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# THE EFFECT OF REPLACING PORK FAT OF INULIN ON THE PHYSICOCHEMICAL AND SENSORY QUALITY OF GUINEA FOWL PATE

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### ABSTRACT

**Background.** Potentially, pâtés could be a functional food and are an important source of proteins, vitamin A, B complex vitamins and iron. Unfortunately, one problem in pâtés is the high level of animal fat, about 30%. Pâté with low-fat guinea fowl meat and animal fat replaced with inulin can result in this product being classified as a pro-health food. The objective of the present study was to determine the effect on pâté with guinea fowl meat of reducing its pork back fat content (about 1/3, 2/3 and 100%) and the adding inulin as a partial fat substitute. The effects on the pâté's chemical and physicochemical composition, as well as on its textural characteristics and sensory properties were analysed.
**Methods.** On the day after production, the following took place: chemical analysis: cooking loss, moisture, protein, total fat, total calories, the pH, lipid oxidation were analysed; physical analysis: colour parameters, texture profile analysis and sensory evaluation were analysed.
**Results.** The pâté prepared with inulin gels as fat replacers had a fat content reduced (up to 82%), and decreased (up to 58%) energy value. The fat reduction and addition of inulin gels decreased hardness and chewiness, but the pâté's appearance, taste and odour, as well as overall quality were similar to the control (full-fat samples).
**Conclusion.** The study demonstrated that inulin can be used in guinea fowl pâtés as a total fat replacer and a potential source of prebiotic.

**Key words:** oligosaccharides, sensory evaluation, proximate analysis, colour, texture profile analysis, lipid oxidation

## INTRODUCTION

Meat products play an important role in human health. They are abundant sources of proteins, fats, essential amino acids, minerals, vitamins and other nutrients. Although fat plays a decisive role in product properties and consumer acceptance, the high saturated fatty acid content in such products results in their consumption being limited. The challenge for the meat industry is to develop low-fat meat products without compromising sensory and textural characteristics.

A good way to reduce animal fat in meat products can be through the addition of inulin (Alvarez and Barbut, 2013). Inulin is a natural reserve oligosaccharide

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in many plants. Commercial inulin contains polymers with varying degree of polymerization (DP) and different amounts of oligosaccharides (Juszczak et al., 2012). The length of molecules is important for technological properties and the pro-health activity of inulin (Glibowski, 2010).

Inulin is applied in the food industry as a fat substitute, a bulking and structure-forming agent, and as a substance-improving rheological properties and taste. These functional properties are mainly related to its ability to form physically stable gels (Juszczak et al., 2012). The resulting gel has a fine and creamy texture, which resembles solid fat (Glibowski, 2010). Because of its chemical structure, inulin can not be digested in alimentary tract (EFSA, 2010). Its caloric value is low (8 $kJ \cdot g^{-1}$). The substitution of fat by inulin causes such products to be characterized by a reduced energetic value.

From a nutritional point of view, inulin exhibits a prebiotic function and health benefits. (González--Herrera et al., 2015). These properties lead to inulin being used as a fat substitute in many non-meat (Juszczak et al., 2012) and meat products (Cegiełka and Tambor, 2012; Flaczyk et al., 2009; Méndez--Zamora et al., 2015; Menegas et al., 2013; Tomaschunas et al., 2013). However, none of these studies used guinea fowl meat as a raw material in pâté production.

Pâtés are produced from cooked meat, fat tissue, liver, broth, salt, spices and additives. Potentially, pâtés could be a functional food, and they are an important source of vitamin A, B complex vitamins, iron and microelements. Unfortunately, the problem in pâtés is their considerable level of animal fat (including saturated fatty acids), which is between 25% and 45% (Lorenzo et al., 2014). Considering the aim of reducing the fat content of pâtés, guinea fowl meat might be a more nutritionally desirable alternative to meat from other livestock. Generally, poultry meat contains higher nutritional quality of protein, less fat and cholesterol than red meat. However, the meat of guinea fowls has better a chemical composition than broilers, and they are a good source of nutrients for humans. The sensory quality of guinea fowl meat is often compared with chicken, but most consumers recognize that guinea fowl has a particular taste and dark colour, similar to the meat of game birds, which clearly distinguishes between these two products. Moreover, guinea fowl meat is very tender. Although guinea fowl meat could be an excellent and healthy alternative for consumers, little research has been done on its quality.

