EFFECT OF OLIVE OIL AMOUNT ON PHYSICO-CHEMICAL PROPERTIES OF PÂTÉ FROM CELTA PIG BREED

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Abstract – Based on healthy properties of olive oil due to its high oleic acid content and the high content in saturated fatty acids of pork backfat, a backfat replacement by olive oil was assessed. For this study, three different levels of replacement of pork backfat (0, 50 and 100%) by olive oil in Celta pâtés were manufactured. The chemical composition, color parameters and texture properties were analyzed. There were not significant (P>0.05) differences between the control batch and the oil enriched pâté in moisture, fat and protein contents. Regarding color parameters, only yellowness values were significantly (P<0.05) affected by fat replacement, since the higher yellowness values were found in pâtés with 100% of pork backfat. Finally, the replacement of pork backfat with emulsified olive oil content resulted in lower (P<0.001) hardness, gumminess and chewiness.

Key Words – Fat replacement, Chemical composition, Texture, Color parameters

I. INTRODUCTION

More and more people worry about their health, and nowadays, food technology attempt to offer us solutions. In bibliography, researches work trying to get meat products with a healthier fatty acid profile. In line with this, Morales-Irigoyen *et al*. [1] studied the replacement of pork backfat (lard) with different levels of emulsified canola oil in liver pâte, while Rodríguez-Carpena *et al*. [2] studied the effect of partial replacement of pork backfat by vegetable oils in burger patties.

A good alternative to replace fat in a meat product is olive oil, which is one of the most famous vegetal oils in the world due to its health properties. The monounsaturated fatty acid most abundant in olive oil is oleic acid (C18:1n9), representing around 70 % of overall fatty acids [3]. An example of oleic acid health benefits are its preventive effect in the development of atheromas and subsequent thrombi [4] or a possible protective effect against the development of cancers [5,6].

Celta is the most important autochthonous pig in the north of Spain. Their breeding and exploitation are well organized, and an association of breeders and a herd book exist for this breed. Due to its good adaptation to the environmental conditions in the autochthonous forests in northern Spain, its rearing in a completely extensive regime, making good use of naturally available food resources, is possible [7]. This breed is also greatly appreciated by consumers for the high quality of the dry-cured meat products [8].

Thus, the aim of this study was to assess the effect of olive oil amount on chemical composition, color parameters and texture traits of pâté from Celta pig breed.

II. MATERIALS AND METHODS

II. 1 Manufacture of the pâté

The pâtés were prepared in the pilot plant of the Meat Technology Center of Galicia. The recipe used for the preparation of pâtés is presented in the Table 1. Pork backfat and pork meat were provided by a local slaughterhouse. Olive oil was acquired in a local supermarket (72% of oleic acid). The backfat and lean pork were precooked at 76 ºC (core temperature) in a hot water bath for 1 h. A pre-emulsion of the fat source (pork backfat, olive oil or the appropriate mixture), water

(obtained from the precooking) and sodium caseinate was carried out during 1 min in a cutter (Talsa, mod K30, Valencia, Spain). Subsequently, the rest of ingredients (lean meat, chestnut flour, salt, white and black pepper, nutmeg, oregano and garlic) were added and chopped until a homogeneous batter (2 min). During the fat pre-emulsion and chopping, the temperature of the raw batter was always above 40 and 46 ºC, respectively. The pâtés were manually distributed into metal cans until completely full (250 g) and these were then hermetically closed prior to thermal treatment (78 °C/75´). The samples were cooled in a blast chiller (-21 °C/30´) and then analyzed. Each pâté was manufactured in triplicate.

Table 1 Recipe used for the preparation of pâtés with different olive oil contents

	Fat replacement		
	0%	50%	100%
Lean	73.29	73.29	73.29
Backfat	12.00	6.00	0.00
Olive oil	0.00	6.00	12.00
Caseinate	2.00	2.00	2.00
Chestnut flour	1.00	1.00	1.00
NaCl	1.25	1.25	1.25
White pepper	0.07	0.07	0.07
Black pepper	0.07	0.07	0.07
Nutmeg	0.20	0.20	0.20
Oregano	0.07	0.07	0.07
Garlic	0.05	0.05	0.05
Water	10.00	10.00	10.00

II. 2 Chemical composition

Moisture, fat and protein (Kjeldahl x 6.25) were quantified according to the ISO recommended standards 1442:1997 [9], 1443:1973 [10] and 937:1978 [11], respectively.

II. 3. Physico-chemical parameters

The pH of samples was measured using a digital pH-meter (Thermo Orion 710 A+, Cambridgeshire, UK) equipped with a penetration probe. Color measurements were carried out using a CM-600d colorimeter (Minolta Chroma Meter Measuring Head, Osaka, Japan). Three measurements were performance for each sample. CIELAB space: lightness, (L*); redness, (a*); yellowness, (b*) were obtained.

