



Development and Characterization of a Functional Chicken Liver Pâté Enriched with Broad Bean and Beetroot Powder

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Abstract: The present paper aims to develop a chicken liver pâté enhanced with nutritionally valuable plant-based ingredients: broad bean and beetroot powder. The objective of this study is to highlight the benefits of these additions in improving the nutritional profile of the final product and in reducing lipid oxidation. The first part presents the current context regarding the reduction of meat consumption and the shift towards functional foods. The nutritional and functional properties of broad bean and beetroot are emphasized, focusing on their content of vegetable proteins, fibers, vitamins, minerals, and bioactive compounds (especially phenolic compounds and betalains). The second part includes the author's own contributions, consisting of formulation, technological processing, and characterization of four pâté variants: a control sample (without plant additions) and three variants with 5%, 10%, and 15% broad bean and beetroot powder. The products were analyzed organoleptically, physicochemically, and sensorially. Results showed that the plant-based additions reduced moisture, lipid content, and energy value, without significantly compromising sensory qualities. Protein and mineral contents remained within acceptable limits, and the plant ingredients brought an additional biological value. This study supports the potential of lentils and beetroot powder as functional ingredients in the meat industry, particularly in reformulated products, offering healthier and more sustainable alternatives for consumers.

Keywords: functional pâté, broad bean, beetroot powder, bioactive compounds, sensory analysis

Introduction

Excessive meat consumption is associated with an increased risk of cardiovascular disease, type 2 diabetes, and cancer, and contributes to greenhouse gas emissions and biodiversity loss. Reformulating meat products with plant-based ingredients is a viable strategy for transitioning to a functional diet. Lentils (Lens culinaris) contain: protein (up to 25%), fiber, folic acid (B9), iron, magnesium, flavonoids, and tannins with antioxidant properties. Beet powder, obtained through dehydration, is rich in betacyanins (betanin), phenolic acids, flavonoids (rutin, quercetin), and natural nitrates, with antioxidant, anti-inflammatory, and cardioprotective effects documented in the scientific literature.

Materials and methods

Ingredients: chicken liver (300 g), chicken breast (200 g), butter (50 g), onion (80 g), garlic (10 g), spices. In variants P5, P10, and P15, the chicken breast was partially replaced with lentils and beetroot powder in proportions of 5%, 10%, and 15%. Process steps: weighing -> boiling -> mincing/chopping -> mixing -> filling containers -> sterilization -> cooling -> storage (max. 20°C, max. humidity 75%). Analysis methods: SR ISO 17025/2005 (water), SR ISO 1444/2008 (fat), SR ISO 937:2007 (protein), STAS 9065/5-1973 (NaCl), EC Regulation 1169/2011 (carbohydrates, energy value). Sensory analysis using the hedonic scale method (STAS 12656-88): panel of 20 tasters, maximum score of 20 points (external appearance 3 pts, cross-section appearance 5 pts, texture 3 pts, taste 5 pts, odor 4 pts).

Results and discussions

Proximate composition

Moisture: 69.41% (PM) -> 67.57% (P15) - below the 74% limit (Ordinance 210/2006); decrease due to fiber in the lentils. Protein: 18.24% (PM) -> 15.52% (P15) - above the minimum of 9%; decrease due to partial meat substitution. Fat: 8.31-9.08% - well below the 30% limit; slight increase in P15 due to unsaturated fatty acids from lentils. NaCl: 0.77% in all samples - below the 2% limit; the vegetable addition does not affect the salt content. Carbohydrates: 2.26% (PM) -> 6.12% (P15) - increase due to starch (lentils) and natural sugars (beets). Energy value: 163.01 kcal/100g (PM) -> 131.43 kcal/100g (P15), a 19.4% reduction. Ash: 1.00% (PM, P5) -> 0.95% (P15).

Acknowledgment: This study was conducted at the Faculty of Food Engineering, "King Michael I" State University of Timișoara, in the physical-chemical analysis laboratory.

Table 1. Proximate analysis of the samples tested

Table with 6 columns: Parameter, PM control, P5 5%, P10 10%, P15 15%, Legal limit Order 210/2006. Rows include Moisture (%), Protein (%), Fat (%), Ash (%), NaCl (%), Carbohydrates (%), and Energy value (kcal/100g).

All values extracted directly from charts Fig. 4.1-4.7 of the thesis. The P10 column (green) highlights the formula with the best sensory score.