Producing pâté with low-fat guinea fowl meat and replacing animal fat with inulin can lead to this product being classified as a functional food. As shown above, studies have been carried out on the use of inulin in various meat products, mainly based on pork and chicken; however, to the best of our knowledge, there are no reports on the use of guinea fowl meat as a raw material. Therefore, the objective of the present study was to determine the effect of adding inulin to pâté with guinea fowl meat on its physicochemical and textural characteristics, and its sensory properties.

## MATERIAL AND METHODS

### Materials

Fresh carcasses of guinea fowl, pork back fat and poultry liver were obtained from a local supermarket. Orafti®HPX (Beneo-Orafti Ltd., Tienen, Belgium), which was used as fat substitute, contained 100% inulin, its degree of polymerisation (DP) is ≥23 and its sweetness level is 0% compared to sucrose. In this experiment, inulin was used in a gel form. Inulin gel was made by hydrating 25 g powder in 100 ml of water to get a 20.0% concentration. The suspension was then heated at 85°C for a few minutes while stirring until dissolved. The aqueous solution was cooled to 50°C. The remaininge ingredients included: broth, bread crumbs, cooked carrots, onion, salt, pepper and nutmeg (Table 1).

### Formulations

Four treatments of meat of guinea fowl pâté were prepared: T0 (with standard fat content – 224.0 g pork back fat per kg of pâté batter), two with reduced fat content and added inulin T1 with 149.5 g pork back fat and 74.5 g inulin gel, T2 with 74.5 g pork back fat and 149.5 g inulin gel, and T3 with total replacement of pork back fat by inulin. Samples and their fat content and ingredient proportions are given in Table 1.

### Pâté preparation

In the experiment, the same raw material was used for different pâté variants, in which raw meat (meat of guinea fowl, liver and optionally fat) was mixed for

**Table 1.** Formulation of pâté prepared with inulin

| Ingredients, g·kg$^{-1}$ pâté batter | Formulations | | | |
|---|---|---|---|---|
| | T0 | T1 | T2 | T3 |
| Cooked meat of guinea fowl | 411.0 | 411.0 | 411.0 | 411.0 |
| Cooked pork back fat | 224.0 | 149.5 | 74.5 | – |
| Inulin gel (20.0% inulin concentrate) | – | 74.5 | 149.5 | 224.0 |
| Broth | 187.0 | 187.0 | 187.0 | 187.0 |
| Poultry liver | 75.0 | 75.0 | 75.0 | 75.0 |
| Breadcrumbs | 37.0 | 37.0 | 37.0 | 37.0 |
| Cooked carrots | 18.7 | 18.7 | 18.7 | 18.7 |
| Onion | 37.0 | 37.0 | 37.0 | 37.0 |
| Salt | 7.5 | 7.5 | 7.5 | 7.5 |
| Pepper | 2.0 | 2.0 | 2.0 | 2.0 |
| Nutmeg | 0.8 | 0.8 | 0.8 | 0.8 |

T0 – 224.0 g pork back fat and 0 g inulin gel, T1 – 149.5 g pork back fat and 74.5 g inulin gel, T2 – 74.5 g pork back fat and 149.5 g inulin gel, T3 – 0 g pork back fat and 224.0 g inulin gel.

