulas and baby food products had a content of *trans* fatty acids less than 4% and thus satisfied the Danish order no 202 of 17.03.1997.

Among the remaining products 70 of 253 samples had a content of *trans* fatty acids higher than 2%. Of these 22 had a content of milk fat in the formula list. Among these were 11 with a content of *trans* fatty acids of 2-5% of the fat which possibly comes from the milk fat alone. However, 11 of these contained >5% *trans* fatty acids and as high as 40% *trans* fatty acids which must come from hydrogenated fat.

Specially soft caramels, cookies, fruit spread, cakes (except industrially produced hole cakes), frozen potatoes and ready to eat pommes frites were remarkable with a high content of *trans* fatty acids and often also a high content of fat.

While the Danish Margarine Industry voluntarily has managed to reduce the content of *trans* fatty acids in retail margarines to about zero, other food products on the Danish food market were still found to contain quite high amounts of *trans* fatty acids (70).

2.3.4 A special dietary choice, rich in industrially produced *trans* fatty acids

A doughnut can contain 3.2 grams of industrially produced *trans* fatty acids and a large portion of French fries 6.8 grams (71). A bag of popcorn, a doughnut and a large portion of French fries can therefore together contain around 20 grams of industrially produced *trans* fatty acids.

A similar meal consisting of 100 grams of biscuits (10 grams of *trans* fatty acids), a large "chocolate bar" (3 grams of *trans* fatty acids) and a bag of microwave popcorn (10 grams of *trans* fatty acids) could in the same way contribute over 20 grams of industrially produced

trans fatty acids. Other similar examples can be easily combined from the data collected.

A doughnut	3.2	grams of *trans* fatty acids
A large portion of French fries	6.8	grams of *trans* fatty acids
A bag of microwave popcorn	10	grams of *trans* fatty acids
Total	**20**	**grams of *trans* fatty acids**
100 grams of biscuits	10	grams of *trans* fatty acids
A large chocolate bar	3	grams of *trans* fatty acids
A bag of microwave popcorn	10	grams of *trans* fatty acids
Total	**23**	**grams of *trans* fatty acids**

Figure 10
A special dietary choice, rich in *trans* fatty acids.

In the light of the above, it is therefore likely that certain population groups, including pregnant women, are unknowingly consuming high levels of industrially produced *trans* fatty acids regularly.

Such eating habits, which are certainly not uncommon, may in a single day average an industrial *trans* fatty acid intake many times the average daily level in Denmark. If such food is consumed rarely, the level of *trans* fatty acids consumed is probably of little biological importance.

If such food is consumed several times a week, the average daily intake of industrially produced *trans* fatty acids over months or years may be on a scale that increases the risk of heart disease considerably and may cause other health problems.

It should be pointed out in this connection that organic food is not allowed to contain chemically modified fats or oils, and is therefore free of industrially produced *trans* fatty acids (72).

2.4 Summary

The margarine industry is achieving the objectives laid down in the Danish Nutrition Council's report from 1994 concerning levels of industrially produced *trans* fatty acids in Danish table margarines. The aim is a level of industrially produced *trans* fatty acids of less than 2%. Bakery and industrial margarines still contain concentrations above the desired level, however, even if monitoring studies clearly show that products of this kind that are low in *trans* fatty acids can be produced. The changes have led to a marked reduction in the average *trans* fatty acid intake in the population since 1994. People making dietary choices that differ from the statistical average may, however, still consume industrially produced *trans* fatty acids from partially hydrogenated oils on a scale that gives rise to unnecessary health risks.

3:

Legislation relating to the level of industrially produced *trans* fatty acids in food

3.1 Denmark

Rules on the listing of ingredients in food

The rules on the listing of ingredients are contained in the Labelling Order (73). The Order contains provisions implementing, among other things, parts of Directive 2000/13/EC of the European Parliament and of the Council (74).

The provisions of the Labelling Order relating to the listing of ingredients relate only to prepackaged foodstuffs. A prepackaged foodstuff must as a rule always have a list of ingredients specifying all the ingredients incorporated in the foodstuff at the production stage. The term 'ingredient' is understood to mean any raw material, including additives, used in the production or preparation of a foodstuff and which is still present in the finished product, possibly in modified form. If an ingredient of a foodstuff itself is a product of several ingredients (constituents), each ingredient (constituent) must in principle appear in the list of ingredients. See Figure 11.

The ingredients in the list of ingredients must appear in descending order of weight. The ingredient present in the greatest amount must therefore appear first.

An ingredient must normally be designated by its specific name. The name may be laid down in legislation, for example in the form of a product standard or according to standard practice. If there is no generally known name, a descriptive name must be used that is suitable for identifying the ingredient.

DK Vaffel med nougatcreme og mælkechokolade · **Ingredienser:** Sukker, hvedemel, hærdet vegabilsk fedtstof, kakao-smør, hasselnødder 9,8%, kakao-masse, skummetmælkspulver, valle-puver, lactose, smørfedt, valle-produkt, fedtfattigt kakaopulver, mælkepulver, emulgator (lecithiner), aroma, invertsukker-sirup, salt, hævemiddel (natriumhydrogencarbonat). Fremstillet i Tyskland. Opbewares køligt og tørt. **Mindst holdbar til: se på siden.**

DK

Choko Pleskner: Småkager med kakaobund (26%).
Nettovægt: 200g.
Ingredienser: Hvedemel, sukker, margarine (delvis hærdet vegetabilsk fedtstof, vand, salt, mælkeprotein, laktose, emulgator (E471, E322), surhedsregulerende middel: Citronsyre; aroma), delvis hærdet vegetabilsk fedtstof, helæg, fedtfattigt kakao (3%), sødmælkspulver, hævemidler (E450, E500), emulgator (E322), aroma: Vanille.
Opbevaring: Tørt og køligt. Efter åbning bevares kagerne bedst ved at folde posens top og eventuelt lukke denne med en clips.
Mindst holdbar til: Se siden af posen.

