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Ranking the Relative Risk of Common Food Products Based on their Fat Composition, with Emphasis on Trans Fat, in Relation to Coronary Heart Disease in Women

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Abstract

Background: In the prospective Nurses' Health cohort study the relative risk of coronary heart disease (CHD) in women was studied in relation to the fat composition of the diet [1]. The numerical consequences of an increase in the relative risk of CHD by enhancing the fat intake at the expense of the of the carbohydrate intake, both at a 5% energy level of the total energy intake, were assessed. As a result the percentage increase or decrease of the relative risk (RR) of CHD in women was established for saturated, mono unsaturated, poly unsaturated, and trans unsaturated fat respectively.

Objective: To range groups of similar food products based on their fat composition in relation to the RR of CHD in women.

Methods: From the USDA National Nutrient Database for Standard Reference, Release 28 [2], per product group the RR_{tot} value of individual products was calculated based on their lipid composition. These calculations were performed for 100 gram of fat present in a product, either in the absence or presence of trans unsaturated fat.

Results: Based on the fat composition of groups of similar food products the total relative risk value (RR_{tot}) of these groups was calculated. This calculation was based on the amount of saturated fat (Satfat), mono-unsaturated fat (Mufat), poly-unsaturated fat (PUfat) and trans-fat (Transfat) present in 100 gram fat of each product. Each type of fat was multiplied with its own cofactor [1] and next summed to give RR_{tot}. The value of each cofactor represents the extent to which this cofactor contributes to the risk of the development of CHD in women. The result of this analysis was converted into a table where the food products are ranked according to increasing RR_{tot} values. Especially the contribution of Transfat to RR_{tot} was emphasized, with special attention to the similarities and differences between industrial and ruminant Transfat.

Conclusions: Obvious from this and many other studies is that industrial based Transfat is deleterious, especially in relation to the development of CHD. Plants do not contain Transfat only their processed products. Animals, with emphasis on ruminants produce their own transfat. Based on the most relevant information it is concluded that, though relatively low in amount (gram) Transfat from ruminants also is associated with biological markers indicative for the development of CHD.

Keywords: *Relative Risk; Coronary Heart Disease; Satfat; MUfat; PUfat; Trans-Unsaturated Fat*

Abbreviations

Satfat: Saturated Fat; MUfat: Mono-Unsaturated Fat; PUfat: Poly-Unsaturated Fat; Transfat: Trans Unsaturated Fat; CHD: Coronary Heart Disease; RR: Relative Risk; RRtot: The Sum of the RR Values of Satfat; Mufat: PUfat and Transfat Per 100 Gram Fat of an Individual Food Product; I-Transfat: Trans-Fat Derived from Industrial Hydrogenation Processes; R-Transfat: Trans- Fat Obtained by Bio-Hydrogenation by Ruminants

Introduction

In the initial, pioneering studies of Keys [1] and of Hegsted [4] the quantitative effects upon replacing carbohydrates by isoenergetic amounts of fat on the serum cholesterol of man were described. The fat composition was quantified in terms of the amount of saturated fat (Satfat), mono-unsaturated fat (MUfat) and poly-unsaturated fat (PUfat) present in a given diet, together with the energy percentage the fat contributed to the diet. The change in the serum cholesterol was stabilized within a four weeks period. In a meta-analysis of 60 controlled trials [5] this initial work was extended by including the HDL cholesterol in the analysis given the observation that a dietary based increase in the concentration of HDL cholesterol lowers the risk of CHD. In addition, the cholesterol enhancing effects caused by Transfat were also quantified. This type of approach has the advantage of obtaining results between changes in cholesterol levels caused by changes in the composition of the dietary fat within a limited time-span. In the long term, prospective "Nurses' Health Study" the quantitative relation between dietary intake of Satfat, MUfat, and PUfat as well of Transfat on the RR of CHD in women was researched [6] and quantified [1]. The results were quantified in terms of the estimated percentage change in the RR of CHD upon equi-energetic substitutions of carbohydrates by fat. Replacing 5 energy percent carbohydrates by either Satfat, MUfat or PUfat results in a 17% increase, and a 19% and 38% decrease in the RR of CHD respectively. Replacing two energy percent of carbohydrates for Transfat results in a 93% increase in the relative risk of CHD, emphasizing the noxious effect of this type of fat. With respect to Transfat this type of fat originates from two different sources, either from industrially hydrogenated plant or fish oils (I-Transfat) [7,8], or from ruminants (R-Transfat) [9]. R-Transfat is produced *in vivo* by the bio-hydrogenation of PUfat. Transfat present in men and non-ruminants such as pigs and poultry is assumed to be caused by the consumption of Transfat containing food products. With respect to Transfat it is obvious that the overall chemical composition of I-TF differs from R-TF [10]. Due to this difference in composition it is not clear if, and to what extent, the physiological effects as expressed by the relative risk of CHD of these two types of Transfat differ from each other. In 2015 the World Health Organisation published a policy brief concerning the elimination of I-TF in Europe [11]. In the same year the FDA in their "News Release" announced that partly hydrogenated oils present in processed food products are "not generally recognized as safe (GRAS)" for use in human food and that "Food manufactures have three years to remove these hydrogenated oils from products" [12]. Currently no systematic research has been performed to ascribe the RR of CHD in women to the fat composition of similar food products enabling the ranking of these food products regarding their RR of CHD in women. To be able to mutually compare the results all food products analyzed a prerequisite is that these products have to contain the same total amount of fat.

