Revista da
ASSOCIAÇÃO MÉDICA BRASILEIRA

www.ramb.org.br

Original article

The influence of food preparation methods on atherosclerosis prevention ☆

Carlos Scherr[a],*, Jorge Pinto Ribeiro[b]

[a]*Instituto do Coração e do Diabetes, Rio de Janeiro, RJ, Brazil*
[b]*Service of Cardiology, Hospital de Clínicas de Porto Alegre and Faculdade de Medicina, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil*

ARTICLE INFO

ABSTRACT

Objective: To analyze the influence of food preparation methods on the composition of fatty acids and cholesterol in foods.

Methods: The chemical composition of cholesterol and fatty acids was analyzed in eight different types of meat and feijoada[1] in relation to different methods of preparation.

Results: Feijoada, when prepared with the beans and meats in separate pots, has less cholesterol (12.1 *vs.* 16.1 mg, respectively, p = 0.005) and saturated fat (1.4 *vs.* 1.9 mg, p = 0.046) than when it is prepared in a single pot. Broiled chicken without the skin has less saturated fat when compared with skinless fried chicken (1,505 *vs.* 7,645 mg, p = 0.049). Broiled shrimp also has a lower saturated fat content than fried shrimp (532 *vs.* 1,262 mg, p = 0.049). Broiled ribeye steak without fat has a lower cholesterol content when compared with the fried steak (102 *vs.* 114 mg, p = 0.049).

Conclusion: The analysis indicates that the method of food preparation influences the fat content of foods, with potential impact on the prescription of low-fat and low-cholesterol diets.

© 2013 Elsevier Editora Ltda. All rights reserved.

1   *Feijoada* is the national Brazilian dish, which consists of a black bean stew with a variety of salted pork or beef products, such as pork trimmings (ears, tail, feet), bacon, smoked pork ribs, and at least two types of smoked sausage and jerked beef.

Influência do modo de preparo de alimentos na prevenção da aterosclerose

RESUMO

Objetivo: Analisar a influência do modo de preparo na composição de ácidos graxos e colesterol em alimentos.

Métodos: Foi analisada a composição química do colesterol e ácidos graxos de oito tipos diferentes de carnes e da feijoada, em relação a diferentes métodos de preparo.

Resultados: A feijoada preparada com as carnes em separado tem menos colesterol (12,1 e 16,1 mg, respectivamente; p = 0,005) e gordura saturada (1,4 e 1,9 mg; p = 0,046) do que quando preparada junto. O frango grelhado sem pele apresenta menor quantidade de gordura saturada

quando comparado com o frango frito sem pele (7645 e 1505 mg; p = 0,049). O camarão grelhado também apresenta menor conteúdo de gordura saturada quando comparado com o frito (532 e 1262 mg; p = 0,049). O contrafilé grelhado sem gordura apresenta menor conteúdo de colesterol quando comparado com o frito (102 e 114 mg; p = 0,049).

Conclusão: As análises aqui realizadas indicam que a forma de preparo influencia no teor de gordura dos alimentos, com potencial impacto na prescrição de dietas com baixo teor de gordura e colesterol.

Introduction

Mortality from coronary heart disease decreased approximately 50% in the United States between the years 1980 and 2000; 44% of this reduction was due to the control of some risk factors.[1] This represented a decrease of 150,000 deaths, and the reduction of only 6 mg/dL of serum total cholesterol was the most important action, responsible for 82,830 prevented or postponed deaths.[1] Although cardiovascular mortality remains high in Brazil, mortality due to coronary heart disease decreased by 26% between 1996 and 2007.[2]

However, studies in Brazilian metropolitan areas indicate that, between 1970 and the mid-2000s, there was a 400% increase in the purchase of processed foods, including foods with trans-fats, and the proportion of energy derived from fat in food purchases increased from 25.8% to 30.5%.[2,3] According to these trends of food purchase, the prevalence of obesity in adults increased from 11.4% to 13.9% between 2006 and 2009.[2] Therefore, it appears that the dietary habits of the Brazilian population are going against the efforts to reduce mortality from coronary artery disease.