DK **Kakaoroulade – Kakaoroulade med creme med vaniljesmag.**
Ingredienser: Creme med vaniljesmag 33,3% (delvis hærdet vegetabilsk olie og vegetabilsk olie, glucosesirup, laktose, emulgator: E471; vaniljearoma), hvedemel, sukker, pasteuriserede æg, glucosesirup, fedtfattigt kakaopulver 2%, laktose, stabilisatorer: E420, E422; emulgatorer: E471, E475; mælkepulver, hvid vekaooverstræk (indeholder emulgator: E322), hævemidler: E450, E500; salt, vaniljearoma, kakaoaroma, syre: E260, citronsyre. Dette produkt kan indeholde spor af nødder. Holdbarhed efter åbning: 5 dage i tillukket emballage.
Produceret 13 uger før udløbsdato.

Figure 11
Examples of lists of ingredients for food products purchased from a Danish chain of stores.

GB · WAFER WITH NOUGAT CREAM AND MILK CHOCOLATE · Ingredients: sugar, wheat flour, hydrogenated vegetable fat, cocoa butter, hazelnuts 9.8%, cocoa mass, skimmed milk powder, whey powder, lactose, butterfat, whey product, low-fat cocoa powder, milk powder, emulsifier (lecithins), flavouring, invert sugar syrup, salt, raising agent (sodium hydrogen carbonate). Made in Germany. Keep cool and dry. Use by: see date on side.

GB · CHOKO PLESKNER: BISCUITS WITH COCOA BASE (26%)
Net weight: 200 g.
Ingredients: Wheat flour, sugar, margarine (partially hydrogenated vegetable fat, water, salt, milk protein, lactose, emulsifiers (E471, E322), acidity regulator: citric acid; flavouring), partially hydrogenated vegetable fat, whole eggs, low-fat cocoa (3%), full-cream milk powder, raising agents (E450, E500), emulsifier (E322), flavouring: vanilla.
Storage: Dry and cool. After opening, the biscuits are best stored by folding over the top of the bag and, where appropriate, sealing it with a clip.
Use by: See side of bag.

MARZIPAN CAKE
275 g
Ingredients: sugar, margarine (partially hydrogenated vegetable fats), pasteurised eggs, wheat flour, wheat starch, glucose, hydrogenated vegetable fat, low-fat cocoa (2%), salt, full-cream milk powder, flavouring: vanilla, bitter almond. Added: emulsifiers (E471, E322, E492), raising agents (E450, E500), acidity regulator (citric acid), preservative (E202).
Use by: 20.01.03
Coronet Cake Company ApS, 4130 Viby Sj.

GB · CHOCOLATE SWISS ROLL –
CHOCOLATE SWISS ROLL WITH VANILLA-FLAVOURED CREAM
Ingredients: vanilla-flavoured cream 33.3% (partially hydrogenated vegetable oil and vegetable oil, glucose syrup, lactose, emulsifier: E471; vanilla flavouring), wheat flour, sugar, pasteurised eggs, glucose syrup, low-fat cocoa powder 2%, lactose, stabilisers: E420, E422; emulsifiers: E471, E475; milk powder, white Vekao icing (contains emulsifier: E322), raising agents: E450, E500; salt, vanilla flavouring, cocoa flavouring, acid: E260, citric acid. This product may contain traces of nuts. After opening, use by: 5 days in sealed packaging. Produced 13 weeks before the use-by date.

For a number of categories of ingredients, including refined oil and refined fat, a category name can be used instead of the specific name of the ingredient.

The precise wording of the category names is laid down in the Labelling Order. Only the category names listed in the Order may be used.

The above-mentioned rules on category names mean, among other things, that refined oil, apart from olive oil, may, instead of the specific name – for example, "rape seed oil" – only be designated as "oil" supplemented by either the designation "vegetable"/"plant" or "animal" or an indication of the specific vegetable or animal origin. The designation "hydrogenated" must furthermore accompany the indication of a hydrogenated oil.

Nutrition labelling in the EU, including Denmark

Rules governing nutrition labelling are contained in the "Order on nutrition labelling, etc. for prepackaged foodstuffs" (75). The Order contains provisions implementing Council Directive 90/496/EEC (76).

The term "nutrition labelling" is understood to mean any information on the packaging concerning the content of the foodstuff in terms of:

1) energy
2) protein
3) carbohydrate
4) fat
5) fibre
6) sodium
7) certain specifically indicated vitamins and minerals.

The provision of nutrition labelling is in principle voluntary, but if a nutrition claim is used, nutrition labelling is mandatory.

The term 'nutrition claim' is understood to mean any indication on the packaging, in the presentation or in advertising that is liable to give consumers the impression that a food product has a specific nutritional characteristic in terms of energy or nutrients.

