Changes induced by prolonged and discontinuous heat treatment on fatty acids of frying oils

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The first two activities of the PhD thesis project are described. Firstly, three lipidic matrices, with different saturated/unsaturated fatty acid ratios (S/I), were subjected to a prolonged and discontinuous heat treatment. The acidity, hydroperoxides concentration, total polar compounds (TPC) and acidic composition were determined. Secondly trend of octanoic acid (C8:0) and of neo-formation trans fatty acids were studied. Trans fatty acids showed a good correlation with TPC.

Modificazioni indotte dal trattamento termico prolungato e discontinuo sugli acidi grassi di oli di frittura

Le prime 2 attività del progetto di tesi di dottorato sono descritte. Sono stati sottoposti a trattamento termico prolungato e discontinuo tre matrici lipidiche con diverso rapporto acidi grassi saturi/insaturi (S/I). Sono state determinate l' acidità, la concentrazione di idroperossidi, i composti polari totali (CPT) e la composizione acidica. E' stato studiato l'andamento dell'acido ottanoico (C8:0) e degli acidi grassi trans di neoformazione che hanno mostrato una buona correlazione con i CPT.

Keywords: lard, olive oil, sunflower seed oil, TPC, acidity, peroxide number, fatty acid composition

1. Introduction

In accordance with the PhD thesis project previously described this poster is based on comparison of three oils, olive oil (S/I 0.17), lard (S/I 0.66), and sunflower oil (S/I 0.15), in order to assess the stability of a frying medium and to identify a possible marker of the oxidation state of triglycerides correlating with TPC. Each oil was chosen for a specific purpose. The olive oil, for its low amount of polyunsaturated fatty acids, shows a good stability during frying. The lard with its high content of saturated fatty acids and low proportion of polyunsaturated fatty acids could be an ideal frying medium, but its cholesterol content does not make it the most used frying bath. Sunflower oil is the most common frying oil. In olive oil the C8:0 showed a particular trend, firstly increased in oil extracted from potatoes, then it was the same in frying oil and in the one extracted and, at the end of heat treatment, the C8:0 was present only in frying bath. The octanoic acid is one of the most significant products of fatty acids oxidation so it should be considered as a possible marker. In potatoes fried in lard the main result was the high trans fatty acids concentration and their good correlation with TPC (R^2 0.953). Trans fatty acids could be considered as good markers because they already appeared at 8 hours of frying in all three frying oils. In sunflower oil there was a good correlation between saturated fatty acids (SFA) and TPC (0.903) for frying bath and a good correlation between polyunsaturated fatty acids (PUFA) and TPC (0.929) for oil extracted from potatoes.

2. Materials and Methods

The three fatty matrix were subjected to a prolonged and discontinuous thermal treatment at 180°C for 8 hours at day for a total of 48 hours. Every day about 100mL of fresh oil was added to frying bath. Frozen pre-fried potatoes were used with a solid/liquid ratio of 1:10 (2L of oil and 200g of potatoes). The total samples obtained (thermo-oxidated oil, frying oil and oil extracted from potatoes) were stored at -20°C and subjected to the following analytical determinations: acidity (EEC, 1991), peroxide value (AOCS, 1989), fatty acid composition (by HRGC-FID), total polar compounds (TPC) (Hein *et al.*, 1998).

3. Results and discussion

The maximum limit of 25% of TPC was exceeded in olive oil and in sunflower oil after 32 hour of thermo-oxidation and at 48 hour in lard. TPC were not exceeded for the frying oils. The oil extracted from potatoes showed an higher concentration of TPC. About acidic composition, the C8:0 is important in olive oil. The octanoic acid is originated from 9-hydroperoxides of oleic, linoleic and linolenic acids that are the major unsaturated fatty acids in edible fats and oils. This short chain fatty acid remain bound to the original triglyceride. The C8:0 showed a good correlation (R^2 0.8426) with TPC in thermo-oxidated olive oil (Fig. 1A). In frying bath, the C8:0 not always showed an increased trend because part of octanoic acid was absorbed by