all batches prior to pâté production in order to account for inter-individual variability between animals. Variation in fat was achieved by changing the relation between back fat and inulin as a fat replacer in different combinations added to the formulation. Variations in the dosage and combination of the fat replacers were chosen with regard to adapting the firmness as much as possible to the full-fat reference. Pâté was produced in a classical way using a bowl chopper. The guinea fowl carcass, pork back fat and carrot were cooked for about 60 min to obtain a soft texture. The cooking loss was determined to adjust the water content. Samples were produced using a bowl chopper. Liver, salt, pepper and nutmeg were chopped to a homogenous emulsion. Cooked guinea fowl meat (skinless and boneless) and pork back fat were ground through a 5 mm plate and placed (in a suitable amount) into the chopper. Subsequently, the broth and previously prepared inulin gel (in a suitable amount) were added. After adding the liver emulsion to the chopper at 45°C, all the ingredients were chopped to the desired fineness. The meat emulsion was filled into aluminum molds (300 ml) and baked in the roaster (XF135, Unox S.p.A., Italy) at 180°C, to a core temperature of 72°C. The samples were cooled to 20–25°C for 1 hr, then stored in a refrigerator (4°C) and evaluated the day after production.

## Chemical analysis

Cooking loss of pâté was calculated from the differences in weights before and after thermal treatment. Chemical analyses of the pâtés were performed 24 hrs after their preparation. Moisture was determined according to ISO 1442:1997. Total nitrogen content was evaluated by the Kjeldahl method using a Kjeltec™ 8100 (Foss Tecator, Höganäs, Sweden). Protein was calculated using the factor 6.25. Total fat was assayed by the Soxhlet method, in accordance with ISO 1444:2000. Total calories (kJ) were calculated in relation to 100 g of samples using the values corresponding to fat (37 kJ·g$^{-1}$), protein (17 kJ·g$^{-1}$) (WHO, 2003) and inulin (8 kJ·g$^{-1}$) (Commission Directive 2008/100/EC). The pH was measured using a digital pH meter CPC-501 (Elmetron, Poland) equipped with a pH electrode (ERH-111, Elmetron, Poland), in accordance with ISO 2917:1999. Lipid oxidation was assessed using the thiobarbituric acid reactive substances' (TBARS) method (Raharjo at al., 1992). TBARS were calculated and expressed as mg malonaldehyde (MDA) per kg of pâté.

### Physical analysis

Colour parameters (CIE L*, a* and b*) were measured on the freshly cut surface of the product using a 8200 Series reflection spectrocolorimeter (X-Rite Inc., USA) with D65 illuminant and 10° standard observer, standardized using black and white tiles. The results were expressed as lightness (L*, 100 = white and 0 = black), redness (a*) and yellowness (b*). The spectrocolorimeter was calibrated against black and white standard tiles. Texture profile analysis (TPA) was performed using a texture analyzer (TA-XT2i, Stable Micro Systems Ltd., UK). For the TPA, nine cylindrical cores (25 mm length · 20 mm diameter) per treatment were cut from the central portion of pâté. Core samples were compressed twice between two parallel plates to 50% of their original height and there was a time interval of 5 s between the two compression cycles, at a crosshead speed of 2 $mm \cdot s^{-1}$. Values of hardness [N], springiness, cohesiveness and chewiness [N] were determined as described by Bourne (1978).

### Sensory evaluation

To determine the sensory quality, quantitative descriptive analysis (ISO 13299:2003) was used with an unstructured, linear graphical scale; 100 mm was converted to numerical values (1–10 conventional units – c.u.). Descriptions were chosen and defined during a panel discussion and then verified in a preliminary session. Twelve sensory attributes were measured to quantify the sensory quality: 2 for appearance in the cross section, 5 for flavour in mouth, 4 for odour by sniffing, and 1 for overall quality (Table 2). The assessment was made by a 8-person panel who were trained according to the requirements of standard (PN--ISO 8586-2:1996). Pâté samples were sliced into approximately equal size and weight (around 10 g) and