Randomized clinical trials have shown that following a diet low in saturated fat lowers serum cholesterol levels as well as the incidence of cardiovascular events. The Oslo Diet-Heart Study, for instance, reported a lower incidence of events in patients who followed a diet low in saturated fat and cholesterol and high in polyunsaturated fat after a myocardial infarction.[4] Among the observational studies that have shown the benefits of the Mediterranean diet, the findings of the EPIC study are of note, which showed that low meat consumption is the second most important item, and the high monounsaturated/saturated ratio is the fifth most important item for cardiovascular protection.[5]

The fatty acid chain and cholesterol are influenced by the method of food preparation, and may increase the levels of the most saturated fatty acids, such as palmitic and myristic fatty acids, or may even allow for beneficial changes such as the increase of polyunsaturated omega 3 and 6 or monounsaturated acids such as the oleic acid.

Previous studies indicate that the cooking methods influence the chemical composition and the cholesterol content of meats.[6-8] Rosa et al.[9] compared the effects of cooking with water, oil, grill, conventional oven, and microwave oven in relation to fat content in chicken breast and thighs, showing that the methods of cooking without oil resulted in loss of fat, while frying lead to oil absorption; there was also a difference in fat absorption between the different cuts. Moreover, Monnier et al.[10] showed an association between the consumption of meat heated to high temperatures and the induction of chronic inflammation in diabetics. Total lipids increase proportionally to the heating time and to the internal temperature reached by the meat; there is an increase in saturated and monounsaturated fats, in addition to a decrease in polyunsaturated fat in relation to raw meat, and a decrease in the polyunsaturated/saturated ratio.

The cooking method used also has influence; broiling is better, followed by boiling, and finally cooking in the microwave.[10] The frying process leads to an increase in free fatty acids and to a decrease in unsaturated and essential fatty acids levels,[11] in addition to oxidation.[12-14]

Adherence to beneficial lifestyle habits has not been successful enough to achieve global recommendations for atherosclerosis prevention, especially regarding dietary habits.[2] This fact may be related to lack of knowledge on suitable alternatives for a good diet, as well as established beliefs without scientific basis. Therefore, in the present study, the influence of food preparation methods on the chemical composition of fats in some types of food was evaluated, aiming to find a foundation for nutritional guidelines that may help in atherosclerosis prevention.

Methods

Material

All foods analyses listed were performed in the laboratories of the Institute of Food Technology (Instituto de Tecnologia de Alimentos – ITAL) of the Secretariat of Agriculture and Supplies of the Government of the State of São Paulo, and funded by the National Institute of Metrology, Standardization, and Industrial Quality (Instituto Nacional de Metrologia, Normalização e Qualidade Industrial – INMETRO) of the Brazilian Ministry of Development, Industry, and Foreign Trade.

Three whole pieces of each kind of meat were purchased, and a sample was removed from each piece for each type of preparation, totaling three samples. Eachsample consisted of three sub-samples, and each sub-sample was taken from a different portion of the original cut, i.e., the beginning, middle, and end. This procedure was adopted in order to minimize problems regarding possible differences between muscle and fat portions, which could influence the final results of the analysis.

Sample preparation

The samples were prepared without any seasoning, so that it would not interfere with the analytical measurements. The beef cut used in this analysis was the ribeye steak. Samples with

and without fat were removed from the same piece of meat, with the difference that, in the sample without fat, all apparent fat was removed before preparation. Regarding the manner of meat preparation, the criteria used are described below.

Roasted meats were cooked by dry heat, placing the meat directly on a container without a lid or roasting pan. The meat was not greased and no water was added. Lower temperatures were used because they yield greater uniformity during the cooking process and lower fluid loss. The temperatures used during the test procedures were 125 ℃ and 165 ℃, considering the first one to be slightly superior. The most recommended approximate temperatures for cooking beef, pork, and poultry in a conventional oven are, respectively, 150 ℃, 175 ℃, and 173 ℃. To evaluate the doneness of the roast, an internal temperature no lower than 77 ℃ was considered.

For broiled meats, the cooking process was similar to that of roasted meats; however, the meat was placed in a baking sheet in the oven, but on a grid, preventing direct contact of the meat with the liquids that drip during cooking. For the cooked meat, a slow cooking process was used in a covered pan with the addition of water. The water was brought to boiling temperature (100 °C) and then the meat was placed in it. The meats were fried by immersing them in hot soy oil. The meat was cut into smaller pieces (strips or cubes). For all cooking procedures described, the meats were cooked until they were well done (above 87 ℃), a temperature that guarantees that the food is free from biological contamination and parasites.