If one wants to provide nutrition labelling voluntarily, there are two options:

1. "The short one", which contains information on the food's total content of: energy, protein, carbohydrate and fat
or
2. "The long one", which contains information on the food's total content of: energy, protein, carbohydrates, sugars, fat, saturated fats, fibre and sodium.

Both "the short" and "the long" nutrition labelling can be supplemented by information on: sugar, alcohol, starch, monounsaturated fatty acids, polyunsaturated fatty acids, cholesterol and certain specifically indicated vitamins and minerals.

It follows from the Order's definition of saturated, unsaturated and polyunsaturated fatty acids that fatty acids with the *trans* double bond cannot be declared as any of these, but the *trans* fatty acids are a part of total fat. The *trans* fatty acid content must therefore be specified in the nutrition labelling where a nutrition claim is made with regard to *trans* fatty acids.

Where a nutrition claim is made with regard to *trans* fatty acids, the labelling may, so far as fats are concerned, assume the following form:

fat	☐	gram/100 gram product
of which		
saturated fatty acids	☐	%
monounsaturated fatty acids	☐	%
polyunsaturated fatty acids	☐	%
trans fatty acids.	☐	%

A change in the Order referred to above will require a change in the EU Directive. Denmark cannot on its own initiative change the rules for nutrition labelling, including introducing compulsory declaration of *trans* fatty acids.

The Commission has announced that the Directive on nutrition labelling will soon be amended.

Order on trans fatty acid levels

The Danish Veterinary and Food Administration has in recent years formulated a number of draft Orders designed to reduce levels of industrially produced *trans* fatty acids in fats and processed products.

These draft Orders have been circulated for comment to interested parties in the private and public sectors. In the light of the answers received from this consultation exercise and a political desire for the rapid phasing-out of industrially produced *trans* fatty acids from food products, a draft text was forwarded to the EU Commission in June 2002. After several consultations and a number of changes in the draft, the Danish government announced the final order March 11, 2003. The text of the final order is shown below.

Order on the content of trans fatty acids in oils and fats etc.

The following is laid down pursuant to Section 13, Section 55, subsection 2 and Section 78 subsection 3 of Act No 471 of 1 July 1998 on foodstuffs etc. (Foodstuffs Act):

Chapter 1 · Scope

Section 1. *This Order applies to oils and fats, including emulsions with fat as the continuous phase which, either alone or as part of processed foodstuffs, are intended, or are likely, to be consumed by humans.*

Subsection 2. *The Order does not apply to the naturally occurring content of trans fatty acids in animal fats or products governed under other legislation.*

Subsection 3. *The Order only applies to products sold to the final consumer.*

Section 2. *It is prohibited to sell the oils and fats covered by the Order to consumers if they contain a higher level of the trans fatty acids defined in the Annex than that stated in Section 3.*

Section 3. *As from 1 June 2003, the content of trans fatty acids in the oils and fats covered by this Order must not exceed 2 grams per 100 grams of oil or fat, cf. however subsection 2.*

Subsection 2. *From 1 June 2003 until 31 December 2003 the oils and fats covered by this Order and included in processed foodstuffs which also contain ingredients other than oils*

and fats and which are produced by the foodstuffs industry, in retail outlets, catering establishments, restaurants, institutions, bakeries etc. may, however, contain up to 5 grams of trans fatty acids per 100 grams of oil or fat.

Section 4. *In products which are claimed to be "free from trans fatty acids", the content of trans fatty acids in the finished product shall be less than 1 gram per 100 grams of the individual oil or fat.*

Chapter 2 · Penalty provisions etc.

Section 5. *A fine shall be imposed on anyone who contravenes Section 2 or Section 4 of this Order.*

Subsection 2. *The penalty may increase to imprisonment for up to two years if the contravention was committed wilfully or through gross negligence, and the contravention*

1) caused damage to health or led to the risk thereof, or

2) resulted in, or was intended to result in, financial gain for the perpetrator themselves or for others, including as a result of savings made.

Subsection 3. *Criminal liability may be incurred by companies etc. (legal entities) in accordance with the rules of Chapter 5 of the Penal Code.*

Section 6. *This Order shall enter into force on 31 March 2003.*

Subsection 2. *Products manufactured before this Order has entered into force, as well as products manufactured within the periods stated in Section 3(2), may be sold until expiry of the best before date.*

Definition of trans fatty acids

For the purposes of this Order, trans fatty acids are defined as the sum of all fatty acid isomers with 14, 16, 18, 20 or 22 carbon atoms and one or more trans double bonds, i.e. C14:1, C16:1, C18:1, C18:2, C18:3, C20:1, C20:2, C22:1, C22:2 fatty acid trans isomers, but only polyunsaturated fatty acids with methylene interrupted double bonds.

Figure 12 illustrates how the phasing-out of industrially produced *trans* fatty acids has been gradually advanced in the various draft Orders and how the phasing out takes place in the final Order.

