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Influence of the frying process on the real fat intake

By **G. Varela** and **B. Ruiz-Roso**

Departamento de Nutrición. Facultad de Farmacia. Universidad Complutense de Madrid.
Ciudad Universitaria. 28040 Madrid.

SUMMARY

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As shown in the former presentation, one fact about repeated frying is that there comes a moment, when the oil used is no longer suitable for frying, that is discarded. The amount may be quite large depending, among other factors, on the composition of the oil itself and on that of the foodstuffs fried. This can be of practical significance for the total lipid intake, since the unsuitable oil is no longer ingested. It is difficult to know the amount of oil discarded for this reason and there is no scientific information in the literature on this subject.

In this paper we try to know the quantitative and qualitative importance of the oil proceeding of repeated frying (RF) which normally is discarded in relation to the total fat intake (FI) in Madrid, as well at domestic level (96 families) as in catering (hospitals, restaurants and schools). For this purpose discarded oils proceeding of the frying of food were collected in the usual quantity, variety and conditions (only olive and sunflower oils were used), both in the households and in the institutions. In the oils, raw and discarded, we also determined their composition in fatty acids.

Our results show that at domestic level, although the dispersion is big, the average values of the discarded oil are the 19.3 ± 18.4% of the inventoried oil. However, in the institutional frying, in which, of course, industrial fryer are utilised, the proportion of discarded oil was much bigger, some time doubling the quantity discarded at domestic level. Curiously, the discarded oils proceeding either from the households or from catering do not show significative differences regarding their composition in fatty acids with respect to raw oil. The reason is that the oils are discarded due to subjective reasons, although they probably might be utilised again. At this moment, we are trying to confirm this last statement.

In conclusion, if you do not take into consideration this percentage of losses, when utilising the inventory as measure technique of the intake of an individual person or a collective, you would overestimate the consumption approximately in 19-20%, and this error would be bigger when some meals are consumed in catering. This obviously would have a repercussion on the estimation of the fat intake, and therefore, of caloric intake and of the indices related to it, as shown in this presentation.

KEY-WORDS: Fat intake – Frying-Olive Oil.

The oil used for frying is not totally consumed and a part is discarded: the one coming from the repeated frying foods, which we will call «frying discarded oil» (DO). This discarded oil has to be eliminated from the theoretical intake aforementioned to know the real intake.

We have completed a study in Madrid on the quantity and quality of the raw cooking oils and discarded fried oils (Figure 1), at both household level and in some public eating places in this city. We have also tested the influence of discarded fried oils in the lipid intake on the population.

Figure 1

Study of the quantity and quality of the raw and thrown out culinary oils in the population of Madrid

Sample characteristics

* Households: 96 (2 districts of Madrid: Salamanca and San Blas, different socioeconomic level
* Institutions: 13
  - 4 kitchens of public Hospitals (Ø meals/day: 540)
  - 5 public schools (Ø meals/day: 225)
  - 4 restaurants — 2 conventional (Ø 100 and 200 meals/day)
    2 fast-food (Ø 250 and 800 meals/day)

In households, the theoretical and real intake of the frying discarded oil (FDO) corresponds to an dietary survey done in two districts of Madrid at different social economic level (Salamanca and San Blas). The technique used was the norm in the catering register, during a period of five days in which it is necessary to include a Sunday. It is known that this technique generally consists of making an inventory of the foods that we have at our disposal at the start of the study, followed by recording all foods bought and produced during the five days of the register. Finally, at the end of the period of study and once again a new list is made.

Knowing the foodstuffs consumed during this time, we can know the intake of energy and nutrients of the group of people of the household studied using the food composition tables published by our Department (1). Since-we know the characteristics of the household studied as regards number of members, age, sex and activities, we can calculate the average daily intake of energy and nutrients per person and day for each member of that household. We will call «theoretical oil intake» the oil consumption coming from this register technique. A part of this oil is used in different cooking techniques as in dressing but the biggest part, in our country approximately 50%, matches the fried food (2).

The method of study followed in the institutions was slightly different from that of the households. Firstly, we deterrnined the total amount of oil used by

the institutions during a period of five days minimum, which divided into the number of meals served it would indicate the «theoretical oil intake» (TOI) per person and meal. We also determined the oil subjectivally discarded coming from both the fryer and the frying pan. With this information, we calculated the real oil consumption with the fried foods and with other cooking processes that correspond to the real intake per person and meal.

In reference to the composition of fatty acids, it was determined in the oils both raw and discarded from frying (FDO). It was analyzed in these FDOs the possible thermolitic alteration as well as oxidized, by means of the quantifying of the total polar content, polymers, dimers and oxidized triacylglycerides, diacylglycerides, polar fatty acids and unsaponificable.