**Table 2.** List of the sensory attributes used for the sensory evaluation of guinea fowl pâté, their definitions and boundary terms

| Attribute | Definition | Bondary terms |
|---|---|---|
| *Appearance* | | |
| Colour | intensity colour in the pâté | 1– non-specific, 10 – specific |
| Lumpiness | visible amount of large particles | 1– not much, 10 – very |
| *Teste* | | |
| Fatty teste | intensity of fatty taste | 1 – absent, 10 – very intensive |
| Bitterness | intensity of bitter taste | 1 – absent, 10 – very intensive |
| Saltiness | intensity of saltiness | 1 – absent, 10 – very intensive |
| Spiciness | intensity of overall spiciness | 1 – absent, 10 – very intensive |
| Sweetness | intensity of sweet taste | 1 – absent, 10 – very intensive |
| *Odour* | | |
| Baked meat | intensity of baked meat odour | 1 – absent, 10 – very intensive |
| Fatty | intensity of fatty odour | 1 – absent, 10 – very intensive |
| Odour of liver | odour of animal liver | 1 – absent, 10 – very intensive |
| Seasoning | intensity of spices odour | 1 – absent, 10 – very intensive |
| *Overall quality* | attribute of total quality of baked pâté | 1 – undesirable, 10 – desirable |

placed in plastic odourless, disposable boxes (volume, 125 ml) covered with lids. All samples were separately coded with three digits and were randomly served to avoid carry-over effects. The test samples were kept in boxes at room temperature (20 ±1°C) for 30 min before analysis. They were presented to panelists in plastic boxes with covers on a white background with assessments cards. Water and unsalted crackers were provided to cleanse the palate between samples.

### Statistical analysis

The complete experiment was repeated three times in a completely randomized design. Chemical analytical determinations were performed in nine replications. Physical analyses were carried out in thirty replications. Sensory analysis was carried out once by 8 people. Values of different parameters were expressed as the mean ±standard deviation. The data were subjected to analysis of variance (ANOVA) and Tukey's comparison of means test ($p < 0.05$).

## RESULTS AND DISCUSSION

The addition of inulin had a significant effect ($p < 0.05$) on the process yield of the pâtés (Table 3). It was found that the yield depends on temperature, cooking time, ingredients and the type of additive, amount and the type of fat in the meat products, and dietary fiber (Alvarez and Barbut, 2013; Choi et al., 2014; Keenan et al., 2014; Ktari et al., 2014; Méndez-Zamora et al., 2015). The presence of inulin was previously reported to induce different modes of behavior. Some authors did not observe any effect of inulin on cooking loss in low-fat meat products (Cegiełka and Tambor, 2012). In other studies, a positive effect and increased yield in products containing inulin were found (Keenan et al., 2014; Ktari et al., 2014; Méndez-Zamora et al., 2015). In this study, reducing the fat content from 22.4% to 0% and replacing it with inulin gel caused a significant ($p < 0.05$) increase in overall cooking loss. These results were in agreement with those of other authors who had applied inulin in order to reduce the fat content of meat products (Alvarez and Barbut, 2013; Cegiełka and Tambor, 2012). According to Alvarez and Barbut (2013), the low cooking loss observed in high-fat samples is due to the positive action of fat to stabilize the meat batter by acting as a spacer within the protein network. Cáceres et al. (2004) observed a similar trend in cooking loss of sausages when using a soluble dietary fibre (SDF) inulin gel. They suggested that it could be due to SDF making the gel structure more compact and therefore preventing proteins from retaining water. Gels formed with polysaccharides favor the formation of a more compact and stronger heat-induced protein matrix, diminishing the links with water and thus increasing cooking loss.

