INFLUENCE OF FRYING OIL ON THE FAT COMPOSITION OF HAMBURGERS

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Background

When a food is subjected to a culinary process of frying, there is a mass transfer characterized by the movement of oil into the food, and the movement of fat and water from the food to the oil. The quantity of the absorbed fat is in relation to the time needed for the cooking of the food, its surface, its moisture and its nature (Lawson, H., 1995; Pozo et col., 1995; Singh, 1995). The continual use of the oil in domestic and industrial friers helps the reactions of oxidation, polimerization, hydrolisis, cycling and isomerization, which lead to the formation of a complex mixture of volatile and no volatile compounds (Pérez-Camino et al., 1987; Dobarganes et al., 1988). From the dietetic point of view, the reduction of the fat content of a food is not easy because its presence conditions the sensory characteristics (colour, flavour and texture). In this respect, vegetable oils (corn, palm, etc.) have been used in the formulation of new meat products in order to reduce the proportion of animal fat (Liu et al., 1991; Smith et al., 1991).

Objectives

The object of this work is the study of the influence of frying hamburgers with different oils on the final composition of its fat.

Methods

The composition of the hamburgers is a mixture of meat from calf and pig. Three different oils were used for frying: extra virgin olive oil, olive oil (virgin and refinated olive oil) and sunflower oil. Hamburgers are fried in a 20 cm diameter frying-pan with an oil volume of 150 ml for 10 minutes at an approximate temperature of 180ºC.

Lipid extraction: Total lipids of fresh and fried hamburgers were extracted by the method of Folch et al. (1957).

Fatty acids composition: Fatty acids percentage composition in hamburgers and in frying oils has been determined by gas chromatography of the methyl esters. Esterification has been carried out with sodium methylate in methanol solution, according to the method described in the Regulations (CEE) Nº2568 of the European Commission (DOCE, 1991). The separation is run by means of a SP-2330 Supelco capillary column (30 cm length x 0.25 mm internal diameter). The identification of the methyl esters is done by comparison with a mixture of known standards: miristic acid (C14:0) miristoleic acid (C14:1), palmitic acid (C16:0), palmitoleic acid (C16:1), estearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2) and linolenic acid (C18:3). The fatty acids proportions are expressed as the percentage of the injected methyl esters total area.

Statistical analysis: The results has been treated statistically with Statgraphics V. 7,0 program. It has been done an analysis of variance with a significance level of 95%. When the differences were significative, a comparison test (LSD) has been effectuated.

Results and discussions

Results indicate that the fatty acid composition of fried hamburgers depends on the oil used to fry. As observed in Table 1, the frying with virgin olive oil reduces significantly ($p<0.05$) the percentage of saturated fatty acids (S: miristic, palmitic and stearic acids), it varies from the 40.31% in fresh hamburger to 35.55%, 38.34% and 35.13% after frying with virgin olive oil, refinated olive oil, respectively. The variations of mono and poliinsaturated fatty acids (MI), mainly oleic acid, increases significantly ($p<0.05$) after frying with virgin and refinated olive oils (47.51% and 45.25% respectively). By contrast, the frying with sunflower oil reduces the monoinsaturated fatty acids percentage from 43.53% (fresh hamburgers) to 38.48% (fried hamburger). Finally, the frying with sunflower oil increases significantly ($p<0.05$) the percentage of poliinsaturated fatty acids (PI), so the linoleic acid varies from 10.34% in fresh hamburger to 21.51% in fried hamburger.

Table 1.- Fatty acid composition of fresh and fried hamburgers fat with virgin and refinated olive oils and sunflower oil

Fatty acids (%)	Fresh hamburger	Fried hamburgers		
		Virgin olive oil	Refinated olive oil	Sunflower oil
Miristic	2.82 ± 0.38^{a}	1.85 ± 0.04^{b}	2.25 ± 0.03^{b}	1.91 ± 0.04^{b}
Palmitic	23.74 ± 0.48^{a}	21.17 ± 0.01^{b}	22.51 ± 0.12^{c}	20.11 ± 0.23^{d}
Estearic	13.75 ± 0.86^{a}	12.53 ± 0.30^{b}	13.58 ± 0.08^{a}	$13.11\pm0.27^{a,b}$
Total saturated	40.31^{a}	35.55^{b}	38.34^{c}	35.13^{d}
Miristoleic	3.47 ± 0.47^{a}	0.88 ± 0.03^{b}	1.10 ± 0.0^{a}	0.91 ± 0.0^{b}
Palmitoleic	3.47 ± 0.47^{a}	$3.08\pm0.15^{a,b}$	3.62 ± 0.05^{a}	2.89 ± 0.09^{b}
Oleic	43.53 ± 1.14^{a}	47.51 ± 0.04^{b}	45.25 ± 0.04^{c}	38.48 ± 0.22^{d}
Total monoinsaturated	48.21^{a}	51.47^{b}	49.97^{c}	42.28^{d}
Linoleic	10.34 ± 0.79^{a}	11.75 ± 0.02^{b}	10.56 ± 0.06^{a}	21.51 ± 0.12^{c}
Linolenic	0.88 ± 0.08^{a}	1.00 ± 0.04^{b}	$0.90\pm0.10^{a,b}$	0.84 ± 0.04^{a}
Total poliinsaturated	11.59^{a}	12.75^{b}	11.79^{a}	22.35^{c}
MI/S	1.20	1.45	1.30	1.20