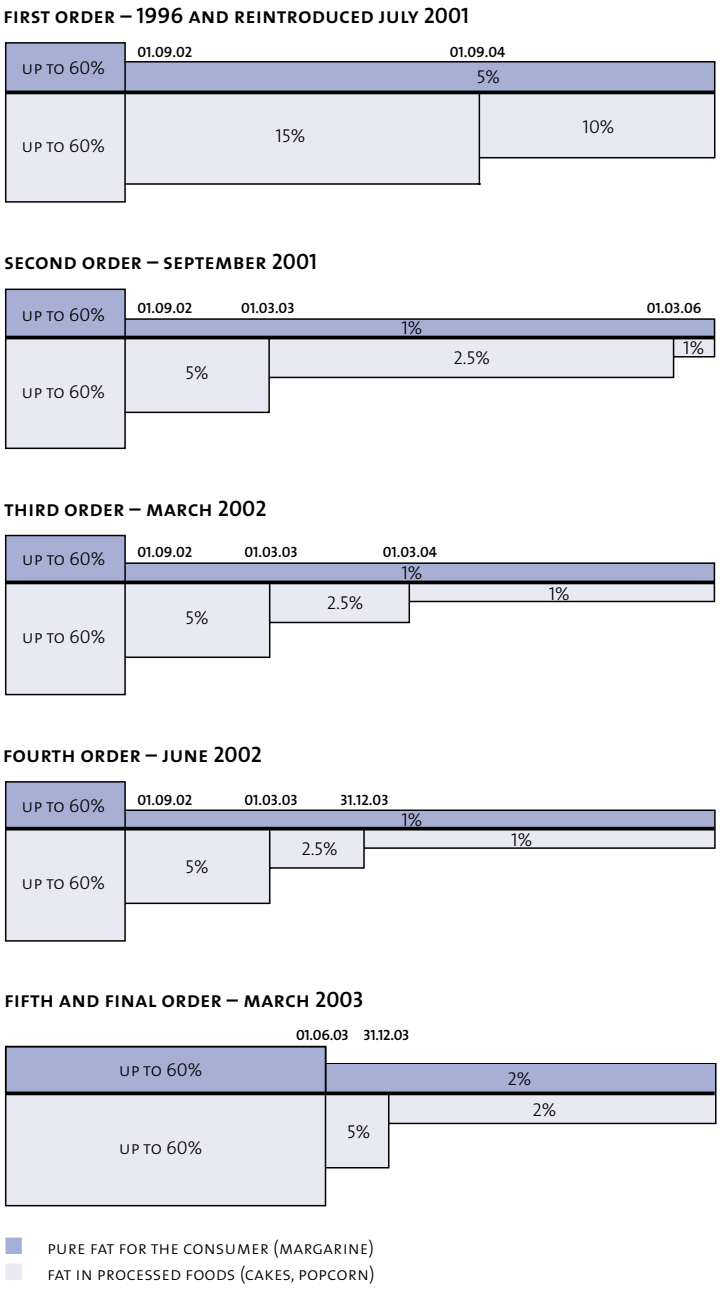

Figure 12
Phasing-out of industrially produced *trans* fatty acids in accordance with draft Orders and final Order.

3.2 Canada and the US

January 1, 2003 Canada as the first country in the world introduced a labelling of the content of *trans* fatty acids (77). July 11, 2003 the Food and Drug Administration (FDA) in USA published its regulations on nutrition labelling. These require that *trans* fatty acids be declared in the nutrition label of conventional foods and dietary supplements on a separate line immediately under the line of the declaration of saturated fatty acids, to be effective by January 1, 2006 (78). FDA has decided not to distinguish between industrially produced *trans* fatty acids and *trans* fatty acids of ruminant origin. Consequently dairy products will be labelled with content of *trans* fatty acids.

The FDA has stated that, with the new labelling rules, it hopes to help give the population a way of following the recommendations from the report issued by the Institute of Medicine (34) on reducing the intake of *trans* fatty acids as much as possible.

The American position is that the population is entitled to information on the conditions to which it is exposed, including the composition of food. A cautious approach is, on the other hand, adopted on restrictive intervention by the authorities. The Danish position is the opposite, namely that the authorities should, via statutory instruments, ensure for example the safety of food at the production stage so that the safety of the chosen diet is not based on the individual consumer's ability to interpret any information on the content of the food that may be difficult to understand.

4:

Conclusion

4.1 *Trans* fatty acids and disease

The Danish Nutrition Council has, in the light of the scientific studies that have appeared since the publication of the report on the influence of *trans* fatty acids on health in 1994, assessed the health significance of *trans* fatty acid levels in the diet of the Danish population.

The adverse effect of a high intake of industrially produced *trans* fatty acids on the development of heart disease has been further documented in the intervening period. Gram for gram, industrially produced *trans* fatty acids appear to have an adverse effect on the development of heart disease that is more than 10 times greater than that of saturated fat.

So far as the effect of *trans* fatty acid intake early in life is concerned, a justified suspicion of an adverse influence has been further confirmed.

In relation to the effect of *trans* fatty acid intake on the development of cancer, no overall data yet exists that allows conclusions to be drawn concerning an effect on the development of this disease.

Data has been obtained that justifies further research on the relation between allergic disorders and the dietary intake of *trans* fatty acids.

More recent studies have led to a justified suspicion that *trans* fatty acids increase the risk of the development of type 2 diabetes.

There is therefore, all in all, a justified suspicion that *trans* fatty acids exert an adverse influence on health, and there is nothing to indicate that ceasing the use of industrially produced *trans* fatty acids in food would have negative consequences for health, and it is also the

Danish Nutrition Council's view that this would not impair the quality of food either.

There is very little data on the influence of *trans* fatty acids from ruminants on the aspects referred to above. The available data indicates, however, that *trans* fatty acids from ruminants, particularly so far as the risk of heart disease is concerned, do not have the same adverse effect as industrially produced *trans* fatty acids.