II. 4 Texture measurement

The Texture Analyzer (TA-XT.plus, Stable Micro Systems, Vienna Court, UK) was used. The penetration test was carried out at room temperature (22 °C) and performed with a 6 mm diameter penetration probe linked to a 5 kg cell at a velocity of 0.8 mm/s and for a distance of 8 mm. Hardness (N), cohesiveness, elasticity, gumminess (N) and chewiness (N) were obtained using the available computer software (TEE32 Exponent 4.0.12. Stable Micro Systems, Vienna Court, UK).

II.5 Statistical analysis

The effect of the pork fat replacement by olive oil on chemical composition, color parameters and texture traits was examined using a mixed-model ANOVA, where the chemical composition, color parameters and texture traits was set as dependent variables, the pork fat replacement by olive oil as fixed effect, and replicate as random effect. The pairwise differences between least-square means were evaluated by Duncan's method. Differences were considered significant if $P<0.05$. The values were given in terms of mean values and standard error (SEM). All analyses were conducted using the IBM SPSS Statistics 19.0 program (IBM Corporation, Somers, NY, USA) software package.

III. RESULTS AND DISCUSSION

III. 1 Chemical composition

The effect of the pork fat replacement by olive oil on chemical composition is shown in Table 2. There were not significant ($P>0.05$) differences between the control batch and the oil enriched pâté in moisture, fat and protein contents. These findings are in disagreement with those reported by Martin *et al.* [12] who found significant ($P<0.05$) differences among treatment on chemical composition, since control group showed higher moisture and protein contents and a lower level of fat. According to Martin *et al.* [12], these differences could be due to the lower lipid content of pork backfat (93% approximately) compared to enriched oil treatments, since pork backfat also

contains protein and water (approximately 1% and 5%, respectively) [13]. An additional reason for explaining the different composition of the control group might be the cooking of pork backfat in water before preparation of the batter which led to a small loss of fat.

III. 2 pH and color parameters

Table 2 shows the effect of the pork backfat replacement by olive oil on pH values and color parameters of pâté from Celta pig breed. The pH values were significantly (P<0.05) affected by fat replacement, since the higher pH values were observed in pâtés with 100% of pork backfat replaced by olive oil. Regarding color parameters, L* and a* values did not show significant (P>0.05) differences among groups, although slightly higher L* and a* values were observed in control group compared to the other ones. This outcome is in disagreement with those reported by Morales-Irigoyen *et al*. [1] who observed that emulsified oil incorporation resulted in significant (P<0.05) changes in lightness, redness and yellowness. When emulsified oil replaced above 50% of lard, the lightness of liver pâté samples increased. When lard was totally replaced, a less red coloration was observed [1].

On the other hand, statistical analysis displayed that yellowness values were significantly (P<0.05) affected by fat replacement, since the higher yellowness values were found in pâtés with 100% of pork backfat. This result is in agreement with data reported by Morales-Irigoyen *et al*. [1] who noticed that the incorporation of emulsified canola oil decreased the yellowness of the liver pâté. Replacement of fat could compensate color changes in emulsified meat products, where animal fat replace by vegetable oil increase lightness and yellowness but decrease redness [14,15]. Color differences like increase in lightness and decrease in redness had been attributed to the distribution of the oil phase into the protein matrix during the chopping process, since vegetable oils seem to be evenly dispersed and are better distributed than the animal fat tissue, increasing fat particles area [16].

Table 2 Effect of olive oil amount on pH values, chemical composition and color parameters of pâté from Celta pig breed

	Fat replacement				
	0%	50%	100%	SEM	Sig.
pH	6.10^{ab}	6.09^{a}	6.13^{b}	0.005	*
Chemical composition (g/100g)					
Moisture	52.46	52.51	51.50	0.284	n.s.
Fat	18.23	18.41	19.63	0.354	n.s.
Protein	24.87	24.53	24.30	0.102	n.s.
Colour parameters					
L*	57.70	56.66	55.88	0.474	n.s.
a*	7.05	6.19	6.14	0.180	n.s.
b*	19.43^{a}	20.18^{ab}	21.15^{b}	0.237	**

$^{a-b}$ Mean values in the same row (corresponding to the same parameter) not followed by a common letter differ significantly (P<0.05)

Sig: significance: ** (P<0.01), * (P<0.05), n.s. (not significant)

III. 3 Texture measurement

As expected, the manufacture of pâté from Celta pig breed with replacement of fat by olive oil resulted in products with different textural properties (Table 3). The replacement of pork backfat with emulsified olive oil content resulted in lower (P<0.001) hardness, gumminess and chewiness. In the gradual replacement of fat by emulsion, the hardness, gumminess and chewiness were diminishing progressively. Emulsified oil presented a softer texture than pork backfat, and hence, the force to compress the pâté samples, related to maximum peak force and the work necessary to compression, was higher in control group. These results are in agreement with those observed by Morales-Irigoyen *et al.* [1] who found lower hardness values in pork liver pâté when pork backfat was replaced with emulsified canola oil. In addition, the decrease in saturated fats and increase in unsaturated fats when pork backfat was replaced by oils could be considered the main factor responsible for a softer consistency in pâté [12]. On the other hand, it would be possible that adipocites structure of backfat tissue remains intact after the manufacture. This might contribute to the higher consistency of control group, since the fat would remain inside the adipocites [12].