Material and Methods

The data of Hu [1], reporting the change in RR of CHD in women upon replacing 5 energy percent of carbohydrate by Satfat (+17%), MUfat (-19%) and PUfat (-38%) and 2 energy percent of carbohydrate by Transfat (+93%) were used. To equalize the difference in percentage for replacing carbohydrates by either regular or Transfat, this percentage was brought from 5% to 1%. The interpolated values for the RR values of Satfat, MUfat, PUfat and Transfat are +3.4%, -3.8%, -7.6% and +46.5% respectively, representing the numerical values of the cofactors. Each type of fat has to be multiplied with its own cofactor and summed to give RR_{tot}. The interpolation mentioned enables the mutual comparison of different food products containing the same amount of fat. The food products analyzed in this study originated from the SR 28 (2015) USDA Food Composition Database [2]. The SR 28 data file was truncated to the relevant information necessary for this study. Per individual food product, characterized by its own NDB number, the amount of total saturated, mono-unsaturated, polyunsaturated and trans fatty acids was divided by 0.96 [13] resulting in the correspond amounts of Satfat, MUfat, PUfat and Transfat. Summing these amounts of Satfat, MUfat, PUfat and Transfat results in the calculated total amount of fat. This latter amount should formally be equal to the reported total amount of lipid of à given product. To compensate for the small differences observed between the calculated and reported total amount of lipid [2], per product the amount of Satfat, MUfat, PUfat and Transfat was multiplied with the total published total amount of fat [2] and divided by the total calculated amount of fat. Next, per food product the total amount of fat was set at 100 gram and the amounts of Satfat, MUfat, PUfat and Transfat were recalculated by multiplying their respective values with 100 and divided by the total amount of fat; per product, the total amount of Satfat, MUfat, PUfat and Transfat equals 100 gram. Per product these calculated values of Satfat, MUfat, PUfat and Transfat were multiplied with their corresponding RR values (the cofactors) of +3.4%, -3.8%, -7.6% and +46.5% respectively, and summed. This summation results in the numerical value the "total" RR of CHD, RR_{tot}, of that product. In addition an identical calculation was performed per product using a RR value of 0% for Transfat. In this case and in the situation that a sample either does not contain Transfat, or Transfat is not determined, Transfat does not contribute to the RR_{tot} value. The SR 28 file consists of 25 different product groups. Per product group similar products were grouped applying the following selection criteria to accept a sample from the SR 28 data file for further analysis. These criteria are:

- A given sample has to contain numerical information, excluding zero, regarding the total amount of saturated, mono, and poly unsaturated fatty acids and the total lipid content.
- The sample should contain at least 1 gram fat per 100 gram product to avoid the impact of less relevant samples on the average RR_{tot} value.
- Similar samples should be present in at least threefold to allow a reliable determination of the RR_{tot} value and its SD (Standard Deviation) value.
- Products containing the name of either its producer, its retail organization, or (fast food) restaurant (chains) were excluded.
- For informative reasons, some of the most frequently consumed products falling under this latter constraint were elaborated.

