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Persimmon Flour Co-Products as Novel Ingredients in the Reformulation of Pork Liver Pâté †

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Abstract: Co-products from the agro-food industry can be used as novel and natural ingredients in the reformulation of traditional foods to reduce the use of synthetic additives or improve their final quality. The aim to the study was to enrich pork liver pâté with persimmon flour co-products at two concentrations, 3 and 6% and to compare their total cholesterol (HPLC), fatty acid (GC) phenolic compounds (HPLC) profiles and lipid oxidation (TBARS assay) after in vitro digestion (INFOGEST consensus method) with the control pâté. The cholesterol content in pâté samples was significantly reduced in a dose-dependent way (control > pâté 3% > pâté 6%; 98 ± 8; 89 ± 3; 68 ± 11 mg/100g pâté, respectively), probably due to the fibre-cholesterol interactions. Gallic, caffeic acids, glycosylated gallic acid, glycosylated coumaric acid and glycosylated quercetin were detected in the enriched pâtés. The sum of all these compounds was 74 and 239 µg/g pâté in the pâtés with 3 and 6% of persimmon flour, respectively. Oleic, palmitic, and linoleic acids were the majority fatty acids found in all pâtés. The increase of lipid oxidation after in vitro digestion was higher in control pâté than in enriched pâtés. In conclusion, the enrichment of pâté with persimmon flours caused a reduction in their total cholesterol content and lipid oxidation after in vitro digestion, without modifications in their fatty acid profile to what the phenolic compounds could be contributing.

Keywords: antioxidants; by-products; kaki

1. Introduction

Currently, there is an increasing demand for natural ingredients with minimal processing. In this context, agro-food co-products could be a useful resource to naturals ingredients with different technological properties, as antioxidants, emulsifier agents, colourants, or water bindings Furthermore, those have high amounts of nutrients like fibre, vitamins, minerals, phytochemicals [1–5]. Pork liver pâté is in Europe widely consumed. It has provided a protein found, vitamins and fat. Due to high-fat content and low natural antioxidants, they suffer lipid oxidations [6], which have negative connotations to health. So added antioxidants to pork liver matrix could prevent or reduce that process. Persimmon fruit is origin to Asia. It has a high amount of sugar, vitamins, fibre, carotenoids, and polyphenolic compounds [7]. Around the world, different foods, like juice, dehydrated pieces, wine, jam, cakes, etc., are made with persimmon. The co-products derived to obtain the mentioned food-based persimmon, like peel and pulp overall, continue to have a high amount of nutrients, and technological properties as colourants, antioxidants, nitrite reduce agents or cholesterol blinding [2,3,5]. So, the aim to the study was to enrich pork liver pâté with persimmon flour co-products at two concentrations, 3 and 6% and to compare their total cholesterol, fatty acid polyphenolic compounds profiles and lipid oxidation after in vitro digestion with the control pâté.

2. Materials and Methods

2.1. Manufacture of Liver Pâtés

For each studied sample, were made three different batches: control pork liver pâté (CP) (without persimmon flour), pork liver pâté enrichment with 3% of persimmon flour cv "Rojo Brillante" (P-3RB) and pork liver pâté enrichment with 6% of persimmon flour cv "Rojo Brillante" (P-6RB) following the procedure described by Lucas-González et al. [5].

2.2. Fatty Acid Profile

Fat extraction was carried out following the Folch method [8]. Derivatization, detection, identification, and quantification of fatty acids was carried out following the procedure describe by Pellegrini et al. [9].

2.3. Total Cholesterol

In crude pork liver pâté, was determined the total cholesterol formulations following the procedure described by Essaka [10].

2.4. Polyphenolic Compound Determination

Polyphenols compounds extraction was carried out following the methodology by Mpofu, Sapirstein and Beta [11]. Polyphenol detection, identification, and quantification were carried out as described by Lucas-González et al. [12].

2.5. Simulated In Vitro Gastrointestinal Digestion

In vitro digestion assay was carried out following the Infogest Cost method [13].

2.6. Lipid Oxidation: 2-Thiobarbituric Acid Reactive Substances (TBARS) Test

For crude and digested samples (after gastric and intestinal steps) were carried TBARS assay [14]. Were expressed the results as a lipid oxidation increase, compared to the corresponding raw sample.