Regarding the chicken breast, three samples for each type were used (with and without skin), which are sold by the kilogram and each sample consisted of approximately 50 grams for each type of treatment. Example: chicken breast with skin: four types of treatment (raw, fried, broiled, and roasted). In the case of chester, three samples were also used, and a piece was taken for each treatment. The samples were again prepared without any seasoning.

Regarding the fish (salmon and namorado sandperch), three fish of each type were used, and a sample was removed from each fish for each type of preparation, totaling three samples. Each sample consisted of three sub-samples ("fish filets") and each sub-sample was taken from a portion of the fish, the beginning, middle, and end. This procedure was adopted in order to minimize problems regarding possible differences between portions of muscle and fat, which could influence the final results of the analyses.

Regarding the feijoada, a total of six feijoada dishes were prepared, each by a different restaurant (cooked together or separate from with the meats) in two states, and two by the Food Science and Quality Center of ITAL, which prepared it in both versions. The ingredients were supplied to restaurants, and they, so as to contribute to the analysis, prepared the feijoada dishes with ingredients that had the same origin and following the request to cook the ingredients together or separately. It is noteworthy that no comparison was made between the feijoada dishes prepared by the restaurants, instead between the different forms of preparation (meats cooked together with the beans *versus* meats cooked separately). Each selected restaurant prepared a different recipe by including or excluding some ingredients, while the laboratory prepared a single recipe ("cooked with meats" and "cooked without meats"), according to the protocol.

Food analysis

Analyses of fatty acids and cholesterol were carried out in seven types of foods: beef ribeye, chicken, chester, pork shank, salmon, namorado sandperch, and feijoada. The entire fatty acids chain was analyzed, and for the purpose of comparison, myristic and palmitic acids were used as the standard for higher saturation; oleic acid was representative of monounsaturated; and omega 3 and 6 represented the polyunsaturated essential fatty acids, which are not synthesized by the human body. Additionally, 113 analyses were made regarding the influence of some methods of preparing these foods.

The overall methodology of food analysis has been previously demonstrated.[15-17] In brief, specific methodologies were used to assess the composition of the food in relation to total lipids,[18,19] cholesterol,[20,21] fatty acid composition,[22] determination of sodium chloride content,[23] and humidity.[24,25] The uncertainties of the analyses are consistent with the criteria established by the ITAL's quality system (NBR-NOW 9001), and did not enter the calculation of the results issued, but are available for consultation. The analyses were performed both on a wet and dry basis, but only the wet-basis analyses were considered, as they represent the food as it is consumed. According to the Decree 27, of January 13, 1998, of the Secretariat of Health Surveillance of the Brazilian Ministry of Health, trans-fatty acids were included in the calculation of saturated fats.

Statistical analysis

Statistical analysis was performed using the nonparametric Mann-Whitney's test to compare measurements of fats, fatty acids, and cholesterol between the different types of foods and preparation methods analyzed. The significance level was set at 5%.

Results

Beef ribeye

Regarding saturated fat, although it was numerically lower in the fat-free broiled form, there was no statistical difference between the preparation methods of broiling and frying with or without fat, except in relation to myristic acid content, which was lower in the fried meat without fat. Regarding cholesterol levels, the broiled meat with fat showed significantly lower levels than the broiled meat without fat ($p = 0.049$), with no differences in other methods of preparation.

Regarding the content of polyunsaturated fat, the fried meat with fat presented the highest levels ($p = 0.049$).

Chicken breast

Regarding the chicken, the best way to consume it is to remove the skin before preparing it, either by boiling or broiling, as shown in Table 1.

Table 1 – Content of fat, fatty acids, and cholesterol in chicken.