**Table 3.** Chemical compositions of the guinea fowl pâtés with different fat and inulin gels contents

| Parameters | Formulations | | | |
|---|---|---|---|---|
| | T0 | T1 | T2 | T3 |
| Cooking loss, % | 16.60 ±0.86d | 17.70 ±0.99c | 20.53 ±1.68b | 26.05 ±2.03a |
| Moisture, % | 51.81 ±0.58d | 55.39 ±0.79c | 59.48 ±0.77b | 61.19 ±1.31a |
| Lipid, % | 18.16 ±2.72a | 13.46 ±0.81b | 7.74 ±1.74c | 3.21 ±0.43d |
| Protein, % | 19.68 ±0.70a | 17.98 ±0.49b | 16.88 ±0.49c | 16.69 ±0.97c |
| Energy, kJ·100 $g^{-1}$ | 1 006.45 ±106.26a | 818.46 ±23.81b | 603.10 ±67.99c | 447.23 ±54.28d |
| pH | 6.25 ±0.08a | 6.26 ±0.06a | 6.28 ±0.07a | 6.27 ±0.10a |
| TBARS, mg MDA·$kg^{-1}$ | 0.025 ±0.02a | 0.065 ±0.01b | 0.093 ±0.01c | 0.103 ±0.02c |

Means ±standard deviation in the same row followed by different lowercase letters indicates significant differences ($p < 0.05$) among formulations ($n = 9$).
Explanation as Table 1.

The chemical composition and energy value of the reduced-fat and inulin-added guinea fowl pâté (T1, T2 and T3) and control (T0) are shown in Table 3. Inulin is usually added to processed foodstuffs in the form of 20–25% water solutions, thus water content typically increases with an increase in the inulin concentration in the product. This trend was also observed in this study. The moisture content in the pâtés with inulin was significantly higher ($p < 0.05$) compared to the control. Similar behavior was found by other authors (Cegiełka and Tambor 2012; Flaczyk et al., 2009; Keenan et al., 2014, Menegas et al., 2013; Méndez--Zamora et al., 2015; Šojić et al., 2011), who reported that fiber, including inulin, increases the water-retaining capacity and therefore the moisture content in meat products.

As expected, the reduced fat samples showed a lower fat content than the control sample. The meat products had varied fat contents resulting from the application of inulin as a fat substitute. At a 1/3 pork back fat replacement, the fat content was reduced by 25%, while in the sample in which 100% pork back fat was replaced, the fat content was reduced by 82% (in this sample the fat was a natural ingredient of meat). This also was connected with a considerable decrease in the energy value of the product – 20%, 42% and 58% for sample T1, T2 and T2, respectively. The inverse relation between fat content and moisture was observed in different types of meat products formulated with inulin (Cegiełka and Tambor, 2012; Flaczyk et al., 2009; Keenan et al., 2014; Ktari et al., 2014; Méndez-Zamora et al., 2015; Šojić et al., 2011; Tobin et al., 2012).

The protein content in the control (T0) was the highest, amounting to approx. 19.7%. The addition of inulin as a pork fat substitute was connected with a decrease ($p < 0.05$) in the protein content in the pâtés. This can be explained by the addition of fiber to food products, which decreases the percentage of other components, such as proteins. Similar results were reported by Flaczyk et al. (2009) and Menegas et al. (2013).

The reduction in fat content and the addition of inulin did not affect ($p < 0.05$) the pH of the products (Table 3). Similar behavior was found by other authors in comminuted meat products (Keenan et al., 2014) and fermented sausages (Menegas et al., 2013). In contrast, Méndez-Zamora et al. (2015) found that the addition of inulin and pectin had significant effects ($p < 0.05$) on the pH of frankfurter sausages. The authors attributed this result to interaction through electrostatic association between polysaccharides and proteins in food and the pH values of ingredients used in the formulation. However, such correlations were not observed in this study.