2.7. Statistical

Results were expressed as mean ± standard deviations of three repetitions. To know the differences between studied samples was carried out a simple ANOVA. Significances statistical differences were considered when *p*-value was <0.05 after Tukey's post hoc test.

3. Results and Discussion

3.1. Fatty Acid Profile

The fatty acid profile of pâtés samples (CS, P-3RB and P-6RB) was monounsaturated, following by saturated and polyunsaturated. Majority fatty acids found in all liver pork pâté formulations were Oleic, palmitic, and linoleic acids. Persimmon flour addition not modified fatty acid profile of pork liver pâté.

3.2. Total Cholesterol

The total cholesterol decreases in pâté samples as increase persimmon flours in the formulation (Table 1). This fact could be due to the ability of persimmon flours to join fat and bile acid [2]. If the cholesterol is bound to the matrix during gastrointestinal digestion, less cholesterol will be available to ingress in bloodstream.

Table 1. Total cholesterol in pork liver pâté samples.

	Total Cholesterol (mg/100g)
CP	98 ± 8 [bc]
P-3RB	89 ± 3 [b]
P-6RB	68 ± 11 [ab]

CP: control pâté; P-3RB: pork liver pâté enrichment with 3% of persimmon flour cv "Rojo Brillante"; P-6RB: pork liver pâté enrichment with 6% of persimmon flour cv "Rojo Brillante". Different Lower letters (a-c) indicate significant differences.

3.3. Profile of Polyphenolic Compounds

In crude enrichment pâté samples, were detected five polyphenolic compounds (Figure 1), which were contributed by persimmon flour. Gallic acid was the largest, whereas a trace amount of quercetin glycoside was detected. The increase in the number of compounds was dose-dependent.