In case the RR of Transfat was set at 0%, only those samples were excluded that did not contain numerical information with regard to saturated, mono, and poly-unsaturated fatty acids and total lipid. In this case the RR_{tot} refers to Satfat, MUfat and PUfat. Per product group analyzed the total number of samples is given, together with the number of samples excluded based on the selection criteria mentioned above. On basis of these criteria the following product groups were excluded from analysis: Product groups 200 (Spices and Herbs), 300 (Baby Foods), 600 (Soups, Sauces and Gravies), 700 (Sausages and Luncheon Meats), 800 (Breakfast Cereals), 1400 (Beverages), 1900 (Sweets), 2100 (Fast Foods), 2200 (Meals, Entrees, and Side Dishes), 2500 (Snacks), 3500 (American Indian/Alaska Native Foods; partly), 3500 (Restaurant Foods). Per product group samples were identified with a similar (biological) origin and/or similar RR_{tot} value. In this way per product group subgroups were identified, of which its individual samples exhibit a similar RR_{tot} value. Samples belonging to a subgroup characterized by extreme RR_{tot} values were considered to be outliers. In all cases, within a product group, the subgroups are significantly different from each other ($P \leq 0.05$). To assess the daily intake of R-Transfat, the annual consumption of dairy products (butter, cheese, milk, yoghurt) and of beef products for Canada, Italy, France, The Netherlands and the USA consumed in 2015 were used. The average fat content for these products was determined based in the R-Transfat amount of the products mentioned above. The information concerning the consumption of butter, cheese (kg per year per capita) and milk (liter per year per capita) in Canada, France, Italy, The Netherlands and the USA were respectively [14-16]. The Canadian, Dutch, French, Italian, US beef consumption were respectively [17-21]. All data were from 2015, except for the beef consumption in Italy, this information was from 2017. For beef, in all cases, the retail weight was used.

Results

Data used

The SR28 data file consists of 8790 individual products integrated into 25 different product groups. Of those product groups the products of thirteen groups were used for analysis. For the analysis excluding Transfat the selected group contained 5189 samples, of which 1998 outliers. From the remaining 3191 samples another 111 were characterized as outlier. The remaining 3080 samples were used for analysis. For the group including Transfat the selected group contained 4086 samples, of which 2740 outliers. From the remaining 1346 samples another 44 were characterized as outlier. The remaining 1302 samples were used for analysis. In all cases outliers were selected based on the criteria mentioned in the Material and Method section.

Analysis of the data

The results of the analysis to cluster similar products per product group based on their weighted sum of the relative risks for CHD of Satfat, MUfat, PUfat and Transfat is presented in table 1. Here it has to been realized that each value of RR_{tot} is expressed per 100 gram fat present in each individual product and that the calculated values for the relative risk are dimensionless and can only be compared mutually. For this reason table 1 is split into two columns. In the right column of table 1 the results for RR_{tot} are described in the absence, and the left column of table 1 the results are described in the presence of Transfat. The major reason for this approach is that currently still an intensive debate is going on concerning the difference in the magnitude of the effect on the RR_{tot} of I-Transfat compared with R-Transfat (per gram Transfat). This debate focuses on the difference in the overall composition of I-Transfat compared with R-Transfat and the difference in effect of each component present in Transfat on the increase in risk of CHD. Some studies conclude the absence of an effect R-Transfat on the risk of CHD [22-24]. Here it has to be noted that two meta-analyses conclude that, despite the low amount of R-Transfat consumed, R-Transfat also enhances the risk of CHD [5,25]. Formally the value of the cofactor of R-Transfat is, in to contrast I-Transfat, not known. Given the CHD enhancing effect of R-Transfat [5,25] it is assumed here, that the value of the cofactor for R-Transfat is the same as for I-Transfat. For this reason in table 1 the column indicated with "Excluding Transfat" the products analyzed either did not contain Transfat, or the contribution of Transfat, both I, and R-transfat, was set at zero. In addition, realizing that Transfat strongly enhances the value of RR_{tot} the numerical effect of Transfat on the increase in RR_{tot} can be estimated by comparing the calculated values for RR_{tot} obtained, either in the absence or presence of Transfat. In table 1 for "Food Group 400; Fats and Oil" detailed information is just presented for oil (canola, flaxseed, soy, vegetable) and salad dressing, characterized by a low content of I-Transfat. It is however not possible to present the same type of information for "partly" and for "fully" hydrogenated products. The reason is that the range of the amount of I-Transfat is about ten times that of the oils mentioned in table 1. A linear regression analysis of these two product groups between the contribution of Transfat to the RRtot value of I-Transfat (gram) and the calculated value of RRtot results for the fully hydrogenated products into Eqn. 1;

$$RR_{tot} = 0.75*(\text{I-Transfat}) + 3.36 \; (R = 1.00) \; \text{(Equation 1)}$$

and for partly hydrogenated products into Equation 2;

$$RR_{tot} = 1.15*(\text{I-Transfat}) - 3.95 \; (R=0.99) \; \text{(Equation 2)}$$