With the skin	Broiled (1)		Boiled (2)		p-value (1)×(2)	Boiled (3)		p-value (1)×(3)	p-value (2)×(3)
	Mean	SD	Mean	SD		Mean	SD		
Fats (g/100 g)	6.1	0.8	6.6	0.8	0.48	7.1	0.6	0.27	0.82
Saturated (mg/100 g)	1748.8	108.5	1,915.6	222.6	0.27	2,227.2	270.7	**0.049**	0.12
Monounsaturated (mg/100 g)	2,848.3	248.2	3,061.5	497.2	0.82	3,102	447.8	0.51	0.82
Polyunsaturated (mg/100 g)	1,275.8	516.3	1,308.1	488.4	0.82	1,488.4	225.8	0.51	0.51
Fatty acids (mg/100 g)									
Palmitic	1,322.9	78.6	1,461.5	182.4	0.27	1,494.4	174.1	0.12	0.51
Myristic	37.2	4.3	42.3	11.2	0.5	43.5	7.6	0.51	0.82
Oleic	2,400.5	201.9	2,614.6	382.4	0.51	2,755.3	375.4	0.27	0.51
Linoleic	1,169.3	466.4	1,220.9	471.2	0.82	1,367.2	192.4	0.51	0.51
Elaidic	16.2	–	–	–	–	165.3	49.3	0.17	–
Trans-linoleic	5.4	–	–	–	–	91.7	18.1	0.17	–
Omega 3	–	–	–	–	–	–	–	–	–
Cholesterol (mg/100 g)	114.5	5.9	104.8	7.6	0.12	116.2	2.4	0.82	**0.049**

Without the skin	Broiled (4)		Boiled (5)		p-value (4)×(5)	Fried (6)		p-value (4)×(6)	p-value (5)×(6)	p-value (1)×(4)
	Mean	SD	Mean	SD		Mean	SD			
Fats (g/100 g)	2.3	0.1	2	0.1	0.046	4.4	0.4	0.046	0.043	0.049
Saturated (mg/100 g)	764.6	43.7	659	14.2	0.049	1504.8	123.2	0.049	0.049	0.049
Monounsaturated (mg/100 g)	961.4	88.6	791.1	71.6	0.049	1,709.5	195.7	0.049	0.049	0.049
Polyunsaturated (mg/100 g)	522.4	35.8	396.3	54.3	0.049	945.2	65.7	0.049	0.049	0.049
Fatty acids (mg/100 g)										
Palmitic	520.5	36.9	453.7	22.9	0.049	913.7	84.2	0.049	0.049	0.049
Myristic	13.6	0.6	11.8	1.3	0.12	25.1	2.1	0.049	0.049	0.049
Oleic	826.1	81.5	678.9	58.4	0.049	1,602.4	171	0.049	0.049	0.049
Linoleic	428.5	17.2	330.4	61.2	0.049	827.5	69.6	0.049	0.049	0.049
Elaidic	–	–	5.7	–	–	178.4	18.8	–	0.17	–
Trans-linoleic	–	–	1.9	–	–	92.8	18.2	–	0.17	–
Omega 3	–	–	–	–	–	–	–	–	–	–
Cholesterol (mg/100 g)	113	8.1	99.6	5.3	0.049	128.1	15.4	0.12	0.049	0.82

Data are shown as mean ± standard deviation; **bold** = p < 0.05: last column shows the p-value of broiled chicken with or without skin.
SD, standard deviation.

Chester

Regarding saturated fat, the boiled chester presented lower levels than the fried (p = 0.049) and the broiled chester (p = 0.049); the latter two did not show any difference between them. The method of preparation did not significantly alter cholesterol levels; regarding polyunsaturated fats, the fried chester had the highest levels. The most recommended way to prepare this type of meat is by boiling it, followed by frying it and lastly, by broiling it.

Pork shank

Regarding saturated fats, cholesterol, and polyunsaturated fats, there were no differences between broiled or roasted pork, whether or not the apparent fat was removed before cooking. When comparing broiled or roasted meat without fat, the former showed lower levels of saturated fat (p = 0.049), thus making it the most recommended method for consumption. Regarding the pork loin, the broiled meat without fat showed much lower levels of saturated fat, myristic fatty acid, and palmitic fatty acid, than the broiled or roasted meat, thus

being the cut and method of preparation more suitable for the consumption of pork.

Salmon

When comparing broiled with boiled salmon, there were no differences, including regarding the levels of omega 3 (p = 0.27), the omega 6:3 ratio, and polyunsaturated fat levels (p = 0.27), except in the content of sodium chloride, which was lower in the boiled fish, and thus it can be consumed in either way.

