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Effect of Intermittent Frying on Tocopherols, Lipid Contents and Lipid Oxidation Products during Plantain Chips Production with Soybean Oil

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Abstract *Frying is a thermal process widely used in Cameroon to produce foods with sensory properties highly appreciated by consumers. As a contribution to the assessment of the risks linked to the excessive consumption of fried foods, we have studied the influence of intermittent frying on the lipid content of the plantain chips produced and the degradation of soybean oil used. Samples of plantain chips and frying oil were collected twice a day for 5 days in the laboratory during intermittent frying (2 min of frying/180°C; each 30 min during 4 hours in the continuously heated oil bath). The lipid content of the chips was determined according to AOAC standard method. Malondialdehyde (MDA) and vitamin E contents of frying oils were analyzed by HPLC while trans fatty acids (TFA) were evaluated by Infrared Spectroscopy. The chips had high lipid content that increased significantly with frying baths (from 17.80 to 27.18g/100g chips). A decrease in vitamin E content was observed with a significant increase ($P<0.05$) in MDA contents in oils after 20 hours of intermittent frying while TFA was not identified. The results showed that continuous heating of soybean oil with intermittent frying have an important effect on lipid content and a deleterious effect on the quality of chips characterized by loss of vitamin E and appearance of oxidation products.*

Keywords. Intermittent frying, plantain chips, soybean oil, Vitamin E, oxidation products.

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Introduction

Frying is a thermal process widely used to produce foods highly appreciated by consumers. Among frying products, plantain (*Musa paradisiaca*) chips are very popular in Cameroon. Deep fat frying is intermittently used all along the day, generally without any control of the temperature and the remaining oil is re-used the day after. In these conditions, thermal degradations involving reactions such as lipid oxidation and Maillard reactions take place, leading to various neo-formed compounds and the loss of the sensory and nutritional qualities of the fried product (Aladedunye & Przybylski, 2009) with health implications. Several frying process parameters have already been addressed (Yomeni, Njoukam & Tchango, 2004; Tarmizi & Ismail, 2008) as well as the performance of the oils. Nevertheless, the diffusion of the results in terms of good frying practices applicable by small-size producers is still an issue. Data concerning the effects of intermittent frying with oils continuously heated on the quality of oils and chips are lacking. We present here the results of a study aimed at determining the changes that occur during intermittent frying of plantain chips with soybean oils. Lipid content of the chips, vitamin E, *trans* fatty acid and lipid oxidation products of oils collected were determined.

Results and discussion

Plantain slices (2 mm; 75 g) were fried in an electric deep batch fryer (Profry Oleoclean, SEB, France) containing 3 liters of refined soybean oil. They were introduced 20 min after the temperature of the batch had reached 180°C +/- 5°C. Samples of plantain chips and frying oil were collected twice a day for 5 days of intermittent frying (slices fried for 2 min each 30 min during 4 hours in the continuously heated oil bath).

Lipid content .It was determined on ground chips with Soxhlet extraction using hexane as solvent. It increased with time (Figure 1), which has been attributed to the increase of the polarity and viscosity of the oils due to oxidation compounds formed during thermal degradation (Gupta, Warner & White, 2004).

Vitamin E. Tocopherols and tocotrienols, were analyzed in oils samples by isocratic HPLC paired with fluorescence detector with quantification with standard solutions of α , γ , β and δ tocopherols and γ tocotrienol. Vitamin E content of the oil decreased continuously with time of continuous heating (Figure 2). Vitamin E is an antioxidant, that reacts with the free radicals formed from the oil fatty acids, retarding oxidation (Margherita, Alamprasse & Ratti, 2007). Intermittent frying and continuous heating of soybean oil is deleterious to this nutrient.