[2]Including Transfat						[1]Excluding Transfat				
Product group and its products	[3]RR_{tot}/100g Fat		[6]R	[7]N	[8]Outlier	Product group and its products	RR_{tot}/100g Fat		N	Outlier
	[4]Average	[5]SD					Average	SD		
Food Group 100A; Dairy Products										
				221	187				221	85
						Human milk	-0.78	NR	1	0
Butter, cheese, (sour) cream, milk, yoghurt	2.52	0.22	0.86	34	3	Butter, cheese, (sour) cream, milk, whey, yoghurt	0.81	0.13	127	7
						Goat cheese, feta	1.39	0.02	4	0
						Dessert topping	2.78	0.25	4	0
Food Group100B; Egg Products										
				29	17				29	11
Eggs (chicken)	-1.72	0.23	0.83	12	2	Eggs (chicken)	-2.33	0,25	18	0
Food Group 400; Fats and Oils										
				189	115				189	9
Oil (canola, flaxseed, soy, vegetable), salad dressing	-4.63	0.35	0.16	20	0	Margarine-like spread, oil, salad dressing	-4.89	0.44	57	0
Partly hydrogenated margarine, industrial oil, shortening, vegetable oil (**see Equation 1**)				46	3	Fish oil, margarine 80% fat, margarine like spread, oil, shortening, vegetable oil spread	-3.47	0.48	73	0
						Animal and poultry fat, hydrogenated oil, shortening	-1.47	0.71	25	0
						Tropical oils	0.73	0.48	8	0
(Fully) hydrogenated coconut, palm kernel, soy oil (**see Equation. 2**)	3.99	0.67	1.0	8	2	(Fully) hydrogenated fish, coconut, palm kernel and soy oil	2.95	0.34	17	0
Food Group 500; Poultry Products										
				382	236				382	43
Chicken, Turkey	-2.04	0.28	0.42	146	2	Turkey	-2.70	0.34	105	0
						Chicken, pigeon, quail	-2,49	0.21	186	0
						Emu	-2.18	0.07	9	0
						Duck, goose, ostrich, pheasant	-1.69	0,43	39	0
Food Group 900; Fruits and Fruit Juices										
				356	356				356	350
						Avocado, olives	-3.13	0.09	6	0
Food Group 1000; Pork Products										
				336	132				336	31
Pork	-1.39	0.27	0.51	204	0	Pork	-1.67	0.26	305	0
Food Group; 1100 Vegetable and Vegetable Products										
									791	773
						Soybeans, corn, pigeon-peas	-4.70	0.28	18	0
Food Group; 1200 Nut and Seed Products										
				137	119				137	14
						Butter-,walnuts, safflower-, flax-,hempseeds, sunflower kernels	-5.77	0.35	18	0
Almonds, mixed nuts, pumpkin-, squash-, sunflower kernels, sunflower butter	-4.17	0.64	-0.84	18	0	Almonds, pistachio- ,pecan nuts, pumpkin kernels, sesame kernels/ butter	-4.32	0.18	41	0
						Acorn, brazil-,cashew-,ginkgo-,hazel-,macadamia-,chestnuts, cottonseed	-3.61	0.36	52	0
						Coconut meat, -milk, -oil	2.95	0.01	12	0
Food Group 1300 and 2300; Beef Products										
				967	370				967	63
Beef (New Zealand)	0.75	0.70	0.91	74	10	Beef (USA, Australia)	-0.81	0.21	859	19
Beef (Australia)	1.30	0.53	0.87	31	0	Beef (New Zealand)	-0.70	0.28	45	10
Beef (USA)	1.55	0.50	0.92	492	13					
Food Group 1500 and 3500; Finfish and Shellfish Products										
				294	263				294	80
Finfish	-2.57	0.47	0.64	25	0	Crustaceans	-4.05	0.70	15	0
Mollusks	-1.33	0,10	1.00	4	0	Mollusks	-2.97	0.93	18	0
						Finfish, eel	-3.20	0.50	166	2
						Butterfish, croaker, mullet, pompano, sea-trout, spot, tilapia	-1.62	0.59	15	3
Food Group 1600; Legumes and Legume Products										
				357	351				357	255
						French, kidney, navy, mung, mungo, soy beans, soy beans and their products	-4.98	0.48	45	0
Peanuts, peanut butter	-3.24	0.17	-0.40	6	0	Yel, broad, pinto, winged, pigeon, yardlong beans, cowpeas, tempeh, lentils, peanuts and their products	-3.70	0.56	57	0
Food Group 1700; Lamb, Veal and Game Products										
				464	333				464	61
Veal	1.16	0.56	0.99	27	0	Veal	-1.02	0.37	108	20
						Lamb, (USA)	-0.90	0.17	110	19
Lamb (Australia, New Zealand)	2.19	0.83	0.92	104	0	Lamb (Australia)	-0.47	0.26	77	0
						Lamb (New Zealand)	-0.27	0.37	108	8
Food Group 1800; Baked Products (exclusive cookies)										
				486	442				486	165
						Bagels, (English) muffins	-4.38	0.77	38	6
Bread, crackers, tortillas	-2.60	1.71	0.77	28	7	Bread, crackers, pancakes, rolls, taco, tortillas, waffles	-3.70	0.88	145	6
Cookies	-1.31	1,51	0.55	10	2	Cookies, cake, pie (crust)	-2.75	0.80	138	10
Cake	1.93	2.15	0.79	6	0					
Food Group 2000; Cereal Grains and Pasta										
				180	172				180	58
						Barley, corn, millet, pats, pasta, rye, sorghum	-4.44	0.47	101	1
Noodles	-2.37	0.97	0.79	8	0	Buckwheat, noodles, rice, spelt, teff, wheat	-3.27	0.50	21	0
Miscellaneous										
French fries (fast food)	-3.97	0.19	0.26	9	1	French fries (fast food)	-4.27	0.19	9	1
Chips (potato, tortilla)	-3.81	0.54	0.54	18	2	Chips (potato, tortilla, corn, rice)	-4.00	0.65	46	3
Chocolate	0.76	0.06	0.99	4	0	Chocolate, cocoa	0.59	0.05	9	0
Home style cookies	10.55	1.30	0.96	13	0	Home style cookies	-1.12	1.07	17	0