4.2 Intake of *trans* fatty acids in Denmark

Studies show that the average daily intake of *trans* fatty acids in Denmark has fallen since 1994 and was in 1996 less than 3 grams per person, of which about half originated from industrially produced, partially hydrogenated fat. The intake of industrially produced *trans* fatty acids seems still to be falling. Nevertheless, population groups with dietary choices differing from the statistical average may very probably often be consuming significant amounts of industrially produced *trans* fatty acids.

The data collected on *trans* fatty acid levels in various products demonstrates that producers can incorporate considerable levels of industrially produced *trans* fatty acids in these products without this being apparent from the list of ingredients. A number of products containing partially hydrogenated fat produced abroad may contain levels of *trans* fatty acid far in excess of the amounts present in fats produced in Denmark.

5:

Recommendations

In the light of the Danish Nutrition Council's reports on *trans* fatty acids from 1994, 2001, 2003, and the present update, the Danish Nutrition Council recommends the following:

1. That industrially produced *trans* fatty acids should not be used in food.

2. That the use of industrially produced *trans* fatty acids in food should be phased out as soon as possible.

6:

Glossary

Association	Coincidence (statistical).
Atopic disorders	Skin disorders probably due to hypersensitivity.
Biopsy	Sample of tissue removed.
***Cis* fatty acids**	The natural way in which double bonds exist in the carbon chains of unsaturated fatty acids.
CLA	Conjugated linolic acid. *Trans* fatty acids of differing chemical configuration, containing a *trans* and a *cis* bond. These two bonds are only separated by a carbon atom (conjugated).
Confidence interval	A calculated range of certainty for an average in which the true average will lie with 95% certainty.
Hydrogenated fat	Unsaturated fat (oil) technically converted to a (partially) saturated product.
Intervention studies	Studies in which lots are drawn among the trial subjects to determine who is to have one type of treatment, for example a particular diet, and who is to have the other. In this way, it is ensured in major studies that the intervention (the diet) is the only difference between the two groups. The amenability to generalisation of an effect found in an intervention study presupposes that the effect is independent of the restrictions applied in the selection of the trial subjects.
LDL	Low Density Lipoprotein. Carries what is known as bad cholesterol. The lowering of LDL in the blood means, all other things being equal, a reduction in the incidence of arteriosclerosis.

Lipids	Fats.
Lipoproteins	Fat-carrying particles in the blood (LDL, VLDL, HDL and Lp(a)), which each contain cholesterol, phospholipid, triglyceride and protein.
Lp(a) *(pronounced Lp little a)*	A special group of LDL particles that possibly promotes arteriosclerosis.
Mechanism studies	Studies in test tubes, on cells or in animals concerning the physiological and/or biochemical processes that may give rise to the effects observed in the observational studies and in the intervention studies.
Observational studies	In *follow-up studies*, the starting point adopted is the exposure status, for example in the exposure to a given dietary component and disease or disease experience in the groups that have been more or less exposed to the component in question. In *case control studies*, the starting point adopted is a group of patients whose exposure situation, for example to a dietary component, is compared with the exposure situation in a random sample from the underlying population from which the patients are drawn. In *observational studies*, both in *follow-up studies* and in *case control studies*, there is a possibility that the groups that have themselves chosen a particular exposure, for example a specific diet, also differ in areas other than diet that are equally or more significant.
***Trans* fatty acids**	Usually polyunsaturated fatty acids which, during the hydrogenation of oils, have received double bonds in an "unnatural" position. Hydrogenation takes place by technical means, but also to a certain extent in the rumen of ruminants.
VLDL	Very Low Density Lipoprotein. Promotes arteriosclerosis.

7:

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Appendix 1

Information and analytical results relating to levels of industrially produced *trans* fatty acids in selected products in which partially hydrogenated fats are listed in the list of ingredients.

PRODUCT	LEVEL OF PARTIALLY HYDROGENATED FAT GRAMS PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACID (*TRANS* 18:1, ELAIDIC ACID) IN THE PRODUCT GRAMS PER 100 GRAMS OF PRODUCT	MANUFACTURER OF PARTIALLY HYDROGENATED FAT		ANALYTICAL RESULTS GRAMS OF *TRANS* FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTALLY FATTY ACID	
			DANISH	FOREIGN		*TRANS* 18:1	*TRANS* 18:2
Assorted wafers	31.6	16.4		x	17.9	55.2	1.3
First-class assorted wafers 300g	31.6	16.4		x			
Desiree assorted wafers 400g	31.6	16.2		x			
Mini chocolate biscuits	18.1	10.0					
Croutons chilli	No information				7.4	48.0	1.5
Cheese crispies	9% per crispy	5% per crispy		x	6.8	19.4	0.8
Princess Biscuits + Wafers 400g	7.4	3.8		x			
Crispbread sandwich	No information		x		3.1	10.2	0.2
Savoury party pastries	12.1	3.3	x		2.8	10.3	0.3
Vanilla wafers	29.0	2.7	x	x			
Magic lemon wafers	29.0	2.7	x	x			
Assorted wafers	26.8	2.5	x	x			
French wafers	11.8	2.7	x		2.4	8.2	0.3
Assorted wafers	27.0	2.4	x	x			
Rich chocolate cookies	No information				2.3	10.0	0.5
Danish pastry	No information				2.2	8.4	0.3
Chocolate caramels	4.4	< 2.2	x				
Cakes with rum flavour	No information				2.0	11.7	0.3
Coconut and currant biscuits	26.8	0.5	x		1.9	6.1	0.1