Namorado sandperch

Both broiled and boiled showed equal results, including the levels of omega-3 (p = 0.51), omega 6:3 ratio, and polyunsaturated fats (p = 0.27). Regarding sodium chloride, it was higher in raw or broiled when compared to the boiled fish.

Shrimp

Comparing with fried shrimp, broiling showed to be the best option, as it has a lower content of lipids, saturated fats, palmitic

Table 2 – Content of fat, fatty acids, and cholesterol in shrimp.

	Broiled		Fried		p-value
	Mean	SD	Mean	SD	
Fats (g/100 g)	1.8	0.3	6.2	1.6	0.049
Saturated (mg/100 g)	531.8	116.7	1263	31.7	0.049
Monounsaturated (mg/100 g)	291.1	11.1	1292.7	336.8	0.049
Polyunsaturated (mg/100 g)	623.3	125.6	3044.1	796.6	0.049
Fatty acids (mg/100 g)					
Palmitic	287.6	71.9	818.1	266.6	0.049
Myristic	20.4	2.7	19.6	1.9	0.82
Oleic	209.5	26.6	1228.9	349.6	**0.049**
Linoleic	104	89.3	2509.5	798.6	**0.049**
Elaidic	4.2	2.4	–	–	–
Trans-linoleic	6.8	–	72.4	41.8	0.17
Omega 3	–	–	–	–	–
Cholesterol (mg/100 g)	2.64	34.5	270.5	13.4	0.51

Data are shown as mean ± standard deviation; **bold** = p < 0.05.
SD, standard deviation.

fatty acid, and exceeds the desirable levels of polyunsaturated fats. It is concluded that the best way to consume shrimp is to broil and the worst is to fry, as shown in Table 2.

Comparison between different types of meats and preparation methods

When comparing some types of meats in the broiled form, no differences were found in relation to cholesterol; as for saturated fat, it was lowest in chicken, highest in the pork loin, and there was no difference between beef ribeye and pork shank (p = 0.27), as shown Table 3.

Feijoada

When comparing the feijoada dishes, the content of saturated fat (p = 0.046) and cholesterol (p = 0.005) were significantly lower when the beans were cooked separately from the meats, when compared to those in which the meats were cooked together with the beans. There was no difference regarding the monounsaturated/saturated ratio. It is noteworthy that, when comparing the different methods of preparations, it becomes evident that the amount of pork added to the beans directly influences the saturated fat content and may influence the results obtained between these two preparation forms.

Discussion

This study demonstrated the influence of food preparation methods on the of cholesterol and fats levels in general, showing, for instance, that the removal of apparent fat in foods prior to cooking it results in a lower fat content when the food goes to the table, which may allow a lower consumption of certain foods instead of restriction, depending on how they are prepared.

Moreover, frying is not necessarily the worst form of preparation in general, such as for the beef ribeye, which

showed no differences that would recommend one method of preparation as the best as less harmful, except for the presence of small amounts of myristic acid and a higher content of polyunsaturated fats when fried with fat.

The literature shows that depending on the oil used, temperature reached, and frying time, the result is polymerization and hydrolysis, which may decrease the unsaturated/saturated ratio with time.[26]

These are the same conclusions that Echart found when comparing two methods of cooking, frying, or using the microwave, demonstrating that frying in soybean oil increases the oleic acids and EPA and decreases linoleic acid, while improving the omega 6:3 ratio in chicken and beef.[27]

One of the studies that best described the changes resulting from the frying process was that by Fillion, which showed that the fat absorbed during the frying process varies with the levels of fat in the fresh food. For instance, potatoes absorb more fat when fried than some types of fish. Therefore, the higher the fat content in the raw food, the lower the amount of fat that will be absorbed during the frying process.[28]

This was observed when analyzing chicken, which in the raw form has less saturated fat than the beef ribeye; considering this fact, frying was worse regarding saturated fat and cholesterol. The same was true regarding fried shrimp when compared to the broiled preparation, but was not true for the beef ribeye.

There are few studies on this subject in the world literature, most of which are very old.