Table 1: *The calculated average Total Relative Risk of similar food products belonging to a food group per 100 gram fat present in the individual products, either in the absence or presence of transfat.*

[1]Excluding transfat; the amount of transfat is either zero, or set at zero and does not contribute to the value of RR_{tot}. [2]Including transfat; the contribution of transfat to RR_{tot} is taken into account, [3]RR_{tot}; total relative risk, [4]Average; average of the RR_{tot} values for a group of similar products, [5]SD; standard deviation, [6]R; correlation coefficient between the RR values of the transfat and of the RRtot of a group of similar products, [7]N; total amount of either products per food group, or product group, [8]Outlier; a sample not relevant for further analysis, based on the selection criteria such as mentioned in the Material and Methods section. Note, the data for all animal products mentioned in Table 1 are all exclusive organ meat.

For the fully hydrogenate products the value of RR_{tot} ranged between 3.5 and 5.0, for the partly hydrogenated products the value of RR_{tot} ranged between -3.9 and 12.6. The lower values of these two products are similar to the values of equations 1 and 2 in the absence of Transfat. Besides the Product Groups studied (see Material and methods) some frequently consumed products (French fries, chips, chocolate and home style cookies), were studies separately and mentioned in table 1 under the heading "Miscellaneous". In table 1 the products are arranged according to the food group they belong to (2). To obtain a clearer picture concerning the relation between food products and their RR_{tot} value this latter table was rearranged. The products falling within the same RR_{tot} range were clustered and arranged from their most positive to their most negative value for RR_{tot} (see Table 2). In contrast to (non-processed) plant based products, part of the animal products contain Transfat. For this reason table 2 was divided into two columns; one for plant based products and the other for animal based products. As mentioned above, it is not yet clear to what extent, I-Transfat and R-Transfat differ in their impact with respect to CHD in women. For this reason both columns were split into a column where the contribution of Transfat was either zero (no transfat present), or set at zero (transfat is assumed not to contribute to CHD) and a column for all products containing Transfat.