The oxidative stability of guinea fowl pâtés was measured based on the TBARS index, which is frequently used as a marker of lipid oxidation. Meat products that have undergone thermal treatments usually exhibit high TBARS levels (up to 4 mg MDA per kg products) (Pateiro et al., 2015) because high temperature (>70°C) is a strong promoter of lipid oxidation. In this study, only small amounts of TBARS were detected in all formulations, independently of the fat content (Table 3). The TBARS levels were ranging from 0.025 mg MDA·kg$^{-1}$ in T0 (225.0 g pork back fat and 0 g inulin gel) to 0.103 mg MDA·kg$^{-1}$ of product in sample T3 (0 g pork back fat and 225.0 g inulin gel). Some authors (Lorenzo and Pateiro, 2013) also believed that pâtés with a higher fat content would yield higher amounts of oxidation products. Surprisingly, the addition of inulin increased TBA-RS values significantly in comparison with the control. The TBARS value of T0 was significantly lower ($p < 0.05$) than for the samples with inulin, while there was no significant difference between T2 and T3. Similar correlations were observed by Cava et al. (2012) and they explained this effect as due to the pro-oxidative action of inulin. Another reason may be the fact that in systems containing fructans reaction the TBA reaction is one of the basic methods of assessment of their quantitative determination. Research on the impact of inulin on the oxidation of fats in meat pâté needs to be continued, perhaps by using other more selective methods.

The addition of inulin had a significant effect ($p < 0.05$) on the colour parameters of the guinea fowl pâté (Table 4). The samples T0 (control) and T1 had a significantly higher ($p < 0.05$) L* (lightness) value and significantly lower ($p < 0.05$) a* (redness) and b* (yellowness) values comparing with the samples T2 and T3. The pâtés in which the fat was replaced by inulin were darker and redder than the pâtés with a higher fat content. This was expected since the increase in the fat proportion contributes to an increase in the L* value and also to a decrease in the a* value. Alvarez and Barbut (2013) concur with our findings, which showed

**Table 4.** Color and textural properties of the guinea fowl pâtés with different fat and inulin gel contents

| Parameters | Formulations | | | |
|---|---|---|---|---|
| | T0 | T1 | T2 | T3 |
| *Color* | | | | |
| L* (lightness) | 66.12 ±0.80a | 65.91 ±0.49a | 64.62 ±0.90b | 63.99 ±0.95b |
| a* (redness) | 3.47 ±0.48c | 3.55 ±0.32c | 3.87 ±0.33a | 3.72 ±0.31b |
| b* (yellowness) | 18.75 ±0.87d | 19.37 ±0.80c | 19.52 ±0.70bc | 19.89 ±0.77ab |
| *Texture (TPA test)* | | | | |
| Hardness, N | 5.27 ±1.01a | 3.97 ±0.60b | 3.74 ±0.51b | 3.32 ±0.22b |
| Springiness | 0.37 ±0.06a | 0.36 ±0.04a | 0.39 ±0.05a | 0.37 ±0.05a |
| Cohesiveness | 0.31 ±0.07a | 0.30 ±0.03a | 0.30 ±0.03a | 0.32 ±0.02a |
| Chewiness, N | 0.59 ±0.16a | 0.43 ±0.06b | 0.44 ±0.09b | 0.40 ±0.10b |

Means ±standard deviation in the same row followed by different lowercase letters indicates significant differences ($p < 0.05$) among formulations ($n = 30$).
Explanation as Table 1.

that low-fat products are typically darker, due to the decrease or absence of glossiness normally provided by fat. According to Jiménez-Colmenero et al. (2010), meat products with a reduced fat content are expected to be redder in colour, due to their greater lean meat content (myoglobin). On the other hand, inulin has been reported to mimic similar glossy characteristics of fat containing products. Cáceres et al. (2004) stated that inulin forms white translucent gels with no dominant colour. This could explain the findings reported in other studies (Cáceres et al., 2004; Menegas et al., 2013), which have shown no significant differences between colour variables with samples containing inulin.