When broiled salmon was compared with fried, the latter form showed doubled fat content, regardless of the type of oil used.[29] Similar results regarding oil types, but not in relation to fats, were published in 2004.[30] In the data presented in the present article, there were no differences between the two preparation methods (broiled and boiled) regarding saturated fat, cholesterol, and omega 3.

Regarding shrimp, broiling increased cholesterol oxidation products (cholesterol oxides with atherogenic characteristics) in relation to the raw food.[31] Similar results were found when comparing fried and roasted salmon.[29] In the analysis

Table 3 – Content of fat, fatty acids and cholesterol in some types of meat.

	Broiled pork shank without fat (1)		Broiled chicken without skin (2)		p-value (1)×(2)	Broiled ribeye steak without fat (3)		Broiled pork loin (4)		p-value (3)×(4)	p-value (1)×(3)
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		
Fats (g/100 g)	4.8	1.9	2.3	0.1	**0.049**	4.3	1.3	8.7	0.5	**0.049**	0.82
Saturated (mg/100 g)	1,656.3	501.4	764.6	43.7	**0.049**	2,026.1	493.5	3,304	140.4	**0.049**	0.27
Monounsaturated (mg/100 g)	1,818.1	621.3	961.4	88.6	**0.049**	1,682.5	637.8	3,953.9	196.9	**0.049**	0.82
Polyunsaturated (mg/100 g)	842.1	561.7	522.4	35.8	0.51	195.6	65.1	706.7	97.6	**0.049**	**0.049**
Fatty acids (mg/100 g)											
Palmitic	1,037.3	280	520.5	36.9	**0.049**	1,045.6	262.5	1,992.8	134.1	**0.049**	0.82
Myristic	52.9	9.3	13.6	0.6	**0.049**	125.9	28.2	98.6	14.6	0.27	**0.049**
Oleic	1,708.1	614.7	826.1	81.5	**0.049**	1,518.9	576.6	3,713.4	148.1	**0.049**	0.82
Linoleic	714.5	504.2	428.5	17.2	0.51	100	29.5	611	91.4	**0.049**	**0.049**
Elaidic	24.8	–	–	–	–	53.2	20.7	–	–	–	0.17
Trans-linoleic	–	–	–	–	–	–	–	–	–	–	–
Omega 3	–	–	–	–	–	–	–	–	–	–	–
Cholesterol (mg/100 g)	118.9	16.3	113	8.1	0.51	114.3	2.5	111.6	6.2	0.51	0.82

Data are shown as mean ± standard deviation; **bold** = p < 0.05. SD, standard deviation.

presented here, broiled shrimp showed lower levels of saturated fat, while fried shrimp had higher contents of mono and polyunsaturated fats.

Regarding meats, one of the few studies dates from 1987, and demonstrated that the removal of the chicken breast skin before broiling resulted in less fat and cholesterol when compared to when the skin remains on the food.[32] These data are consistent with those of the present study.

From the clinical point of view, the method of preparation has been associated with cardiovascular and mortality endpoints.

Regarding the risks, the consumption of fried foods, either fried in soybean or sunflower oil, was not associated with the incidence of coronary heart disease or overall mortality, when comparing between quartiles during 11 years of follow-up.[33]

The Multi-Ethnic Study of Atherosclerosis (MESA) identified an inverse association between a higher intake of omega 3 from fish and the presence of subclinical atherosclerosis assessed by intima-media thickness of the carotid artery, which was also associated with the consumption of fish that was not fried, that is, either boiled, steamed, roasted, or raw.[34] These findings were recently reproduced by Ansorena.[35]

The consumption of fish such as tuna, either boiled or roasted, was associated with lower heart rate, decreased systemic vascular resistance, and increased ejection fraction; on the other hand, the consumption fried fish was associated to left ventricular contractility abnormalities, reduced ejection fraction, lower cardiac output, increased vascular resistance, and a trend toward higher left ventricular diastolic volume.[36]

Despite the progress made in recent decades regarding the pharmacological management of dyslipidemias, dietary intervention still has the key role in primary and secondary prevention of ischemic heart disease. The DIRECT clinical trial[37] reopened the controversy on the best diet composition, demonstrating that an intervention with low-carbohydrate levels may result in favorable changes in the lipid profile, when compared with a low-fat diet or Mediterranean diet. However, regardless of the type chosen, knowledge of food composition and the influence of the food preparation method is a prerequisite for an adequate diet prescription, and can allow for greater adherence to a healthier diet for the heart, considering the low adherence rate to all types of diet of three months.[38]

The findings of this study may enhance adherence to a healthier diet from the cardiovascular point of view, allowing the individual to have a wider choice of menu in the form of food preparation, and better educate patients regarding healthier eating habits, and norms such as frying always being inadvisable.