Animal based		**Range of RR_{tot}**	**Plant based**	
Maximum effect of Transfat	No effect of Transfat		Maximum effect of Transfat	No effect of Transfat
		$10 < RR_{tot} \leq 3.5$	Home style cookies Hydrogenated oil, -margarine and -shortening	
Butter, cheese, (sour) cream, milk, yoghurt.	Fully hydrogenated fish-oil. Dessert topping.	$2.5 < RR_{tot} \leq 3.5$	Hydrogenated, coconut, palm kernel, soy oil, and shortening	Fully hydrogenated coconut, palm kernel, industrial oil, nutmeg, ucuhuba butter. Coconut meat, -milk, -oil.
Beef (USA). Lamb (Australia, New Zealand).		$1.5 < RR_{tot} \leq 2,5$	Cake	
Beef (New Zealand, Australia) Veal.	Butter, cheese (cow, goat), (sour) cream, milk, yoghurt.	$0,5 < RR_{tot} \leq 1.5$	Chocolate	Tropical oils. Chocolate, cocoa (butter).
	Lamb (Australia, New Zealand)	$-0.5 < RR_{tot} \leq 0.5$	Margarine (48-80% fat), vegetable oil spread (37-60% fat)	Croissants
Pork. Mollusks.	Human milk Animal, poultry fat. Beef, veal, lamb (USA). Animal fat. Tilapia, mullet, croaker, pompano, pout, butterfish.	$-1.5 < RR_{tot} \leq - 0.5$	Bread, crackers, toaster, tortillas, taco shells, cookies	Shea nut oil, partly hydrogenated soy-oil, shortening. Home style cookies.
Eggs (chicken). Crustaceans. Chicken, turkey.	Eggs (chicken). Chicken, pigeon, quail, emu, duck, goose, ostrich, pheasant. Pork.	$-2.5 < RR_{tot} \leq -1.5$	Noodles	French fries (home prepared). Biscuit, bake, pastry, doughnuts.
Finfish	Fish oil, poultry fat. Turkey Finfish, eel, mollusks	$-3.5 < RR_{tot} \leq -2.5$	Peanuts, peanut butter Margarine-like spread, industrial canola, safflower oil.	Margarine 80% fat, margarine like spread, oil, shortening, vegetable oil, spread. Avocado, olives. Cookies, cake, pie (crust). Rice.
	Crustaceans	$-4.5 < RR_{tot} \leq -3.5$	Almonds, mixed nuts, pumpkin, squash, sunflower kernels, sunflower butter French fries (fast food) Chips (potato, tortilla)	Peanuts and products, lupines, yel, winged beans, cowpeas. Bread, crackers, muffin, pancakes, rolls, taco shells, tortillas. Noodles. Acorn, brazil, cashew, chest, ginkgo, hazel, macadamia nuts, breadfruit, cotton seeds. Cereals grains and Pasta. French fries (fast food), chips.
		$RR_{tot} \leq -4.5$	Oil (canola, flaxseed, soy, vegetable), salad dressing	Margarine-like spread, oil, salad dressing. Soybeans, sweet corn, pigeon-peas Almonds, beech, butter, hickory, pecan, pistachio, walnuts, pumpkin, flax-. sunflower seeds, sesame seeds and products. French, kidney, navy, mung, mungo, soy beans and their products. Barley, corn, millet, oat, rye, semolina, sorghum, spelt, wheat, quinoa, wild rice and their products (bulgur, couscous, pasta).

Table 2: *Ranking of plant and animal, or animal derived food products, either in the absence or presence of Transfat, based on their calculated Total Relative Risk value.*

Overall fat composition of meat and dairy products

In table 3 for meat and dairy products the average amount Satfat, Mufat, PUfat and Transfat is presented. Noticeable is the relatively high amount of Satfat and low amount of Mufat in dairy products as compared with especially the meat composition of beef. PUfat is relatively low in ruminants and their (dairy) products and relatively high in the non-ruminants, the reverse is observed for Transfat. For ruminants and their (dairy) products the average amount of Transfat is 4.6 ± 1.1%, for the non-ruminants the average amount of Transfat is 1.0 ± 0.4%.

Food Product	Fat (100g)			
	Satfat (g)	Mufat (g)	Polyfat (g)	Transfat (g)
Dairy products[1]	63.3 ± 1.5	28.2 ± 1.1	4.6 ± 0.6	3.9 ± 0.5
Beef, Australia	42.8 ± 4.0	48.4 ± 4.9	4.5 ± 1.9	4.3 ± 0.8
Beef, New Zealand	46.9 ± 4.6	45,3 ± 4.4	5.1 ± 1.7	2.7 ± 0.8
Beef, USA	41.2 ± 3.1	48.0 ± 3.4	5.6 ± 1.6	5.2 ± 1.1
Lamb, Australia	45.8 ± 2.5	40.5 ± 1.7	7.4 ± 1.9	6.2 ± 0.9
Lamb, New Zealand	50.3 ± 3.6	37.1 ± 2.8	7.4 ± 3.0	5.1 ± 1.3
Veal	40.7 ± 2.5	48.5 ± 4.0	6.3 ± 2.4	4.5 ± 0.7
Pork	36.4 ± 2.5	47.1 ± 3.3	15.7 ± 2.6	0.8 ± 0.3
Veal	40.7 ± 2.5	48.5 ± 4.0	6.3 ± 2.4	4.5 ± 0.7
Pork	36.4 ± 2.5	47.1 ± 3.3	15.7 ± 2.6	0.8 ± 0.3
Eggs	35.8 ± 1.7	43.2 ± 1.5	20.4 ± 0.7	0.6 ± 0.2
Chicken	30.9 ± 1.2	46.5 ± 3.1	21.8 ± 3.2	0.7 ± 0.3
Turkey	31.0 ± 0 .7	36.4 ± 2.3	31.2 ± 2.1	1.4 ± 0.2
Finfish	31.0 ± 0 .7	36.4 ± 2.3	31.2 ± 2.1	1.4 ± 0.2

Table 3: *Average overall fat composition per 100 g fat of meat from frequently consumed animals and some of their products.*

[1]Dairy products involved are butter, cheese, (sour) cream, milk, yoghurt.