The effects of replacing back fat with different levels of inulin gels on the textural properties of pâtés are presented in Table 4. Fat reduction and adding inulin significantly ($p < 0.05$) decreased hardness and chewiness, but did not affect springiness and cohesiveness (Table 4). These differences could be attributed to fat content and other dietary ingredients e.g. proteins and inulin, due to their high binding ability and water-retaining capacity (Choi et al., 2014; Šojić et al., 2011). According to some authors, hardness in meat products is related to their fat content. Alvarez and Barbut (2013) found that fat reduction in cooked pork batters from 20% to 5% brought about a 35% decrease in hardness, and other parameters of texture. According to Cruz et al. (2010), the addition of inulin significantly affects the texture of products, because it is incorporated into the food matrix, promoting and strengthening connections between the various components. It could be also attributed to differences in composition, resulting in a different protein/fat/water ratio, which is a determining factor of the resulting gel consistency. The results suggest a high correlation between some of the textural parameters and both the fat and moisture contents of meat products. The products with added inulin exhibited different texture profiles with more pronounced characteristics, such as hardness and chewiness. This may be related to the type of inulin added to the meat mixture (in gel or powder form) and the amount of inulin used. Inulin added as powder tends to increase the hardness of meat products, whereas when added as a gel, it gives softer products. Texture modification through the use of different forms of inulin inclusion in a range of meat products is well documented in the literature (Alvarez and Barbut, 2013; Cegiełka and Tambor, 2012; Cruz et al., 2010; Keenan et al., 2014; Ktari et al., 2014; Menegas et al., 2013; Méndez-Zamora et al., 2015). In this study, inulin gel was used, and this can explain the decreased hardness and chewiness of the pâtés with

**Table 5.** Sensory evaluation of the guinea fowl pâtés with different fat and inulin gels contents

| Attribute | Formulations | | | |
|---|---|---|---|---|
| | T0 | T1 | T2 | T3 |
| *Appearance* | | | | |
| Colour | 8.63 ±1.30a | 9.04 ±1.07a | 8.75 ±1.04a | 8.13 ±1.96a |
| Lumpiness | 6.25 ±2.19a | 6.38 ±2.50a | 6.38 ±2.62a | 6.75 ±2.05a |
| *Odour* | | | | |
| Baked meat | 6.88 ±2.10a | 7.88 ±1.89a | 6.50 ±1.20a | 7.00 ±1.77a |
| Fatty | 6.63 ±2.26a | 6.38 ±2.00a | 6.38 ±2.07a | 6.25 ±2.05a |
| Odour of liver | 6.50 ±2.14a | 6.25 ±2.60a | 6.13 ±2.36a | 6.03 ±2.00a |
| Seasoning | 7.13 ±1.46a | 6.75 ±1.39a | 6.13 ±2.36a | 5.75 ±3.01a |
| *Teste* | | | | |
| Fatty teste | 6.13 ±2.03a | 6.01 ±2.20a | 5.88 ±2.53a | 6.25 ±2.05a |
| Bitterness | 8.50 ±0.76a | 8.03 ±1.07a | 8.38 ±0.74a | 7.75 ±1.75a |
| Saltiness | 6.00 ±1.60a | 6.13 ±1.36a | 6.38 ±1.85a | 6.88 ±1.64a |
| Spiciness | 7.38 ±1.41a | 7.02 ±1.51a | 7.38 ±1.77a | 5.51 ±1.77a |
| Sweetness | 7.75 ±1.75a | 8.25 ±1.16a | 7.63 ±2.00a | 8.02 ±1.60a |
| *Overall quality* | 8.13 ±2.17a | 7.38 ±1.69a | 6.75 ±2.38a | 6.75 ±2.82a |

Means ±standard deviation in the same row followed by different lowercase letters indicates significant differences ($p < 0.05$) among formulations ($n = 8$).
Explanation as Table 1.

