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Almond industrial deep-fat frying

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The results of a study of almond deep-fat frying in an industrial plant are reported. The objective was to evaluate the quality and efficiency of deep-fat frying (very usual in most industries that work on nut products), keeping constant the oil level, in the point of view of fried almond homogeneity and quality. Also, changes in high oleic sunflower oil (colour, cracklings, stability, and polar compounds) and almond (water content, water activity, oil content, oil stability and fatty acids) composition were studied. The results show that fried almond and oil characteristics are kept under normal levels for at least 50 frying operations. After that, colour, cracklings and polar compounds of the frying oil begin to rise, almonds oil stability drops and water content and water activity rise. During frying process, almonds water content drops from 4.4% to 2.4% wet basis, water activity drops from 60.5% to 11.5% at 25°C decreasing almond self-life, and a high absorption of fatty acids into the almonds is observed.

Behaviour of extra virgin olive oil in potato frying. Thermoxidative alteration of the fat content in the fried product

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Today, there is a renewed interest in oils rich in monoenic acids because of their stability an health-promoting properties. According to data of our research group, optimal results for frying in any oil can be optained when there is high turnover of the oil in the fryer, because the thermoxidative and hydrolytic changes can be minimised. One of the best estimates of oil quality is its polar content. In many countries the limit to reject an oil used in frying is 25% of polar content.The aims of this study are: 1) To stablish the behaviour of an extra virgin olive oil in repeated and intermittent deep fat frying of potatoes with a fast turnover of fresh oil, 2) To compare the content of polar material in extra virgin olive oil-fried potatoes with that of the oil used for frying. Sets of 500g of potatoes were fried discontinuously 20 times in 3L of extra virgin olive oil. The lipid of the fried potatoes was extracted four times with diethyl ether using a 1:50 (w/v) ratio in each extraction operation. The quantity of polar components in the olive oil and in the lipid extracts was determined by the silicagel column chromatography method of Waltking and Wessell slightly modified. The amount of polar compounds (mg/100 mg oil) significantly increased after 20 fryings respect to the fresh oil (5.6 ± 0.3 vs 2.9 ± 01.). The amount of polar component in the fries (mg/100 mg extracted oil) was 6.9 ± 0.2 after the 20th frying. It should be noted that the level of polar content in the fries was slightly but significantly higher than in the frying oil. Data from this study indicated that repeated frying of potatoes in extra virgin olive oil with a frequent turnover of unused oil throughout the frying slightly increased the level of polar material in the fryer oil during the first 20 fryings, containing the fries slightly but significantly higher altered compounds than the respective frying oil. Data also suggest that an extra virgin olive oil performs satisfactorily in frying operations being possible to use the oil many times until the 25% of polar content is reached.

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Benefits of the consumption of olive oil-fried sardines in the prevention of hypercholesterolemia in rats. Effects on some serum lipids and cell-damage marker enzymes

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The consumption of n-3 fatty acids in the diet has been suggested as a consequence of hypolipemic properties and eicosanoid production modulation of these fatty acids. PUFA n-3 has been shown to have

hypocholesterolemic effects, however, recent reviews suggest a sharp hypotriglyceridemic effect of PUFA n-3 which may exceed the capacity of most current drugs. However, toxicologists taking into account the vulnerability to oxidation of n-3 fatty acids, suggest that consumption of oxidized lipids may have severe consequences. Taking all these facts into account the prevention of hypercholesterolemia and the possible harmfulness of cholesterol-enriched diets containing 1) casein and olive oil, 2) sardines from the 1st and 2nd fryings in olive oil, or 3) sardines from the 8-10th fryings in the same olive oil were studied in growing Wistar rats. Food intake of group 3 was the lowest, leading to significantly ($p<0.05$) lower weight gain and liver weight, and a greater hepatosomatic index. The increase in serum cholesterol (mmol/L) of groups 2 (0.96) and 3 (0.98) was markedly lower than in group 1 (13.89) by reducing VLDL+LDL cholesterol concentrations. Triacylglycerol levels were roughly 58% lower ($p<0.05$) in sardine diets than in group 1. The changes in phospholipid concentration in sardine diets were related to the cholesterol intake. Some marker enzimes such as Lactate Dehydrogenase, α-Hydroxybutyrate Dehydrogenase, Creatine Kinase activities were not significantly affected by fried sardine consumption, however Alanine aminotransferase and alkaline phosphatase were higher in group 1. Increased γ-glutamyltransferase activity and aspartate aminotransferase/alanine amino transferase ratio were found in group 3 vs groups 1 and 2. Data shows that sardine diets put in check the cholesterol-raising induction and decrease the level of some damage markers, but caution is required when sardines from a used olive oil are consumed.

