Food Chemistry 243 (2018) 192–201

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Fried potatoes: Impact of prolonged frying in monounsaturated oils

Carla S.P. Santos[a], Lucía Molina-Garcia[a,b], Sara C. Cunha[a], Susana Casal[a,c,*]

[a] REQUIMTE, Laboratory of Bromatology and Hydrology, Faculty of Pharmacy, University of Porto, Rua Jorge de Viterbo Ferreira 228, 4050-313 Porto, Portugal
[b] Department of Physical and Analytical Chemistry, Faculty of Experimental Sciences, University of Jaén, Campus las Lagunillas, E-23071 Jaén, Spain
[c] EPIUnit - Instituto de Saúde Pública, Universidade do Porto, Rua das Taipas, nº 135, 4050-600 Porto, Portugal

ARTICLE INFO

Keywords:
Deep-frying
White potatoes
Nutritional and sensory quality
Acrylamide
Ascorbic acid
Oxidation
Monounsaturated fats

ABSTRACT

Fresh potatoes were intermittently deep-fried up to recommended limits (175 °C, 8 h/day, 28 h) in extra-virgin olive oil (EVOO), peanut oil (PO) and canola oil (CO), and compared for diverse chemical components and sensorial attributes, aiming to quantify the impact of prolonged frying on potatoes nutrients, and the potential alterations resulting from the use of different monounsaturated-rich oils.

Independently of oil type, its degradation promotes time-dependent losses of important potato nutrients, as vitamin C. Regarding the monounsaturated-rich oils tested, potatoes fried in CO had more equilibrated fatty acid profiles, but higher amounts of aldehydes derived from PUFA oxidation, while in EVOO were enriched with phenolic compounds. Acrylamide amounts were not affected by oil type or frying hours. Sensory degradation was gradually perceived by the panellists, except in PO.

Prolonged frying should not be studied only on the basis of oil degradation because, even if within regulated limits, it induces loss of important food compounds.

1. Introduction

Deep-frying is among the most popular cooking methods worldwide. Several studies comparing performances of different vegetable oils during prolonged frying are found in the literature, as recently reviewed (Hosseini, Ghorbani, Meshginfar, & Mahoonak, 2016; Nayak, Dash, Rayaguru, & Krishnan, 2016), but when searching for the nutritional impact from the consumer's perspective, on the fried food, data on nutritional and sensory changes during prolonged frying are scarce (Boskou, Salta, Chiou, Troullidou, & Andrikopoulos, 2006; Carlson & Tabacchi, 1986; Han, Kozukue, Young, Lee, & Friedman, 2004; Romano, Giordano, Vitiello, Grottaglie, & Musso, 2012; Salta, Kalogeropoulos, Karavanou, & Andrikopoulos, 2008; Zhang, Zhang, Cheng, Wang, & Qian, 2015). Fried food incorporates fat in variable amounts, while being enriched in oil components, as fatty acids and vitamin E (Casal, Malheiro, Sendas, Oliveira, & Pereira, 2010; Chiou, Kalogeropoulos, Boskou, & Salta, 2012). Simultaneously, some food components are loss by evaporation or leaching, as moisture itself, or degraded, as ascorbic acid, while new compounds are formed during these hot oil-food interactions, including highly pleasant ones, as the typical fried volatile flavors, or unhealthy ones, as degraded lipids and acrylamide (Camire, Kubow, & Donnelly, 2009).

Potatoes (*Solanum tuberosum* L.) are regarded as an excellent source of carbohydrates, supply protein of high relative biological value (90–100), while being very low in fat (0.1%) (Camire et al., 2009). They are also rich in several micronutrients, as essential minerals, carotenoids, phenolic compounds, and vitamin C (Camire et al., 2009). However, to increasing its digestibility, potatoes are consumed only after cooking, by boiling, roasting, frying, among others (Decker & Ferruzzi, 2013). Therefore, together with the agronomic practices, postharvest storage methods and potato varieties, known to influence potatoes composition, the cooking method and, in the particular case of frying, the cooking oil determines the nutrients truly available to consumers.