potatoes. At 32nd hour the C8:0 concentration was similar in both oil and, at the 48th hour it was disappeared in fat extracted from potatoes and was increased in frying oil (Fig. 1B)
In lard, trans fatty acids showed a good correlation (0.9531) with TPC (Fig. 2). This suggest that the trans fatty acids should be considered as a valid marker to evaluate the thermal oxidation also because they already appear at 8 hours of frying in all three frying oils. In sunflower oil the SFA and PUFA should be proposed as alternative to the TPC, respectively with a correlation index of 0.9039 (Fig. 3A) and 0.9292 (Fig. 3B) in frying bath and in fat extracted from potatoes. About other fatty acid it was showed an increase in the concentration of palmitic acid (C16:0) and fatty acid with trans isomers versus a significant reduction of oleic and linoleic acids. In particular, the C16:0 increases in olive oil and in lard, respectively of 27 and 9% compared with a decrease of C18:1. In sunflower oil the C18:2*n6cis* was degraded for the C16:0 that was increased of 12%. The initial research project has been confirmed for next year by expanding the program with two new matrices: palm oil and soya beans oil and adding analysis to determine volatile organic compounds (VOCs) and neo-formation compounds by mass spectrometry (MALDI-TOF).

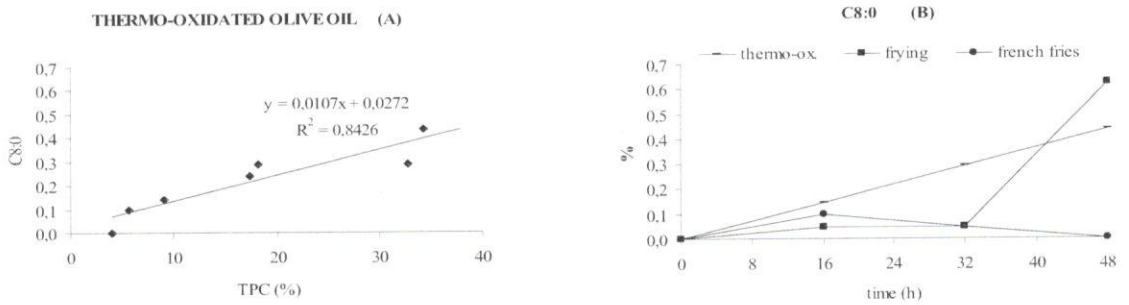

Figure 1 *(A) Correlation between C8:0 and TPC in thermo-oxidated olive oil. (B) The C8:0 trend in olive oil in thermo-oxidated oil, in frying bath and in the extracted fat from potatoes.*

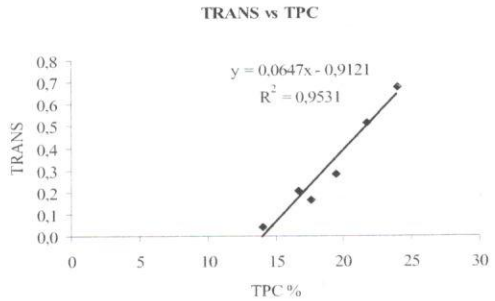

Figure 2 *Correlation between trans fatty acids and TPC in lard extracted from potatoes.*

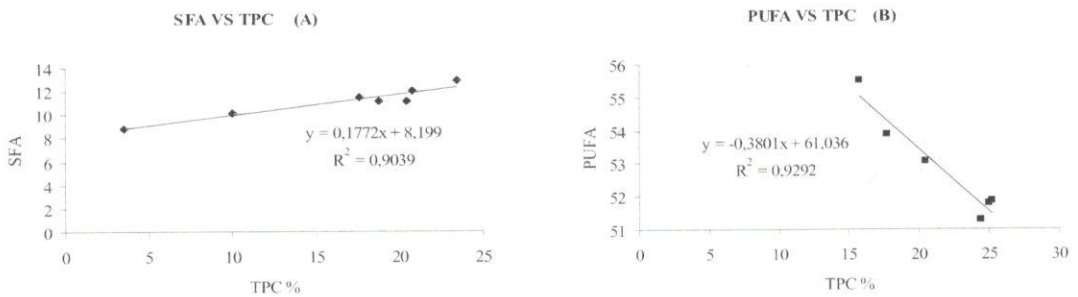

Figure 3 *(A) Correlation between SFA and TPC in frying sunflower oil. (B) Correlation between PUFA and TPC in sunflower oil extracted from potatoes.*

4. References

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