PRODUCT	LEVEL OF PARTIALLY HYDROGENATED FAT GRAMS PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACID (*TRANS* 18:1, ELAIDIC ACID) IN THE PRODUCT GRAMS PER 100 GRAMS OF PRODUCT	MANUFACTURER OF PARTIALLY HYDROGENATED FAT		ANALYTICAL RESULTS GRAMS OF *TRANS* FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTALLY FATTY ACID	
			DANISH	FOREIGN		*TRANS* 18:1	*TRANS* 18:2
Puff pastry ribbons	0.3	0.1		x	1.8	6.6	0.5
Giant chocolate-covered cream turtles	3.5	< 1.8	x				
Cocoa swiss roll	16.6	1.6		x			
Cocoa swiss roll with cream	15.4	1.6		x			
Vanilla/Lemon wafers	21.1	1.5	x	x			
Nut cream	No information				1.5	4.5	0.1
Marzipan cake	16.0	1.5	x	x	1.5	7.0	0.3
Tiger swiss roll with cream	14.8	1.5		x			
Marzipan cake	15.9	1.5	x	x			
Marzipan cake	15.9	1.5	x	x			
Chocolate bar	7.7	< 1.7	x		1.5	8.0	0.0
Oatmeal biscuits	24.7	0.5	x		1.4	7.2	0.3
Apple pie	8.9	0.2	x		1.4	7.2	0.3
Chocolate swiss roll	16.7	1.3	x	x			
Pleskner (biscuits)	33.5	0.6	x		1.3	4.5	0.2
Brown cookies	17.0	1.3	x				
Biscuit assortment	16.0	1.2	x				
Festival Creams Chocolate	19.4	1.2	x	x			

continued...

PRODUCT	LEVEL OF PARTIALLY HYDROGENATED FAT GRAMS PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACID (*TRANS* 18:1, ELAIDIC ACID) IN THE PRODUCT GRAMS PER 100 GRAMS OF PRODUCT	MANUFACTURER OF PARTIALLY HYDROGENATED FAT		ANALYTICAL RESULTS GRAMS OF *TRANS* FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTALLY FATTY ACID	
			DANISH	FOREIGN		*TRANS* 18:1	*TRANS* 18:2
Mini Cookies Chocolate Chip	20.4	1.1	x	x			
Mini Cookies Chocolate Chip	21.4	1.1	x	x			
Danish Cookies	23.3	1.1	x	x			
Chocolate nut caramel	No information				1.1	4.6	0.0
Weekend chocolate cake	10.2	1.0	x	x			
Weekend sponge cake	10.4	1.0	x	x			
Lemon swiss roll with sifted icing sugar	9.1	0.9		x			
Romkugler (small, round rum-flavoured cakes) – clear foil	9.8	1.0	x	x			
Strawberry swiss roll with cream	9.0	0.9		x			
Bilberry swiss roll with cream	8.8	0.9		x			
Mega Cookies Chocolate Chip	16.6	0.9	x	x			
Mega Cookies Chocolate Hazelnuts	17.0	0.9	x	x			
Wholemeal biscuits	17.9	0.9	x	x			
Raspberry swiss roll with cream	8.8	0.9		x			
Tiger swiss roll	13.0	1.3		x	0.9	4.2	0.5
Raspberry swiss roll with cream	8.9	0.9	x	x			
Bilberry swiss roll with cream	8.9	0.9	x	x			

PRODUCT	LEVEL OF PARTIALLY HYDROGENATED FAT GRAMS PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACID (*TRANS* 18:1, ELAIDIC ACID) IN THE PRODUCT GRAMS PER 100 GRAMS OF PRODUCT	MANUFACTURER OF PARTIALLY HYDROGENATED FAT		ANALYTICAL RESULTS GRAMS OF *TRANS* FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTALLY FATTY ACID	
			DANISH	FOREIGN		*TRANS* 18:1	*TRANS* 18:2
Digestives	17.4	0.8	x	x			
Marzipan cake	15.6	1.5	x	x	0.8	3.5	0.2
Tiger swiss roll with cocoa cream	12.3	1.2		x	0.7	4.1	0.4
Wholemeal vegetable biscuits	15.1	0.7	x	x			
Cheese biscuits	14.9	0.7	x	x			
Cream Crackers	14.0	0.7	x	x			
Marzipan swiss roll	6.8	0.7	x	x			
Marzipan swiss roll	6.6	0.6	x	x			
Marzipan swiss roll	6.6	0.6	x	x			
Strawberry swiss roll with cream	6.5	0.6	x	x			
Coconut rings (no added sugar)	15.0	0.6	x				
Small Christmas cookies (no added sugar)	14.0	0.6	x				
Vanilla rings (no added sugar)	15.0	0.6	x				
Vanilla biscuits	12.5	0.6	x	x			
Rye biscuits	13.0	0.6	x	x			
Wholemeal biscuits	11.8	0.6	x	x			
Cereal biscuits	14.0	0.6	x	x			
Chocolate-covered vanilla biscuits	12.7	0.6	x	x			