From the vegetable oil perspective, many types of vegetable oils are available for deep-frying purposes, highly based on availability, tradition, and thermal resistance. Soybean and sunflower are more generally accepted worldwide, canola oil is common in various European countries and Canada, peanut oil is also used in several countries, while olive oil is more traditionally used around the Mediterranean Sea (Hosseini et al., 2016). While the health impact of saturated fats is still under discussion, and hydrogenated ones are fading out, vegetable unsaturated fats have moved to the forefront, and among them, monounsaturated fats (MUFA) are increasingly providing a broader spectrum of functionality and health benefits (Gillingham, Harris-Janz, & Jones, 2011), with an inherent higher thermal oxidation stability than polyunsaturated fats (PUFA). Several "high-oleic" vegetable oils, both natural (as olive oil and peanut oil) or "modified" (high-oleic

* Corresponding author at: Laboratory of Bromatology and Hydrology, Faculty of Pharmacy, University of Porto, Rua Jorge de Viterbo Ferreira 228, 4050-313 Porto, Portugal.
E-mail addresses: csps.santos@gmail.com (C.S.P. Santos), lucymolgar@gmail.com (L. Molina-Garcia), sara.cunha@ff.up.pt (S.C. Cunha), sucasal@ff.up.pt (S. Casal).

http://dx.doi.org/10.1016/j.foodchem.2017.09.117
Received 2 June 2017; Received in revised form 11 September 2017; Accepted 22 September 2017
Available online 27 September 2017
0308-8146/ © 2017 Elsevier Ltd. All rights reserved.

rapeseed (canola), high-oleic sunflower, high-oleic soybean, or palm-olein fractions), are increasingly available. As stated above, a huge amount of research has been dedicated to the comparative performance of different frying oils, but most studies are strictly focused on oil degradation and lipid absorption, without evaluating the true impact on potatoes quality. Those who do, evaluate potatoes quality for single compounds and not as a global nutritional approach (Boskou et al., 2006; Carlson & Tabacchi, 1986; Han et al., 2004; Romano et al., 2012; Salta et al., 2008; Zhang et al., 2015).

Therefore, the aim of the present work was to compare the nutritional and sensory quality of fresh potatoes during intermittent deep-frying, in three MUFA-rich oils commercially available to consumers: peanut oil (PO), canola (CO) and extra virgin olive oil (EVOO), up to oil recommended disposal point (25% of total polar compounds – TPC). The main focus is the nutritional, sensory, and potential health impacts of the degraded fat interacting with potato bioactive compounds, while attempting to compare the gains and losses from using different monounsaturated-rich oils.

2. Materials and methods

2.1. Frying assays

White potatoes (*Solanum tuberosum* L., Fontane variety) were chosen due to their frying aptitude and availability in the local market (Porto, Portugal). Their proximal composition included 1.2 g of sugars, 0.1 g of lipids and 1.6 g of fiber, all on a 100 g fresh basis, further detailed in Table 1. EVOO and PO were commercially available in Portugal, while CO was acquired in France.

The present work was designed to simulate restaurant frying, heating the oils for 8 h a day (intermittent thermal stress – 8 h heating and 16 h cooling), with frying cycles every 30 min. Deep-frying assays were performed in three deep-fat electric fryers (TRISTAR, FR-6929 model, The Netherlands), at 175 °C (periodically controlled with a calibrated digital thermometer), using 1.5 L of oil on each, without reposition. Fresh potatoes were cut into toothpicks (1 × 1 × 4 cm), washed, drained, and a batch (50 g) was fried during 6 min, every 30 min, during 8 h per day, up to 28 h, imposed by the total polar compounds content in PO and CO (> 25%), based on dielectric readings oil (Food Oil Sensor, Switzerland).

Potatoes samples were collected in triplicate every 4 h, except on the first day (first sampling at 8 h). Some analyses were immediately executed, namely sensory analysis, instrumental color, moisture and total ascorbic acid. The remaining portions were stored at −20 °C until further analyses. Fresh vegetable oils were also analyzed for some compositional parameters.

2.2. Chemical analysis

2.2.1. Moisture

Moisture was determined after grinding, by infrared drying at 105 °C (Scaltec SMO 01, Germany), until constant weight, being expressed in g *per* 100 g of raw or fried potatoes.

2.2.2. Lipid content

Incorporated fat was extracted with petroleum ether (40–60 °C; 0.01%BHT) using an automatic Soxhlet device (Büchi Extraction System, B-811). Lipids were dried under vacuum before weighting, and stored at 4 °C.