Different superindexes in each row indicate significative differences ($p<0.05$)
MI/S: Relation monoinsaturated fatty acids /poliinsaturated

The changes observed in the oils used to fry (Table 2) are opposite the hambugers fat. So, palmitic, estearic and linoleic acid

percentages increase and oleic acid percentage decreases in olive oils after the fry. This fact indicates the mass tranfer during frying, characterized by the movement of oil into the food and the movement of fat and water (steam) from the hamburger into the oil.

Table 2.- Fatty acid composition of oils before and after frying

Fatty acids (%)	Virgin olive oil		Refinated olive oil		Sunflower oil	
	fresh	fried	fresh	fried	fresh	Fried
Miristic	ND	0.25±0.02	ND	0.30±0.01	0.06±0.01^b	0.5±0.01
Palmitic	13.50±0.1^a	14.76±0.16^b	11.67±0.05^a	13.04±0.12^b	5.94±0.03^c	10.20±0.09^b
Estearic	3.03±0.11^a	4.20±0.09^b	3.42±0.07^a	4.65±0.12^b	4.56±0.13^c	6.31±0.06^b
Total saturated	15.52^a	19.19^b	15.09^a	18.00^b	10.55^b	17.00^b
Miristoleic	ND	0.07±0.01	ND	0.07±0.00	ND	0.13±0.01
Palmitoleic	1.11±0.01^a	1.41±0.05^b	1.22±0.03^a	1.44±0.03^b	0.13±0.02^c	0.98±0.03^b
Oleic	71.09±0.08^a	67.90±0.24^b	71.36±0.30^a	65.98±0.18^b	22.93±0.1^b	31.36±0.17^b
Total monoinsaturated	72.20^a	69.42^b	72.58^a	67.49^b	23.06^c	32.47^b
Linoleic	9.84±0.12^a	10.12±0.06^b	10.83±0.07^a	13.02±0.28^b	65.10±0.07^c	49.24±0.06^b
Linolenic	0.80±0.01^a	0.78±0.07^a	0.86±0.10^a	0.93±0.02^a	0.79±0.06^a	0.81±0.16^a
Others	0.56±0.13	0.49±0.06	0.58±0.15	0.55±0.13	0.42±0.01	0.38±0.08
Total poliinsaturated	11.20^a	11.39^a	12.27^a	14.49^b	66.31^c	50.43^b
MI/S	4.7	3.6	4.8	3.8	2.2	1.9

Different superindexes in each row, for each oil, indicate significative differences ($p<0.05$)
MI/S: Relation monoinsaturated fatty acids /poliinsaturated. ND: non detected

Applied "Mixture law" (Pérez-Camino et al., 1991) to palmitic,oleic and linoleic fatty acids:

$100 \cdot \%C_x$ fried hamburger = $a \cdot \%C_x$ oil before frying + $(100-a) \cdot \% C_x$ freh hamburger

a = % oil in fried hamburger C_x = fatty acid

It is possible to know the lipid exchange during frying (Tabla 3). The results indicates that the 17.7%, 8.3% and 20.3% of fat fried hamburger correspond to virgin olive oil, refinated olive oil and sunflower oil, respectively. While the 12.1%, 15.1% and 26.7% of fried oils correspond to hamburger fat. This indicates that the higher lipid exchange takes place when frying with sunflower oil.

Table 3.- Lipid exchange between oil and lipids of hamburger during the frying

Oil	% fryinf oil absorbed by the food				% lipids of the food tranfer to the oil
	Palmitic	Oleic	Linoleic	Mean	
Virgin olive oil	20.8	14.5	-	17.7	12.1
Refinated olive oil	10.0	6.5	-	8.3	15.1
Sunflower oil	20.2	-	20.4	20.3	26.7

Conclusion

As a conclusion, the results show a significant increase of the relative monoinsaturated/saturated fatty acids when frying with virgin and refinated olive oils (1.45 and 1.30 respectively), in relation to sunflower oil (1.20). From the dietetic point of view, frying with virgin olive oil is recommended in order to improve the fat composition and stability.

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