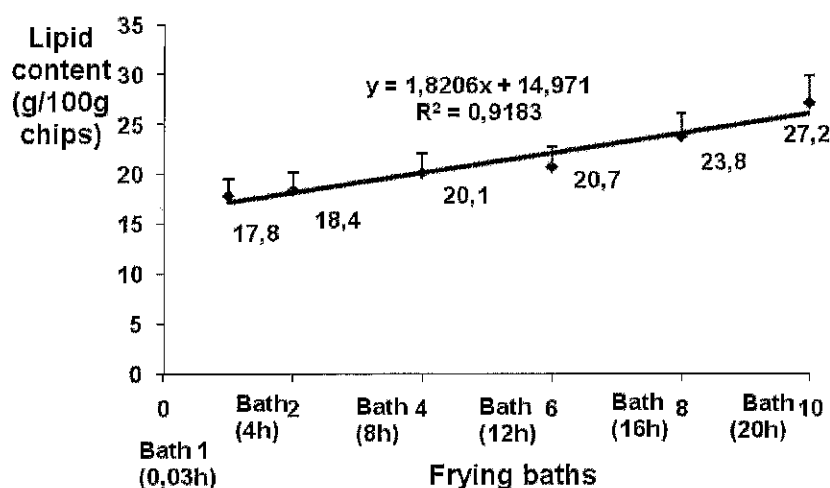


Figure 1: Changes in lipid contents of plantain chips produced with soybean. Chips were collected from different baths during intermittent frying (180°C/2 min).

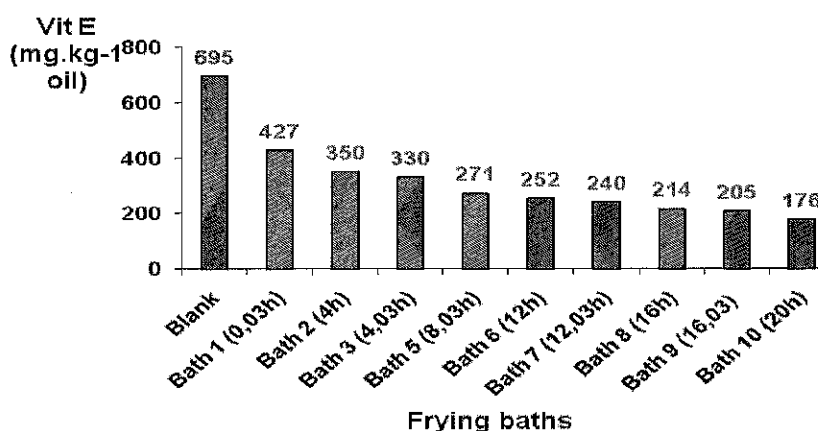


Figure 2: Changes in vitamin E content (tocopherols plus tocotrienols) of the soybean oils collected during production of plantain chips by intermittent frying (180°C/2 min).

Oxidation products

Malondialdehyde (MDA) was analyzed in collected oil samples, by U-HPLC in isochratic mode with fluorescence detection after the formation of MDA-(TBA)₂ complex in acid conditions. MDA concentration, determined by comparison of tetraéthoxypropane calibration curve, increased with time of continuous frying (Figure 3), indicating lipid oxidation during intermittent frying. The formation of *trans* fatty acids was followed by Infra red spectroscopy with the specific appearance of an absorption peak at 966 cm⁻¹. With intermittent frying, no significant change of the absorbance was observed, suggesting that no changes in the *trans* fatty acid content of the

oils happened during the time of frying with soybean oil.

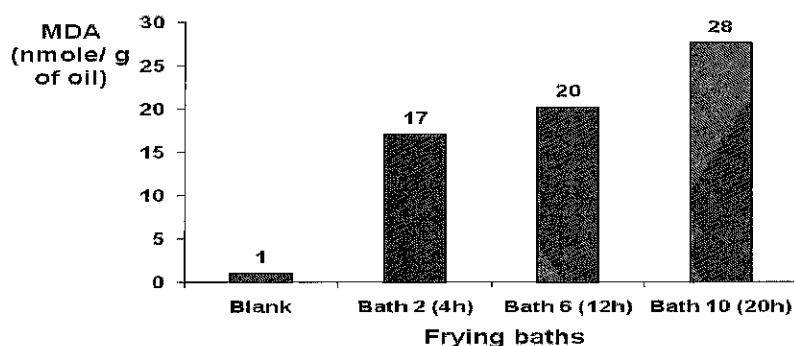


Figure 3: Secondary oxidation products (Malondialdehyde: MDA) in oils collected during production of plantain chips with soybean oil by intermittent frying (180°C/2 min).

Conclusion

Producing plantain chips by intermittent frying with continuous heating of soybean oil leads to a progressive increase of lipid content of the chips and a decrease in the vitamin E content of the frying oil. Lipid oxidation products are progressively formed in the oils, which could impair the quality of chips. Fortunately, no *trans* fatty acids were identified by IR spectroscopy after 20 h of intermittent frying. We are now studying the effect of the oils issued from intermittent frying on some biological functions of the rats.

Acknowledgements

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