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PRODUCT	LEVEL OF PARTIALLY HYDROGENATED FAT GRAMS PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACID (*TRANS* 18:1, ELAIDIC ACID) IN THE PRODUCT GRAMS PER 100 GRAMS OF PRODUCT	MANUFACTURER OF PARTIALLY HYDROGENATED FAT		ANALYTICAL RESULTS GRAMS OF *TRANS* FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTALLY FATTY ACID	
			DANISH	FOREIGN		*TRANS* 18:1	*TRANS* 18:2
Rich Tea Fingers	13.5	0.6	x	x			
Romkugler (small, round rum-flavoured cakes) - 9 pieces	9.8	1.0	x	x	0.6	4.7	0.0
Biscuits	10.6	0.5	x	x			
Roxy apricot swiss roll	No information				0.5	4.2	0.5
Marzipan cake	26.6	0.5	x				
Small rusks (no added sugar)	13.0	0.5	x				
Deluxe cream Christmas crullers	14.5	0.5	x		0.4	1.8	0.1
Treacle sponge layers for layer cake	4.0	0.4		x			
Deluxe lemon cake	5.1	0.4	x	x			
Deluxe marble cake	5.1	0.4	x	x			
Hazelnut sponge cake		0.3		x			
Rum-flavoured cake	9.0	< 0.2	x		0.2	1.3	0.0
Deluxe chocolate cake	5.1	0.3	x	x			
Deluxe strawberry cake	5.2	0.3	x	x			
Deluxe kiwi cake	5.2	0.3	x	x			
Deluxe chocolate orange cake	5.2	0.3	x	x			
Chocolate cake	17.3	0.3	x	x			
Swiss roll with cream and fruit	15.0	0.3	x				

PRODUCT	LEVEL OF PARTIALLY HYDROGENATED FAT GRAMS PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACID (*TRANS* 18:1, ELAIDIC ACID) IN THE PRODUCT GRAMS PER 100 GRAMS OF PRODUCT	MANUFACTURER OF PARTIALLY HYDROGENATED FAT		ANALYTICAL RESULTS GRAMS OF *TRANS* FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTALLY FATTY ACID	
			DANISH	FOREIGN		*TRANS* 18:1	*TRANS* 18:2
Marble cake without nuts		0.3		x			
Marble moon (moon-shaped marble cake)		0.3		x			
Pound cake cocoa		0.3		x			
Marble pound cake		0.3		x			
Cocoa pound cake		0.3		x			
Orange pound cake		0.3		x			
Sponge cake with crisp caramel		0.3		x			
Strawberry cake		0.3		x			
Apple pie		0.3		x			
Mini lemon half moon		0.3		x			
Vanilla pound cake		0.3		x			
Spicy sponge cake		0.3		x			
Chocolate moon		0.3		x			
Family sponge cake		0.3		x			
Mini chocolate half moon		0.2		x			
Mini orange half moon		0.2		x			
Nut biscuits	No information				0.2	0.9	0.2
Vanilla creams	2.8	0.0		x	0.2	0.6	0.2

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PRODUCT	LEVEL OF PARTIALLY HYDROGENATED FAT GRAMS PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACID (*TRANS* 18:1, ELAIDIC ACID) IN THE PRODUCT GRAMS PER 100 GRAMS OF PRODUCT	MANUFACTURER OF PARTIALLY HYDROGENATED FAT		ANALYTICAL RESULTS GRAMS OF *TRANS* FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTALLY FATTY ACID	
			DANISH	FOREIGN		*TRANS* 18:1	*TRANS* 18:2
Chocolate flakes	13.2	0.3	x		0.1	0.3	0.0
Small Christmas cookies	5.8	< 0.2	x		0.1	0.2	0.3
Choco orange	No information				0.1	0.2	0.1
Vanilla wafers	< 1		x		0.1	0.5	0.0
Fibre crusts	6.0	0.1	x	x			
Raspberry swiss roll without cream	0.9	0.1	x	x			
Raspberry swiss roll with cream	0.9	0.1		x			
Apricot swiss roll without cream	0.9	0.0	x	x			
Honey slices	9.6	0.0	x		0.0	0.0	0.0
Coconut tops	21.2	0.0	x		0.0	0.0	0.0
Strawberry marzipan cake	No information				0.0	0.3	0.0
Konditorkræs (confectioner's titbits)	No information				0.0	0.0	0.0
Small marzipan cakes	No information				0.0	0.0	0.0
Oatmeal crunchies	No information				0.0	0.0	0.0
Raspberry rings	1.6	Not listed	x				
Raspberry cakes	1.1	Not listed	x				
Coconut rings	1.6	Not listed	x				
"Napoleon's hats" (triangular cakes with marzipan filling)	0.4	Not listed	x				

PRODUCT	LEVEL OF PARTIALLY HYDROGENATED FAT GRAMS PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACID (*TRANS* 18:1, ELAIDIC ACID) IN THE PRODUCT GRAMS PER 100 GRAMS OF PRODUCT	MANUFACTURER OF PARTIALLY HYDROGENATED FAT		ANALYTICAL RESULTS GRAMS OF *TRANS* FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTALLY FATTY ACID	
			DANISH	FOREIGN		*TRANS* 18:1	*TRANS* 18:2
Nougat flakes	1.2	Not listed	x				
Orange flakes	1.2	Not listed	x				
Orange flakes with stripes	1.3	Not listed	x				
Peanut biscuits	1.1	Not listed	x				
Vanilla dream biscuits	1.6	Not listed	x				
Vanilla rings	1.9	Not listed	x				
Oatmeal biscuits	1.1	Not listed	x				
Apple pie	1.5	Not listed	x				
Vanilla wafers		< 1%		x			
Large liquorice sticks (Graffiti)	2.3	< 0.1	x				
Black Prince (liquorice)	1.3	< 0.1	x				
Chocofant (liquorice)	0.5	0.0	x				
Marzipan eggs	0.1	0.0	x				

Appendix 2

Analytical results relating to levels of industrially produced *trans* fatty acids in selected products in respect of which partially hydrogenated fats are *not* listed in the list of ingredients.