An estimate of the intake per capita of R-Transfat in some "Western" countries

To estimate the intake per capita of the amount of R-Transfat, of some "Western" countries, information was gathered for the annual consumption of major dairy products (milk, cheese, butter) and beef and their average amount of fat [14-21]. From this information an estimation could be made (see Table 4) of the total amount of R-Transfat consumed per product and per country, and the total amount of T-transfat consumed per day per capita.

Country	Consumption of dairy products expresses per liter or kg per capita per annum				
	[1]Milk (g)	Cheese (kg)	Butter (kg)	[2]Beef (kg)	
USA	71.9	16.72	2.6	17.8	
Canada	70.6	13.06	2.8	24.5	
France	53.1	28.01	8	12.1	
Italy	49.4	22.47	2.4	21.1	
The Netherlands	47.0	19.02	3	10.5	
Estimated percentage fat of the products involved (gram fat/100 gram product)					
	2	25	80	20	
[3]Percentage transfat per 100 gram fat of the products involved					
	3.9	3.9	3.9	[4]4.1	
	Average amount if Transfat (g) per liter of kg product				
	0.071	1.05	3.78	0.55	
	Total amount of R-Transfat (g) consumed per capita per day per product				**R-Transfat (g) consumed per day**
USA	0.15	0.43	0.22	0.67	1.47
Canada	0.15	0.33	0.24	0.40	1.12
France	0.11	0.72	0.68	0.45	1.96
Italy	0.11	0.57	0.21	0.47	1.36
The Netherlands	0.10	0.49	0.26	0.24	1.08

Table 4: *Estimation of the total amount of R-Transfat consumed per capita per day for some western countries*

[1]One liter milk is assumed to weigh 1kg. [2]Retail weight. [3]Data used from Table 3. [4]Average value of the percentage Transfat for beef of the three countries mentioned. For the USA the value mentioned in Table 3 for the USA has been used.

An anomaly observed

Before starting the discussion section an anomaly has to be addressed. This anomaly concerns the "mean intake" of specific types of dietary fat. The percentage total fat intake amounted 38.1%. Per 100 gram fat the amounts of Satfat, Mufat, PUfat and Transfat are respectively 40.9, 42.0, 11.3 and 5.8 gram (2). These values are the baseline values. Applying the values of the cofactors used in throughout his study, the RR_{tot} of this "mean fat intake" amounts 1.62. Since this "mean overall fat intake" is the reference point (1) this latter value should be zero. To address this anomaly, it has to be realized that upon using 100 gram fat, the four types of fat are communicating vessels; enhancing on type of fat causes a decrease in the amount one, two, or three other types of fat. Using the observation that Mufat and PUfat are interchangeable (1), together with the information of the "mean fat intake" in this study is set at 100 gram, assuming a fixed ratio of Mufat over PUfat (42.0 gram/11.5 gram) and the requirement that the RR_{tot} value is set at zero, the amount of Satfat, PUfat and Transfat can be calculated for each amount of Mufat. Assuming that the amounts of Mufat and PUfat are identical to the amounts as mentioned (2) amounts of Mufat, PUfat and Transfat are respectively 44.5, 12.0 and 2.6 gram/100gram fat. Assuming that the amounts of Satfat is identical to the amount as mentioned (2) the amounts of Mufat, PUfat and Transfat are respectively 44.5, 12.0 and 2.6 gram/100gram fat. Assuming that the amounts of Transfat is identical to the amount as mentioned (2) the amounts of Satfat, Mufat and PUfat are respectively 20.6, 58.0 and 15.6 gram/100gram fat.