2.2.3. Fatty acids composition

Fatty acids composition of lipid extracts and fresh vegetable oils was evaluated by gas chromatography, after cold transmethylation (ISO 12966-2:2011, 2011), using a FAME CP-Select CB column (50 m × 0.25 mm) on a Chrompack CP 9001 gas chromatograph (Chrompack, Middelburg, The Netherlands). Fatty acids identification and FID calibration was accomplished with a certified reference mixture of fatty acids methyl esters (TraceCert – Supelco 37 component FAME mix, USA). Fatty acids were expressed in g *per* 100 g of potatoes or vegetable oils.

2.2.4. Tocopherols

Tocopherols of potato lipid extracts and fresh vegetable oils were quantified by normal-phase HPLC with fluorescence detection, using tocol (Matreya, USA) as internal standard and direct dilution in hexane (Casal et al., 2010). Individual calibration curves were prepared for each identified tocopherol compound (Sigma-Aldrich, Germany). Results were expressed in μg/100 g for potatoes or mg/100 g for oils, with a quantification limit of 0.2 μg/100 g.

2.2.5. Ascorbic acid

Total ascorbic acid extraction was carried out according to Santos, Cunha, and Casal (2017), using an aqueous solution with 8% acetic acid and 3% metaphosphoric acid, together with *tris*-(2-carboxy-ethyl)-phosphine-hydrochloride (2.5 mM) (Carl Roth, Germany) for dehydroascorbic acid reduction, under light protection. Chromatographic analyses were performed using a HPLC system (Gilson, France), with a photodiode array detector (Varian Prostar, USA), controlled by a data processor software (Varian Star Workstation, USA). Chromatographic separation was achieved using a reversed-phase C18 Spherisorb ODS-2 column (Waters, 3 μm, 150 × 4.6 mm, Ireland) with a gradient of acetate buffer (30 mM) and aqueous methanol (30/70 v/v), at 0.6 mL/min. Quantification was based on external standard method using L-ascorbic acid standard (Sigma-Aldrich, USA), subjected to the entire extraction procedure, with a quantification limit of 5 μg/mL of extract.

2.2.6. Total carotenoids

Total carotenoids of both potatoes and fresh vegetable oils were estimated by UV absorbance according to Nagata and Yamashita (1992), after extraction with acetone:hexane (40:60), being expressed in μg of β-carotene equivalents per 100 g of potatoes or oils.

2.2.7. Antioxidant activity

Sample extracts were prepared according to Pérez-Jiménez et al. (2008). For potatoes, extracts were prepared with acidic methanol/water extraction, followed by acetone/water, while the fresh vegetable oils were directly diluted in ethyl acetate.

Total reducing capacity, as a broad estimation of total phenolics, was determined by the colorimetric Folin-Ciocalteu method (Wu et al., 2012) adapted to 96-well microplates. For the radical scavenging activity, extracts were analyzed for their capacity to scavenge the stable 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical (Wu et al., 2012). The *β*-carotene/linoleic acid bleaching assay was also applied to the extracts (Fukumoto & Mazza, 2000). Gallic acid (Sigma-Aldrich, USA) was used as reference on all the assays, within the 0.125–50 μg/mL range (R^2 > 0.998), with the results expressed in mg of gallic acid equivalents (GAE) per 100 g of potatoes or oils.

2.2.8. Acrylamide

Acrylamide content of potatoes was analyzed by GC–MS in selected ion monitoring mode, after extraction with water and 1,2-dichloroetane and derivatization with xanthydrol, as detailed in Molina-Garcia et al. (2015), with a quantification limit of 1 μg/100 g.

2.2.9. Volatile compounds

Potatoes volatile compounds were analyzed by headspace solid-phase micro extraction (HS-SPME) coupled with GC–MS (Agilent, Little Falls, DE, USA), based on a previously developed protocol (Molina-Garcia, Santos, Cunha, Casal, & Fernandes 2017), with slight adaptations and validation for the potato matrix. Two internal standards (4-methyl-2-pentanol and 1,2,3-trichloropropane, Sigma, USA, 0.2 μg each from ethanol solutions) were added to an accurate amount of potatoes

Download English Version:

https://daneshyari.com/en/article/5132546

Download Persian Version:

https://daneshyari.com/article/5132546

Daneshyari.com