Overall, it is clear that depending on the type of meat used, actions such as the removal of apparent fat before cooking and broiling in some cases brings benefits, mainly for those types with lower fat content in the raw form.

Limitations

Not all the possible methods for food preparation were assessed, and many of the foods available for the table were unexplored.

Conclusion

The analyses shown here indicate that there are no foods that should be banned from healthy diets in relation to cholesterol and saturated fat contents, but there is a need for the education of patients on how best to prepare these foods.

Conflict of interest

All authors declare to have no conflict of interest.

REFERENCES

1. Ford ES, Ajani UA, Croft JB, Critchley JA, Labarthe DR, Kottke TE, et al. Explaining the decrease in U.S. deaths from coronary disease, 1980-2000. N Engl J Med. 2007;356:2388-9.
2. Schmidt MI, Duncan BB, Azevedo e Silva G, Menezes AM, Monteiro CA, Barreto SM, et al. Chronic non-communicable diseases in Brazil: burden and current challenges. Lancet. 2011;377: 2042-53.
3. Scherr C, Ribeiro JP. What the cardiologist should know about trans fats. Arq Bras Cardiol. 2008;90:e4-6.
4. Leren P. The Oslo diet-heart study. Eleven-year report. Circulation. 1970;42:935-42.
5. Trichopoulou A, Bamia C, Trichopoulos D. Anatomy of health effects of Mediterranean diet: Greek EPIC prospective cohort study. BMJ. 2009;338:b2337.
6. García-Arias MT, Navarro MP, García-Linares MC. Effects of different thermal treatments and storage on the proximate composition and protein quality in canned tuna. Arch Latinoam Nutr. 2004;54:112-7.
7. Potter NN, Hotchkiss JH. Ciencia de los alimentos. 5ª ed. Zaragoza: Acribia; 1995. p. 667.
8. Gokolu N, Yerlikaya P, Cengiz E. Effects of cooking methods on the proximate composition and mineral contents of rainbow trout (Oncorhynchus mykiss). Food Chem. 2004;84:19-22.
9. Rosa FC, Bressan MC, Bertechini AG, Fassani EJ, Vieira JO, Faria PB, et al. Effect of cooking methods on carcass chemical composition and cholesterol of poultry breast and tight meat. Ciênc Agrotec. 2006;30: 707-14.
10. Monnier VM, Obrenovich ME. Wake up and smell the maillard reaction. Sci Aging Knowledge Environ. 2002;2002:pe21.
11. Alfaia CM, Alves SP, Lopes AF, Fernandes MJ, Costa AS, Fontes CM, et al. Effect of cooking methods on fatty acids, conjugated isomers of linoleic acid and nutritional quality of beef intramuscular fat. Meat Sci. 2010:84:769-77.
12. Warmer K. Impact of high-temperature food processing on fats and oils. Adv Exp Med Biol. 1999;459:67-77.
13. Fillion L, Henry CJK. Nutrient losses and gains during frying: a review. Int J Food Nutr. 1998;49:157-68
14. Sanchez-Muniz FJ, Oils and fats: changes due to culinary and industrial processes. Int J Vitam Nutr Res. 2006;76:230-7
15. Scherr C, Ribeiro JP. Redução do risco cardiovascular. Nova tabela de composição de colesterol e ácidos graxos em alimentos. Rio de Janeiro: Guanabara Koogan; 2009.
16. Scherr C, Ribeiro JP. Fat content of dairy products, eggs, margarines and oils: implications for atherosclerosis. Arq Bras Cardiol. 2010;95:55-60.
17. Scherr C, Ribeiro JP. Chemical food composition: implications for atherosclerosis prevention. Rev Assoc Med Bras. 2011;57: 151-5.
18. Folch J, Lees M, Stanley GHS. A simple method for the isolation and purification of total lipids from animal tissues. J Bioll Chem. 1957;226:497-509.