Comparation of analytical methods for quality evaluation of frying oil

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Five analytical methods, free tatty acid, iatroscan@ technique, dielectric constant, oxifrit@, fritest@, were compared to determination of polar compounds and altered methyl esters in frying oil.

Free fatty acid did not significantly ($p=0.05$) correlate with other methods.

Iatroscan technique showed a high and significant ($p=0.05$) correlation coefficients with standard method and altered methyl esters, but need laboratory technique.

Significant linear relationships ($p=0.05$) were found between dielectric constant, oxifrit@, fritest@ and each of the other methods. This quick-test methods need little technical expertise, were found to be a reliable indicator or deteriorated frying oil, and can be done on the spot at restaurants and food service institution to replace polar compounds.

Comparative study of the effect on the sardine fatty acids composition during deep-frying and canning in olive oil processes

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During deep-frying and canning processes, cuantitative changes in the fat content of sardines are produced. Naturally, these changes introduce important modifications in the fatty acids composition of the food either fried or canned and also, although in a minor scale, in the culinary or coating oil which is used. Changes produced in sardine lipids and in the culinary fat or coating oil by processes like deep-frying and canning in olive oil have been studied. Regarding SFA, there was a significant reduction in canning, while in fried sardines the reduction could hardly be appreciated. Respect to the MUFA, and due to high content of MUFA of the oil which was used in the processing, the interchange in this family during the processes presented a positive increase for the food and a negative one for the culinary or coating oil. Regarding PUFA ω-6 we noted that in either olive oil and in raw sardines PUFA can be found in a similar proportion, and therefore there was not a favourable net interchange during the processing of the fish. The PUFA ω-3, as they are characteristic of the fish fat, and are absent in olive oil, had significant interchanges during the processes, favourable to the oils in deep-frying and canning. In conclusion our results show that there is an important influence of the oil used in the processing on the final composition of the sardines fat. This influence is much more remarkable in the canning than in the deep-frying, being the final composition of the just canned sardines fat more similar to the one of olive oil than the one of the fried sardines.

Dietary effects of sunflower oil used for frying on lipemia and HDL composition in rats

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The effect on lipemia, HDL composition, food intake and weight gain was determined in rats fed a diet with 15% sunflower oil that had been used in 75 repeated fryings. This used oil contained 19% polar material. Serum lipids, HDL composition and weight gain in rats fed this diet for four weeks were compared to rats fed a control diet that contained 15% unused sunflower oil. In both groups of rats the food intake was similar, while the weight gain observed in rats fed used oil was significantly lower. In addition, the food efficiency and the protein efficiency -ratios were decreased in rats fed the used oil. No treatment effect was found on HDL-triacyglycerols levels. However, phospholipids and all forms of cholesterol were significantly increased in the HDL from rats fed the diet containing used sunflower oil. As a consequence of the HDL composition change, the amount of all forms of serum cholesterol increased in rats fed used oil, while the amount of serum triacylglycerols remained unchanged in both groups of rats.