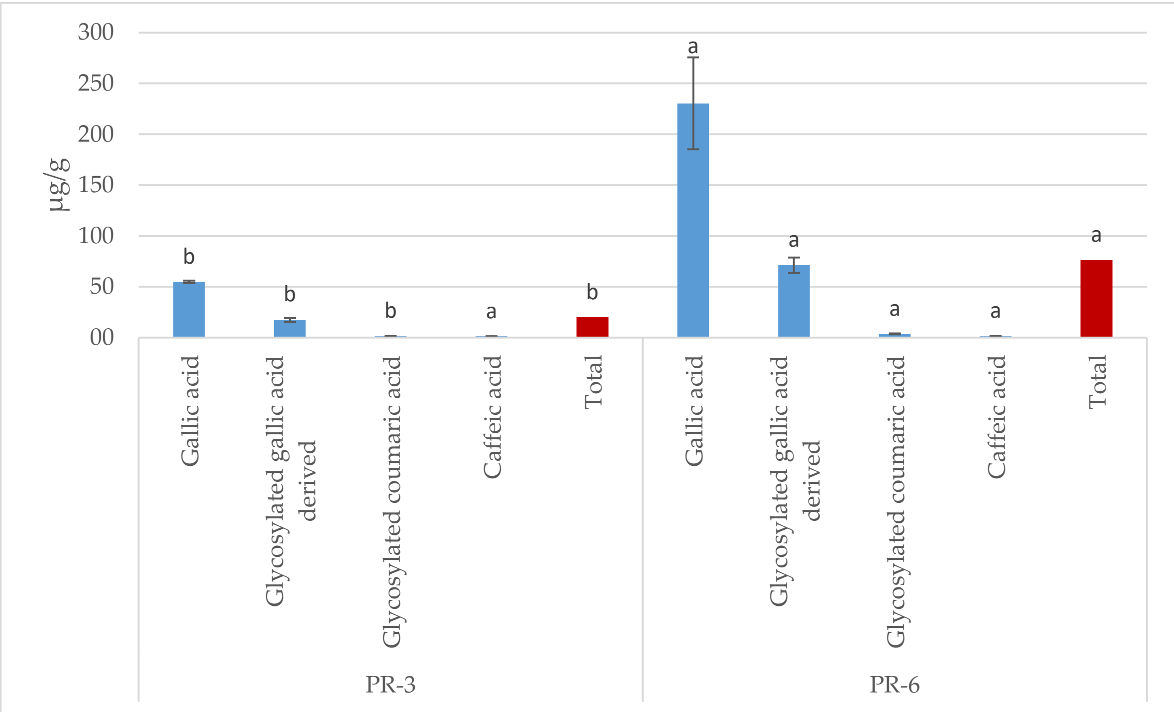

Figure 1. Polyphenol profile in pâté enriched with persimmon flours. CP: control pâté; P-3RB: pork liver pâté enrichment with 3% of persimmon flour cv "Rojo Brillante"; P-6RB: pork liver pâté enrichment with 6% of persimmon flour cv "Rojo Brillante". Total: Sum of four polyphenols quantified. Different case lower letters (a-b) for each individual phenolic compound and the total indicate significant differences between the two studied samples.

3.4. Lipid Oxidation After In Vitro Digestion

The incorporation to the persimmon flour to pork liver pâté reduce lipid oxidation raise after in vitro gastrointestinal digestion (Figure 2). The phytochemicals present in persimmon flour, like carotenoids and polyphenols, could be the responsibility of this lipid oxidation reduction after in vitro digestion.

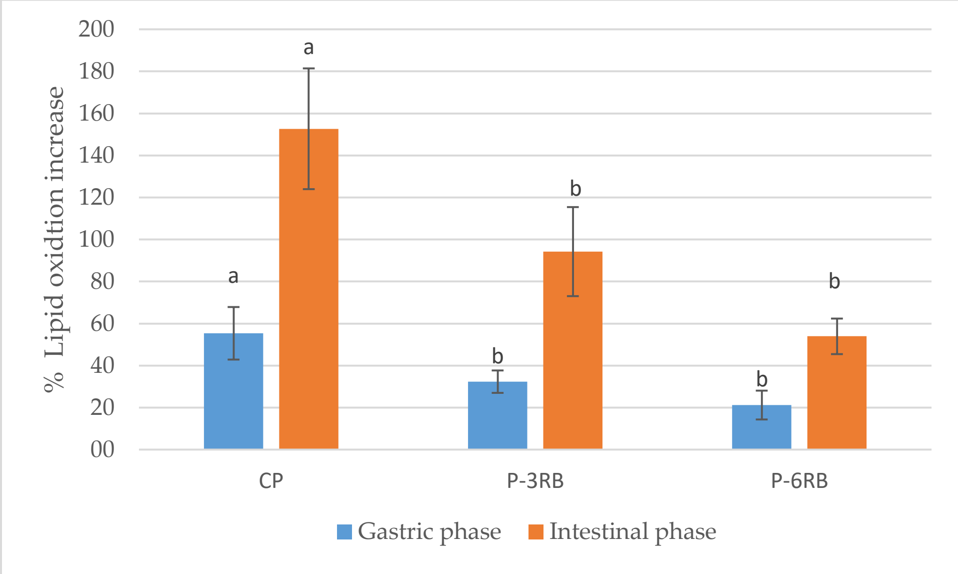

Figure 2. Lipidic oxidation increase (%) of pork liver pâté samples after in vitro gastrointestinal digestion. CP: control pâté; P-3RB: pork liver pâté enrichment with 3% of persimmon flour cv "Rojo Brillante"; P-6RB: pork liver pâté enrichment with 6% of persimmon flour cv "Rojo Brillante". Different case lower letters (a-b) for each simulated digestion phase indicate significant differences between the three studied samples.

4. Conclusions

The enrichment of pâté with persimmon flours caused a reduction in their total cholesterol content and lipid oxidation after in vitro digestion, without modifications in their fatty acid profile to what the phenolic compounds contributed by persimmon flours could be contributing.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "conceptualization, R.L.-G., J.F.-L. and M.V.-M.; methodology, R.L.-G. and M.V.-M.; investigation, R.L.-G. resources, J.Á.P.-Á.; writing—original draft preparation, R.L.-G.; writing—review and editing, J.F.-L. and M.V.-M.; supervision, P.J.A.; funding acquisition, P.J.A. and J.F.-L." All authors have read and agreed to the published version of the manuscript.

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