In Table I we can see the average lipid intake of the 96 households in Madrid. We can observe that the theoretical intake is quite higher than the real, that is, approximately 19.3% of the oil is discarded. Because of this, some time ago we considered the need to take into account this discarded oil when the food intake is studied by the register technique. By a series of data not confirmed experimentally up to date, we estimate that 20% would be an ideal figure to be used, and it is what we have been using for the last 30 years in our studies of the Nutritive State of the Spanish Population in collaboration with the National Institute of Statistics (3, 4, 5, 6).

In Table I we can see the quantitative influence on the total lipid intake of the discarded oil in households. We see that, if we leave out the frying discarded oil, the total lipid intake is overestimated at approximately 9.7%.

Table I

Average fat intake in 96 households of Madrid (g/person/day)

	Teoretical intake	Real intake	% of difference
Culinary oil	62.9 ± 32.2	53.0 ± 31.1	-19.3 ± 18.4
Total fat intake	121 ± 11.0	100 ± 40.5	-9.7 ± 11.2

However, if the results in the households aforementioned confirm our estimation of the real figure of FDO, it is not so with the first results obtained percentages of discarded oil in the institutions in the fryer as well as in the pan. According to Table II, in both processes the discard percentage was much bigger than in the households. In all institutions studied (restaurants, hospitals and schools), when the industrial fryier is used the percentage of discarded oil is bigger than when the frying pan is used, the average being approximately 42.4% in the fryier and 26% in the pan. Nevertheless, in the institutions most fryings are generally done in the fryer, keeping the frying pan for special dishes.

Table II

Institutions

Average percentage of thrown out oil from deep-fryer or frying pan

	Deep-fryer %	Pan %	Ø Deep-fryer + pan %
Restaurants	50.2±27.5	28.6±12.0	37.9±10.1
Hospitals	42.5±12.3	20.0±3.5	33.5±5.6
Schools	35.5±23.8	30.4±6.5	26.9±4.3
Institutions average	42.4	26.3	32.8

If we take into account both fryer and pan discards, restaurants have the biggest percentage of discarded oil followed by hospitals, being schools where the best use of cooking oil is made. However, the least discarded oil occurs as an average in the households studied.

Another one of the aims of this study is to decide whether the exchange of lipids between the cooking oils and the fried foodstuffs, change significantly the lipid composition of the discarded oils, as it happened in the laboratory tests (7). This change, if it is produced, could contradict the qualitative estimation of the total lipid intake. In Table III we present the first results in respect to the composition in the families of fatty acids, of both crude and discarded oils from the dining rooms of the four Madrid hospitals studied. As we can see, there are no significant differences between the composition of crude and discarded oils. Therefore, frying oils are discarded in principle before their composition in fatty acids changes.

Table III

Fatty acids (%) of raw oils and thrown out from four hospitals of Madrid

	Raw sunflower oil	Thrown out oil
SFA	7.20±0.79	8.0±1.6
MUFA	32.00±4.79	32.5±5.5
PUFA	58.30±5.30	58.7±3.6

However, if we obseve the results we obtained in the laboratory (7) (reproduced in Figure 2), we see that in the repeated fried food (fatty meat in olive oil in this case) an increase of saturated fatty acids and a reduction of monounsaturated fatty acids is produced in the oil, although this occurs very slowly. This means the number of fried foods ought to rise, we say in order of 10, to find significant differences. We should bear in mind that in the case of public dining

rooms or industrial frying, the relation between the volume of oil and the weight of the foodstuff is much bigger than is normal at a domestic level. This makes us think that the discarded oils coming from households or institutions included in the study were prematurely discarded.

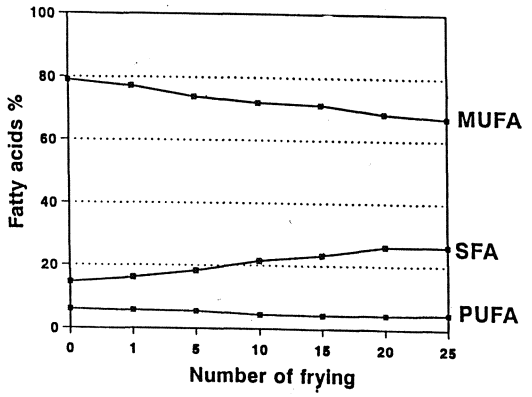

Figure 2
Changes in fatty acids composition of olive oil used in repeated fryings of fatty meat

We are led to similar conclusions by the results at a laboratory level relative to the increase of the polar compounds in sunflower oils coming from repeated frying of potatoes, obtained in this same department by the group of Sánchez-Muniz and collaborators (8), shown in Table IV. We see that 50th frying can be reached without arriving at the value of the polars, with or without replacement of oils, that obstruct its reuse, according to the diverse legislations including the Spanish one. However, the result would possibly be different in the frying of foodstuffs with high fat content, above all unsaturated fats as in the case of fish.