Discussion

A detailed study is presented here concerning the relative risk of common food products based on their fat composition, with emphasis on trans fat, in relation to coronary heart disease in women. Some research has been presented previously relating the type of fat, belonging to Food Group 400; Fats and Oils, to the predicted effects on serum lipids [31], or serum cholesterol [5]. The observed changes [5,31] from positive to negative values parallel the ranking from positive to negative values in this study. Regarding this study, for the analysis of different food products to calculate their corresponding RR_{tot} values the food products mentioned in the USDA National Nutrient Database for Standard Reference [2] were used. The comparison between the RR_{tot} values of (similar) food products (see Table 1) and the ranking of these food products based on their RR_{tot} values (see Table 2) was based on equal amounts of fat (100g) per product. This approach enables one to rank the health properties of the fat composition, with emphasis on the relative risk of CHD, of numerous products. Here it has to be realized that in this study the focus of the food products analyzed was on products originating from one singular agricultural product. In addition, special attention was paid to the impact of Transfat on the value of RR_{tot} with emphasis on either plant or animal based products. For these animal and plant based product groups, the most RR_{tot} enhancing fat is Transfat. For plant based products, especially the hydrogenated products, containing substantial amounts of I-Transfat exhibit a relative high positive RR_{tot} value. For animal based products the situation is more complex, since ruminants produce their own endogenous R-Transfat [9]; the overall chemical composition of I-Transfat differs from R-Transfat. The translation of this difference into a difference in magnitude of effect of I-Transfat versus R-Transfat on the RR is still matter of intense debate [22-26]. For this reason in this study the contribution of Transfat to RR_{tot} is either set at zero (Table 2 column "No effect of transfat"), or assuming the maximum effect of Transfat, irrespective whether one is dealing with either R or I-Transfat (Table 2 column "Maximum effect of Transfat"). The largest amount of Transfat is observed in partly hydrogenated products, up to 14.4 gram R-Transfat per 100 gram fat. In addition, the substantial amount of Transfat in "home style cookies" should be mentioned. In table 1 the correlation coefficient between the RR values of the amount of Transfat per 100 gram product and the RR_{tot} value of a group of similar products is given. High values for this correlation are mainly observed in products containing more than 1% of transfat. The following products have to be mentioned separately since they formally do not obey the selection criteria such as mentioned in the Material and Methods section. The first product is human milk (n = 1). This sample is mentioned as a kind of reference point. From literature it is, however, obvious that the transfat composition of the diet of lactating mothers, affects the transfat composition of their milk [26-28]. Furthermore it is shown that in Canada during the period from 1998 to 2005 the decrease in intake of Transfat by lactating mothers is accompanied by a decrease of Transfat in their milk [29]. In addition, under the heading "Miscellaneous" in table 2, some relevant, frequently consumed food products from industrial origin are mentioned. Their position on the ranking scheme can be found in table 2. For animal based products, irrespective of the absence or presence of Transfat, the product range with decreasing value of RR_{tot} is in both cases: dairy products, ruminant meat, pork, eggs, poultry, finfish. A comparison between the Transfat content of animal based products (see Table 3) clearly shows that average amount of Transfat present in ruminants is about four times that of non-ruminants. The presence of Transfat in finfish is surprising though, according to the data in the USDA National Nutrient Database for Standard Reference, Release 28 [2], this amount is low. This Transfat present in fish mainly appeared in processed fish. An interesting question to be addressed is if the health aspects, with emphasis on CHD, of I-Transfat differ from R-Transfat. The per capita consumed amount of R-transfat calculated for some Western countries ranges from 1.1 to 2.0 gram per day. These values are comparable with the values mentioned for Danish women (1.5 gram R-Transfat/day) and men (2.0 gram R-Transfat/day) [30] and other countries [31]. Assuming that women are consuming 1800 kcalories/day containing 35% fat than the total amount of fat consumed per day is 70 gram fat. This amount equals 2.1 gram R-Transfat which, using the value of the cofactor for Transfat, equals a Relative Risk factor of RR = 1.0. In the WHO review concerning a meta-regression analysis on Transfat [25] it is concluded that: "Replacement of TFA from any source by *cis*-PUfat improves relevant blood factors into a direction associated with reduced risk of CHD". In other words, if small amounts of R-Transfat already are associated with an increased risk in CHD, this signal cannot be ignored. For this reason, the value of the cofactor of R-Transfat was assumed to be the same as for I-Transfat. The consequence of this assumption is that, with respect to table 1, the column "Including transfat" is assumed to represent the real values for RR_{tot}. This assumption is also applicable for table 2, the column "Maximum effect of Transfat" for animal based products. The last problem that needs to be addressed is the anomaly described above (see chapter 6.6) concerning the difference between the calculated value of 1.65 for RR_{tot} and its expected value of zero. The most easy assumption is that the values for the cofactors used in this study are slightly deviant from their real values. Another assumption is the following. In this study the data of Hu., *et al.* [1] were used. These data were collected during a 14 years period. During this period the intake of fat (total fat, Satfat, Mufat, PUfat and Transfat) decreased as percentage of the total energy; the total fat intake decreased with about 25% [33]. This decrease in fat intake as percentage of the total energy intake is compensated by an increase in the intake of carbohydrates. This gradual change in both fat and carbohydrate fat intake could also cause this deviance.

Conflict of Interest

There is no financial or other form of conflict of interest.

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