	Values for rats fed diet containing	
HDL Measurement	Unused oil	Used oil
Total cholesterol (TC) (mmol/L)	1.38±0.07[a]	1.70±0.12[b]
Free cholesterol (TC) (mmol/L)	0.19±0.02[a]	0.20±0.03[a]
Esterified cholesterol (EC) (mmol/L)	1.019±0.13[a]	1.57±0.12[b]
Triacylglycerols (Tg) (mmol/L)	0.13±0.01[a]	0.14±0.12[a]
Phospholipids (PL) (mmol/L)	1.22±0.06[a]	1.43±0.06[b]
TC/PL	0.57±0.03[a]	0.62±0.04[a]
TC/Tg	4.92±0.38[a]	5.99±0.57[a]
FC + PL/EC + Tg	1.82±0.09[a]	1.68±0.11[a]
Esterification index[a]	85.98±1.84[a]	97.71±4.61[b]

[a] Esterification index = Esterified cholesterol (EC)/Total cholesterol (TC). Results (mean ± SEM) of samples analysed bearing different superscripts are significantly different ($p<0.05$).

Effect of frying on the composition of three fishes. Comparison with other culinary processes

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Deep-fat frying is one of the major culinary process that provide good sensory properties and a quick elaboration. Their effect over food composition depends on many factors as the type of food, used oil and the combination of temperature/time applied. Fish is a traditional food in the «Mediterranean diet». Although many culinary technologies can be used in the elaboration of fish dishes, frying is one of the most common. Nutritional value of cooked fish can differ significantly from that of raw fish. The purpose of this work was to stablish the compositional and energetic differences between raw and fried fishes for three common species: hake (merluza), sole (lenguado), and codfish (bacalao); as well as the differences between fried hake (merluza) and stewed hake. Coating and frying gave rise to a high increase in the fat percentage of fishes. Fat percentages in raw and cooked fishes were: hake 3.75 and 10.47%, codfish 1.26 and 7.13%, sole 8.03 and 16.42. The applied technology leads to evaporation. The losses of moisture were 10.33% for hake, 7.65% for codfish and 7.8% for sole. Also some significant increases of the protein percentages were observed: 2.2% hake, 2.2% codfish and 4.94% sole. All these changes, specially those of fat percentages, led to considerable increases in the energetic values of fried fishes the Kcal/100g in raw and fried fishes were: hake 113 and 182, codfish 83 and 152, sole 114 and 205.

Fried hake showed 7.94% more fat, 4.38% more protein, 2.26% more carbohydrates and 0.43% more ashes than stewed hake. The energetic value were 182 in fried hake and 84.6 in stewed hake.

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Evolution of extra virgin olive oil natural antioxidants during continuous frying

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In this work, the evolution of degradation of Extra Virgin Olive oil natural antioxidants has been studied during twenty five frying of potatoes. The most important natural antioxidants in olive oil, polyphenols (Tyrosol and hidroxytyrosol) and Vitamin -E (α-tocopherol) were analized by HPLC. In polyphenolic antioxidants, Hidroxytyrosol had a very important degradation until the sixteenth frying, then it couldn't be detected. Tyrosol degradation was slower and it was detected until the twenty-fifth frying. Both evolutions are compared. Polyphenols

concentration are expressed as Tyrosol. On the other hand, α-tocopherol had a linear degradation how the frying number was increased. All the natural antioxidant studied had different evolution under the assayed conditions.

Frying performance of red palm olein, RBD palm olein, and corn oil

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Red palm olein is a new cooking oil produced in Malaysia. It is carefully processed with stringent quality control to preserve the inherent high contents of β-carotene, tocopherols, and tocotrienols. The high level of natural antioxidants found in red palm olein would contribute to its thermal stability and the antioxidants could also be adsorbed or absorbed into the foods during frying, thereby enhancing the keeping quality of the fried foods. A comparative study was therefore undertaken to evaluate the frying performance of red palm olein, RBD (refined, bleached, and deodorised) palm olein and corn oil.

The quality changes of various oil samples during frying at 180°C for 3 hr per day for 5 consecutive days were monitored. Thiobarbituric acid (TBA) value, free fatty acids content (FFA), iodine value, color, and viscosity of the oil samples were determined. Sensory quality of the prawn crackers fried in these oils and their oxidative stability were also examined.