Table IV
Total polar compound (g/100g) in sunflower oils from repeated frying of potatoes

Without addition of raw oil			With addition of raw oil		
raw	30 th frying	50 th frying	raw	30 th frying	50 th frying
3.75	17.29	24.13	5.09	17.99	18.92

(Sánchez-Muniz *et al.*, 1992)

The results of the analysis of polar compounds done to FDO coming from the households or institutions included in our study, also are in line with what was previously mentioned in relation to their composition of fatty acids (Table V), the average values of the total polar content are well below the 25% maximum allowed by legislation. The results of the FDO coming from restaurants, taking into account the hydrolitic as well as the oxidised alterations, showed the highest levels of alteration and the household results the lowest. In different kinds of oils, olive has a content of altered compounds significantly less than that of sunflower oil (Table VI). But as we said before, in the conditions studied, that correspond with the normal ones in the households and in institutions, the discarded oils will be perfectly usable.

Table V
Total polar content and different polar compounds in discarded oils (%)

	Schools	Hospitals	Restaurants	Households
Total polar content	9.6±2.8	10.5±3.0	19.9±12.6	6.6±2.6 [ab]
Triacylglyceride polymers	5.9±2.4	5.6±1.7	15.8±12.2	3.2±1.4 [ab]
Triacylglyceride dimers	30.7±4.9	31.4±3.9	31.8±6.3	16.9±6.6 [abc]
Oxidized triacylglycerides	38.8±6.9	41.4±6.0	28.2±6.3 [ab]	27.2±4.3 [ab]
Diacylglycerides	17.9±3.4	15.7±4.5	19.5±9.2	40.8±7.2 [abc]
Fatty acids + polar unsaponifiable	6.6±1.7	5.8±1.2	4.5±1.9	12.6±5.9 [abc]

Mean ± SD
a= significantly different to schools; b= significantly different to hospitals; c= significantly different to restaurants. ($p<0.05$, student's test).

Table VI
Samples grouped according to the oil used for cooking (%)

	Sunflower oil	Olive oil
Total polar content	12.6±8.5	7.5±3.4
Triacylglyceride polymers	8.8±8.3	3.9±1.9
Triacylglyceride dimers	31.7±4.8	20.1±8.4*
Oxidized triacylglycerides	36.8±8.9	29.8±6.6*
Diacylglycerides	16.8±4.0	35.8±11.8*
Fatty acids + polar unsaponifiable	5.9±1.8	11.0±5.8*

Mean ± SD
*= significantly different to sunflower oil. ($p<0.05$, Student's test).

However, Dobarganes and col (9) find different results in Andalucia although coming from food shops. We have to take into account that, due to local habits, fish constitutes practically 100% of the fried food in the food shops; whilst in the samples of Madrid the percentage of fish among fried foods was

much less and other foods prevailed with less raw fat content, such as potatoes, chicken, etc. Notwithstanding in future works we will try to examine in more detail this subject that shows once again the heterogenity of our dietary and technological habits that logically have repercussions on the nutritive value of our intake. As is well known, this heterogenity in our diet in the different geographic zones of Spain makes an average knowledge of our nourishment diffficult, but at the same time shows a rich cultural inheritance that we should maintain and is perfectly compatible with correct eating.

On the other hand, with a specific purpose although speculative, we indicate in Figure 3 the way the fat intake per person and per meal is overestimated if we do not take into account the oil discarded by the different institutions studied.

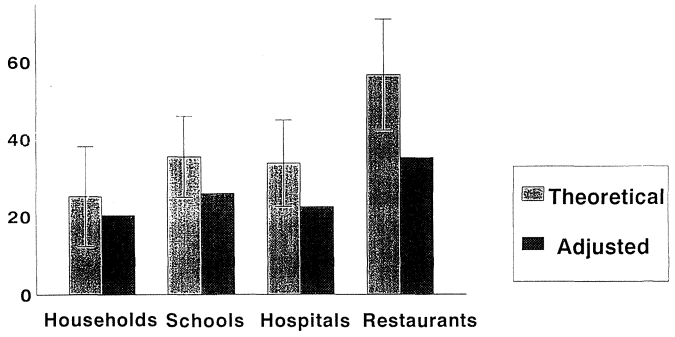

Figure 3
Oil consumption (g/person and meal) by record method and adjusted discontinuing the thrown out oil used for frying in households and catering services

CONCLUSIONS

1.– In a country like Spain a great proportion of the total lipid intake comes from the fat used in fried food, and not considering the quantity of the frying discarded oil would significantly overestimate the lipid intake and logically the different parameters related to them.

2.– In the households as well as in the public dining rooms, with the conditions studied by us, frying oils are discarded in general long before their composition in fatty acids changes, or the content of polars compounds reach the 25% maximum value allowed by the legislation.

3.– Due to the heterogenity of Spanish dietary habits and with the cooking processes used, it is necessary, as we propose, to study deeply and to expand these studies to the rest of the regions of Spain.

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