19. Gerber A, Van Gullik D. Normas analíticas do Instituto Adolfo Lutz. São Paulo: Instituto Adolfo Lutz; 1985. p.270.
20. Bragagnolo N, Rodriguez-Amaya DB. Avaliação comparativa de três métodos para determinação de colesterol em gema de ovo. Arq Biol Tecnol. 1993;36:237-51.
21. Schmarr H, Gross HB, Shibamoto T. Analysis of polar cholesterol oxidation products: evaluation of a new method involving transesterification, solid phase extraction, and gas chromatography. J Agric Food Chem. 1996;44:512-17.
22. Firestone D. Official methods and recommended practices of the American Oil Chemists Society. Champaign: American Oil Chemists Society, 2008. p.11-96.
23. Helrich K. Official methods of analysis of the Association of Official Analytical Chemists. Arlington: Association of Official Analytical Chemists; 1990. p.842.
24. Silva PHF, Pereira DBC, Oliveira LL, Costa Jr LCG. Físico-química do leite e derivados: métodos analíticos. Juiz de Fora: Editora Oficina de Impressão Gráfica; 1997. p. 28-9.
25. Cunniff P. Official methods of analysis of the Association of Official Analytical Chemists. Arlington: Association of Official Analytical Chemists; 1998.
26. Choe E, Min DB. Chemistry of deep-fat frying oils. J Food Sci. 2007;72:R77-86.
27. Echarte M, Ansorena D, Astiasarán I. Consequences of microwave heating and frying on the lipid fraction of chicken and beef patties. J Agric Food Chem. 2003;51:5941-5.
28. Fillion L, Henry CJ. Nutrient losses and gains during frying: a review. Int J Food Sci Nutr. 1998;49:157-68.
29. Echarte M, Zulet MA, Astiasaran I. Oxidation process affecting fatty acids and cholesterol in fried and roasted salmon. J Agric Food Chem. 2001;49:5662-7.
30. Al-Saghir S, Thurner K, Wagner KH, Frisch G, Luf W, Razzazi-Fazeli E, et al. Effects of different cooking procedures on lipid quality and cholesterol oxidation of farmed salmon fish (Salmo salar). J Agric Food Chem. 2004;52:5290-6.
31. Echarte M, Conchillo A, Ansoren D, Astiasarán I. Cholesterol oxidation products in fresh and frozen shrimps, raw and grilled. Nutr Hosp. 2005;20:293-6.
32. Prusa KJ, Lonergan MM. Cholesterol content of broiler breast fillets heated with and without the skin in convection and conventional ovens. Poult Sci. 1987;66:990-4.
33. Guallar-Castillón P, Rodríguez-Artalejo F, Lopez-Garcia E, León-Muñoz LM, Amiano P, Ardanaz E, et al. Consumption of fried foods and risk of coronary heart disease: Spanish cohort of the European Prospective Investigation into Cancer and Nutrition study. BMJ. 2012;344:e363.
34. He K, Liu K, Daviglus ML, Mayer-Davis E, Jenny NS, Jiang R, et al. Intakes of long-chain n-3 polyunsaturated fatty acids and fish in relation to measurements of subclinical atherosclerosis. Am J Clin Nutr. 2008;88:1111-8.
35. Ansorena D, Guembe A, Mendizábal T, Astiasarán I. Effect of fish and oil nature on frying process and nutritional product quality. J Food Sci. 2010;75:H62-7.
36. Mozaffarian D, Gottdiener JS, Siscovick DS. Intake of tuna or other broiled or baked fish versus fried fish and cardiac structure, function, and hemodynamics. Am J Cardiol. 2006;97:216-22.
37. Shai I, Schwarzfuchs D, Henkin Y, Shahar DR, Witkow S, Greenberg I, et al. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. N Engl J Med. 2008;359:229-41.
38. Dansinger ML, Gleason JA, Griffith JL, Selker HP, Schaefer EJ. Comparison of the Atkins, Ornish, Weight Watchers, and Zone diets for weight loss and heart disease risk reduction: a randomized trial. JAMA. 2005;293:43-53.