Red palm olein exhibited significantly better oxidative and hydrolytic stability during frying (α=0.05). At the end of frying period, TBA values were 54.0, 60.9, and 65.8 μmoles malonaldehydes/kg oil, while FFA were 0.42, 0.48, and 0.53% for red palm olein, RBD palm olein, and corn oil, respectively. The iodine values decreased by 8.6, 9.4, and 16.9g of I_2/100g oil, while viscosity increased by 16.8, 21.0, and 28.2 centipoise for red palm olein, RBD palm olein, and corn oil, respectively. Color intensity of red palm olein decreased dramatically during the first two days of frying, while color intensity of RBD palm olein and oil increased with frying times. Prior to storage, prawn crackers fried in RBD palm olein and corn oil had better overall acceptability than those fried in red palm olein. However, after 14 weeks of storage at 25°C, prawn crackers fried in red palm olein showed the most superior oxidative stability.

Kinetic behaviour of the hydrolysis of palm olein used for frying

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The enzymatic hydrolysis of used frying palm olein with different degrees of alteration were measured using porcine pancreatic lipase (acylglycerol acylhydrolase EC 3.1.1.3.). Titrimetric assay was employed to determine lipolytic activity. In all cases hydrolysis corresponds to a Michaelis-Menten saturation kinetic behaviour, in agreement with the straight line observed in the Eadie-Hofstee plot. Each data set was fitted to the Michaelis-Menten equation by non-linear regression and the corresponding K_M^{app} and V_{max}^{app} were estimated. Our results show that the kinetic parameters K_M^{app} and V_{max}^{app} did not change in the process of friying (Table I). The alterations obtained after frying in palm olein may induce different effects which enhance or interfere with enzymatic hydrolysis. The possibility that all these effects may balanced could be responsible for the absence of changes in the kinetic parameters.

Table I
Kinetic parameters for the hydrolysis of unused palm olein and palm olein after being used in 40 and 90 fryings

Number of fryings	K_M^{app} (mM)·10	V_{max}^{app} (μmol/min·mg E)·10^3
0	5.1±0.7	166±7.6
40	4.0±0.6	147±6.8
90	5.3±0.9	226±14.0

Lipid exchanged during frying of frozen prefried potatoes in olive oil

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Lipid exchanges during frying of frozen prefried potatoes in olive oil were studied. After 15 frying operations, changes in the major food components, as well as in the fatty acid and triglyceride

parameters was different: in sunflower, high oleic sunflower and olive-pomace oil both indexes increased in a linear way; virgin olive oil showed a parabolic change, reaching a stable value of K_{232} and K_{270}. The slope of the regression was triple (K_{232}) and double (K_{270}) for sunflower oil compared to the other oils. The higher stability of virgin olive oil in frying processes is demonstrated.

Use of domestic fryer among university student's families. Preliminary data

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Pan frying is the usual way for food frying at homes in the Mediterranean Countries, however a marked increase in the use of domestic deep-fryers has been produced in these countries during the last decade. The aim of this study is to get data about the utilization of domestic fryers: 1) Type of oil used for frying, 2) Kind of food fried in it, and 3) Number of fryings until rejection of oil. For this, a previous survey was performed between 50 persons belonging the Madrid University to know which kind of food and oils they used for frying. Afterwards, another survey was performed between 250 university students, belonging to the Madrid University, in which homes was used the domestic fryer. The most of them were women aged 19-22. 74,6% employed olive oil, 17,3% sunflower oil and 8,1% both of them. Nobody used another kind of fat or oil. 56% of users fried every type of food in the same oil, while 30% changed the oil when fish was the food to fry. 14% never fried fish in domestic fryers but in pan. About the number of fryings, the most of the people did not answer this question, being 10-20 fryings the most usual answer. The most frequent foods fried were potatoes, frozen prefried potatoes and fish, followed by every kind of frozen-precooked foods. The foods fried preferently in pans were the fresh ones, while the frozen precooked ones were fried mainly in domestic fryers. No food was indifferently fried. The frying frequency changed from 9,9 times/week for the potatoes to 1,6 times/wk for the breaded breast. Results of this survey will be used to perform a study on deep frying the most consumed foods among the users of domestic fryers, our group will fry the most consumed frozen foods bearing in mind the frequency and the preference of frying. The chosen foods are: croquettes, pasties, fritters, prefried potatoes, fish fingers, breaded fish, breaded ham and cheese and squid fried in batter.

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