Table 3 Effect of olive oil amount on texture parameters of pâté from Celta pig breed

	Fat replacement				
TPA traits	0%	50%	100%	SEM	Sig.
Hardness (N)	4.50[b]	3.33[a]	3.33[a]	0.15	***
Elasticity (mm)	1.01	1.00	0.99	0.006	n.s
Cohesiveness	0.47[b]	0.44[a]	0.44[a]	0.005	*
Gumminess (N)	2.15[b]	1.47[a]	1.37[a]	0.07	***
Chewiness (N)	2.12[b]	1.44[a]	1.33[a]	0.06	***

[a-b] Mean values in the same row (corresponding to the same parameter) not followed by a common letter differ significantly (P<0.05)
Sig: significance: *** (P<0.001), * (P<0.05), n.s. (not significant)

IV. CONCLUSION

The fat replacement by olive oil in the formulation of a Celta pâté had a slight impact on physico-chemical characteristics. Emulsified olive can be employed to replace pork backfat in Celta pâté improving the texture properties. So, more studies will be necessary for a better knowledge of the positive influence of the pork backfat replacement by olive oil on the nutritional and oxidative stability of the Celta pâtés.

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REFERENCES

1. Morales-Irigoyen, E. E., Severiano-Perez, P., Rodriguez-Huezo, M. E. & Totosaus, A. (2012). Textural, physicochemical and sensory properties compensation of fat replacing in pork liver pâté incorporating emulsified canola oil. Food Science and Technology International 18: 413-421.
2. Rodríguez-Carpena, J. G., Morcuende, D. & Estevez, M. (2011). Partial Replacement of Pork Back-Fat by Vegetable Oils in Burger Patties: Effecton Oxidative Stability and Texture and Color Changes during Cooking and Chilled Storage. Journal of Food Science 76: C1025-C1031.
3. White, P. J. (2000). Fatty Acids in Oilseeds (Vegetable Oils). In Fatty Acids in Foods and Their Health Implications (pp 209-238). New York: Marcel Dekker, Inc.
4. Huang, C. L. & Sumpio, B. E. (2008). Olive Oil, the Mediterranean Diet, and Cardiovascular Health. American College of Surgeons 207: 407-416.
5. Keys, A., Menotti, A., Karvonen, M. J., Aravanis, C., Blackburn, H., Buzina, R., Djordjevic, B. S., Dontas, A. S., Fidanza, F. & Keys, M. H. (1986). The diet and 15-year death rate in the seven countries study. American Journal of Epidemiology 24: 903-15.
6. Trichopoulou, A., Lagiou, P., Kuper, H. & Trichopoulos, D. (2000). Cancer and Mediterranean dietary traditions. Cancer Epidemiology, Biomarkers & Prevention 9: 869-73.
7. Fonseca, S., Gómez, M., Domínguez, R. & Lorenzo, J. M. (2015). Physicochemical and sensory properties of Celta dry-ripened "salchichón" as affected by fat content. Grasas y Aceites 66: e059.
8. Lorenzo J. M., Montes, R., Purriños, L., Cobas N. & Franco, D. (2012). Fatty acid composition of Celta pig breed as influenced by sex and location of fat in the carcass. Journal of the Science of Food and Agriculture 92: 1311-1317.
9. ISO (1997). Determination of moisture content, ISO 1442:1997 standard. International standards meat and meat products. Genève, Switzerland: International Organization for Standardization.
10. ISO (1973). Determination of total fat content, ISO 1443:1973 standard. International standards meat and meat products. Genève, Switzerland: International Organization for Standardization.
11. ISO (1978). Determination of nitrogen content, ISO 937:1978 standard. International standards meat and meat products. Genève, Switzerland: International Organization for Standardization.
12. Martin, D., Ruiz, J., Kivikari, R. & Puolanne, E. (2008). Partial replacement of pork fat by conjugated linoleic acid and/or olive oil in liver pâtés: Effect on physicochemical characteristics and oxidative stability. Meat Science 80: 496-504.
13. Ockerman, H. (1989). Sausage and processed meat formulation. New York:Van Nostrand.
14. Cáceres, E., García, M. L. & Selgas, M. D. (2008). Effect of preemulsified fish oil – as source of PUFA n-3 – on microstructure and sensory properties of mortadella, a Spanish bologna-type sausage. Meat Science 80: 183-193.
15. Choi, Y. S., Choi, J. H., Han, D. J., Kim, H. Y., Lee, M. A., Kim, H.W. et al. (2009). Characteristics of low-fat meat emulsion systems with pork fat replaced by vegetable oils and rice bran fiber. Meat Science 82: 266-271.
16. Youssef, M.K. & Barbut, S. (2010). Physicochemical effects of the lipid phase and protein level on meat emulsion stability, texture, and microstructure. Journal of Food Science 75: S108-S114.