an increased level of inulin. The sensory properties of a product are a very important attribute since this determines the consumer's preference. No significant difference ($p > 0.05$) was observed (Table 5) between the sensorial qualities of reduced-fat samples (T1, T2 and T3), when compared with the control (T0). This is an important observation as consumers are unwilling to compromise on quality arising from the removal of a constituent perceived as unhealthy or the inclusion of health promoting ingredients compared to conventional products. In the available literature, there are no research findings concerning the effect of inulin in liver pâté on sensory properties. However, many studies showed no significant difference in other products containing inulin compared to conventional controls (Flaczyk et al., 2009; Menegas et al., 2013). Other authors described that fat reduction and inulin addition improved the odour and taste of the meat products. Šojić et al. (2011) stated that reduced-fat cooked sausages with inulin had a significantly higher score for odour and taste than the controls. Similar results were also reported by Cáceres et al. (2004) and Méndez-Zamora et al. (2015), who found that the addition of inulin (29.2 $g \cdot kg^{-1}$ of product) improved the acceptance of some attributes such as the flavour and overall acceptance of low-fat frankfurter sausages.

Tobin et al. (2012) observed that a lower content (10%) of fat in sausages less favorably affects the flavour than a higher one (25 and 15% fat). Whereas Keenan et al. (2014) observed reduced acceptability with increasing inulin (75 $g \cdot kg^{-1}$ of product) in meat products. They suppose this is most likely due to the onset of texture modification brought on by a high level of inulin inclusion. In our study, there was no significant effect of reducing fat and the addition of inulin on the taste parameters of the pâtés, except spicy flavour. However, other studies have also shown a positive correlation between high fat content and increased salt perception in meats (Keenan et al., 2014; Tobin et al., 2012). This contrasts with the findings of the present study, but our data indicates that factors other than the salt level, such as the background composition, can play a key role in its perception, as postulated by Ruusunen et al. (2005). Spicy odours were found by Tomaschunas et al. (2013) to be more intensive in low-fat than in full-fat meat products. They assumed that the release of aroma compounds was related to solvation in the lipid phase. With a decrease in fat and the quantity of spices, intensities in sweetness and off-flavour decreased, whereas metallic attributes (odour) and the odour of liver, as well as flavour descriptors, i.e. peppery, bitterness, metallic, liver flavour and aftertaste were enhanced. Furthermore, Shamil et al. (1991/1992) reported higher perceived bitterness with fat reduction, due to the tendency of bitter compounds to be hydrophobic and to reside in a lipophilic environment. This effect is also supposed to be related to such attributes as peppery taste and saltiness (Tomaschunas et al., 2013). As predicted, the results showed that the addition of Orafti HP inulin to pâtés did not have any effect on sweetness. This can be explained by the fact that Orafti HP is composed of only inulin. Thus, it is possible to formulate guinea fowl pâté with a reduced fat content, approx. 1/3 (T1), 2/3 (T2) and even the 100% (T3) with no change in product acceptability. A formulation containing inulin could provide beneficial health effects associated with the intake of prebiotics, such as the inhibition of pathogen growth in the gut, increased calcium absorption from the diet, relief of constipation, and no change in the glucose index and insulin levels in the blood (Menegas et al., 2013).

## CONCLUSIONS

According to the analysis of chemical composition, the formulations prepared with inulin gels as fat replacers had nutritional advantages compared with the fat sample for the following reasons: they have a reduced fat content by 25% (sample with 149.5 g pork back fat and 74.5 g / 18.6 g inulin gel / inulin powder) or by 82% (sample with 0 g pork back fat and 225.0 g / 55.9 g inulin gel / inulin powder), this was also connected with a considerable decrease in the energy value of the product (by 20% to 58%, respectively) and the incorporation of inulin as dietary fiber. The texture study showed that fat reduction and added inulin gels decreased hardness and chewiness, but did not affect the springiness and cohesiveness. The sensorial analysis of the guinea fowl pâtés with inulin gels showed that appearance, taste and odour as well as the overall quality were similar to the control (full fat samples). Although all samples were sensorily acceptable, the pâté with 18.6 g of inulin powder scored the high marks for overall quality. The chemical and textural analysis and sensory evaluation demonstrated that inulin can be used in guinea fowl pâtés as a fat replacer.

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