PRODUCT	TYPE OF FAT ACCORDING TO LABELLING	FAT CONTENT GRAMS PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS GRAMS OF FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTAL FATTY ACID	
				TRANS 18:1	*TRANS* 18:2
Instant soup, asparagus	Vegetable fat and oil	14.00	2.88	19.9	0.7
Cake slice with strawberry filling	Vegetable fat	16.40	2.64	15.9	0.2
Large roll	No packaging (therefore no information)	38.20	2.59	6.7	0.1
Dry mix for buns	Vegetable fat	7.80	2.43	29.5	1.7
Vanilla rings (no added sugar)	Vegetable margarine, rape-seed oil	24.50	1.64	6.5	0.1
Puff pastry rolls	Vegetable margarine	23.00	0.88	3.7	0.1
Cinnamon rolls	Vegetable margarine	13.80	0.8	5.6	0.2
Croissant	No packaging (therefore no information)	27.00	0.79	2.7	0.2
Crispbread, Runda Sesam	Vegetable fat	11.00	0.47	3.8	0.5
Praline	Vegetable fat	18.00	0.23	1.3	0.0
Seed buns	Vegetable fats	6.0	0.19	3.1	0.1
Organic chocolate biscuits	Organic vegetable oil	41.70	0.16	0.1	0.3
Biscuits	Vegetable fat	29.80	0.14	0.0	0.5
Confectionery	Vegetable fat	45.90	0.12	0.0	0.3
Light potato salad	Crème fraîche, vegetable oil	13.00	0.12	0.7	0.3
Organic rusks	Organic vegetable fats (vegetable oil)	23.50	0.11	0.0	0.5
My choice Havrekex (oatmeal biscuits)	Vegetable oil	24.80	0.1	0.1	0.3
Hazelnut slice	Vegetable fat	29.20	0.09	0.3	0.0

PRODUCT	TYPE OF FAT ACCORDING TO LABELLING	FAT CONTENT GRAMS PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS GRAMS OF FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTAL FATTY ACID	
				TRANS 18:1	*TRANS* 18:2
Chocolate muffins	Vegetable fat	22.00	0.09	0.0	0.4
Prawn salad	Vegetable oil	38.00	0.07	0.0	0.2
Delicatessen remoulade sauce	Vegetable oil	46.00	0.05	0.0	0.1
Chicken salad	Vegetable oil, crème fraîche	33.20	0.04	0.0	0.1
French hot dog dressing	Vegetable oil	28.00	0.03	0.0	0.1
Toasting buns	Vegetable fat (oil and hydrogenated fat)	7.00	0.03	0.1	0.3
Crispy M&M's	Cocoa butter, vegetable fat	Any fat content is so low that it cannot be measured	Any fat content is so low that it cannot be measured	0.0	0.0
Chocolates with marzipan and filling	Cocoa butter, vegetable fat, butterfat	37.6	Any fat content is so low that it cannot be measured	0.0	0.0
Bounty minis	Cocoa butter, monoglycerides and diglycerides of fatty acids, butterfat	33.20	Any fat content is so low that it cannot be measured	0.0	0.0

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PRODUCT	TYPE OF FAT ACCORDING TO LABELLING	FAT CONTENT GRAMS PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS GRAMS OF FATTY ACID PER 100 GRAMS OF PRODUCT	ANALYTICAL RESULTS % OF TOTAL FATTY ACID	
				TRANS 18:1	*TRANS* 18:2
Lemon muffins	Vegetable oil, vegetable fat, lemon oil	30.70	Any fat content is so low that it cannot be measured	0.0	0.0
Liquorice Allsorts	The surface treatment agent is vegetable oil	3.20	Any fat content is so low that it cannot be measured	0.0	0.0

Appendix 3

Analytical results relating to levels of industrially produced *trans* fatty acids in microwave popcorn.

PRODUCT	GRAMS OF FAT PER 100 GRAMS OF PRODUCT	LEVEL OF *TRANS* FATTY ACIDS IN THE PRODUCT GRAM PER 100 GRAMS OF PRODUCT	% OF TOTAL FATTY ACID	
			TRANS 18:1	*TRANS* 18:2
Mikro Pop	24.2	9.7	40	0
Mikro Pop	10.6	3.7	34	0.5
Microwave Popcorn	31.5	2.3	6.6	0.8
Popz Popcorn	27.3	1.9	6.2	0.7
Popz Popcorn, butter flavour	24.4	1.5	5.6	0.5
Mikro Pop	22	0.1	0	0.6
Mikro Pop	21.2	0.1	0	0.6
Micro Popcorn	26.9	0.1	0.3	0.1
Flying Popcorn	13.9	0.1	0	0.6
Organic Popcorn	22.2	0	0	0.3
Micro Pop	11.2	0	0	0.2

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