Sensory analysis

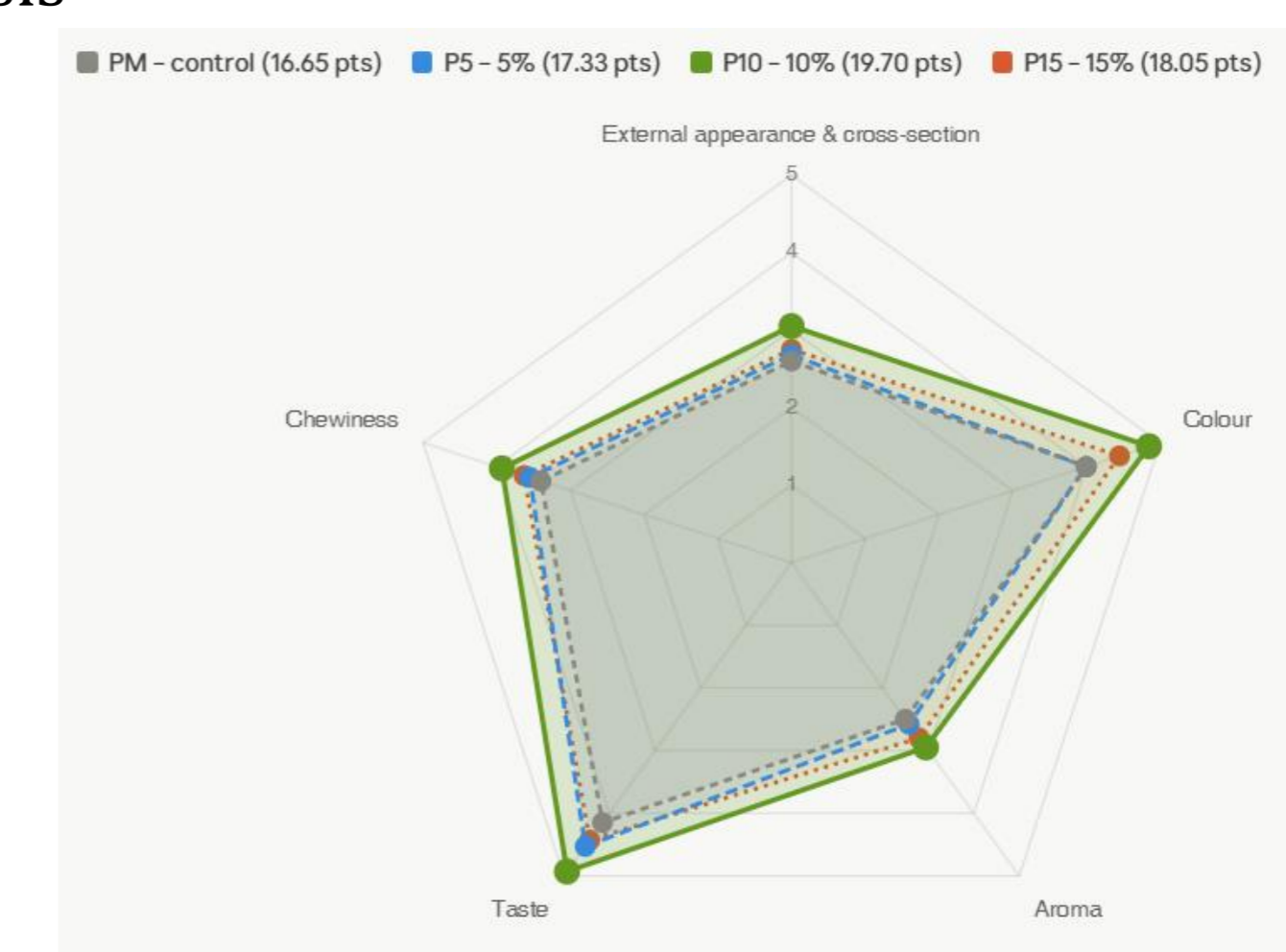


Figure 1. Sensory analysis of the samples tested

The radar chart (Figure 4.8) compares the four pâté formulations across five sensory attributes - external appearance and cross-section, colour, aroma, taste, and chewiness - scored from 0 to 5. Results show a progressive improvement with increasing vegetable addition, with PM scoring the lowest (16.65/20), followed by P5 (17.33/20), P15 (18.05/20), and P10 achieving the best overall score (19.70/20). Formula P10 recorded the highest values on all five attributes, particularly colour (4.85) and taste (4.93), attributed to the natural betacyanins in beetroot powder and the textural contribution of lentil proteins and soluble fibres. Formula P15, while strong overall, showed a slight drop in aroma (2.80), suggesting that at higher substitution levels the characteristic scent of the base product begins to be masked. These results confirm P10 as the optimal formulation, achieving the best balance between sensory quality and vegetable addition level.