Pâté with Added Fresh Date Palm By-Products: A Preliminary Study

Martin-Sanchez A.M. [1], Ciro G. [1], Sayas-Barbera E. [1], Fernandez-Lopez J. [1], Sendra E. [1], Barber, X. [2], V, Vilella-Espla J. [3], Ben-Abda J. [4], Perez-Alvarez J.A. [1]

[1] IPOA Research Group, Agro-food Technology Department and [2] Operative Research Centre, University Miguel Hernández, Orihuela (Alicante, Spain).
[3] Date Palm Research Centre "Phoenix Station" (Elche, Spain).
[4] Agronomic Superior Research and Teaching Institute (Tunisia).

Abstract— **OBJECTIVES: The aim of this study was to investigate the application of and intermediate food product (date palm paste obtained from fresh date by-products in a campagne type pork liver pâté. Therefore, the most relevant parameters were evaluated: physicochemical characteristics, pigment and lipid oxidation, nitrite and salt content, texture and sensory analysis.**

MATERIALS AND METHODS: Pork liver pâtés were elaborated according to the traditional formula and practice (5, 10 and 15% of date palm by-products paste were added). pH, aw, CIELAB parameters, TBARS, moisture, metmyoglobin, heme iron, residual nitrite and sodium chloride content, texture and sensory analysis were evaluated at 0, 2 and 4 processing time.

RESULTS: The addition of date paste decreased aw and pH, but increased moisture. A 10% of date addition was enough to avoid lipid oxidation through all storage time. Myoglobin stability was not greatly affected, and date seemed to stabilize heme iron. Also, salt content was reduced proportionally with date content. The texture was affected in some parameters, a 5% increased hardness, gumminess, chewiness and springiness, while a 15% of date did not; this high concentration improved cohesiveness. Instrumental colour was the most affected parameter; however, panellists preferred samples with added date.

CONCLUSIONS: The use of date by-products in liver pâté could be an advantage, since dates show antioxidant activity, reduce aw and do not affect pigments stability. Moreover, a healthier product with antioxidant compounds is obtained without affecting the sensorial qualities. It is necessary to evaluate the most suitable concentration to do not affect colour.

Keywords— **Pâté, date palm by-products.**

I. INTRODUCTION

Nowadays consumers are more concerned with their health and its relation with diet, demanding healthier foods. However, meat products are associated with a high content of fat and cholesterol, salt, nitrite or lipid oxidation products, which are related with several illnesses, such as cardiovascular diseases, cancer, hypertension and obesity [1]. Likewise, there is an increasing demand in developed countries towards sustainable food production. Therefore, the incorporation of functional ingredients from by-products from agro-food industries could be a strategy to develop healthier meat products, but also to increase the eco-efficiency in the food industry [2].

Date palm (*Phoenix dactylifera* L.), is widely cultivated in some Mediterranean regions. In Europe, the main date palm cultivars are concentrated in the South east of Spain (Elche and Orihuela). In the last years, the average production in the main grove (Elche) is around 4.000 metric tons, of which less than 100 tons are commercialized as fresh date [3]. Date harvesting is habitually accompanied by fruit losses during picking, selection, storage and conditioning processes. Moreover, fresh dates are very perishable due to their high moisture and sugar content. Thus, the amount of date "second and low-grade dates" reach very high percentages of the production, being discarded or used for animal feeding [4]. However, dates are rich in compounds potentially beneficial for human health, such as fibre, vitamins, minerals and antioxidants [5].

Thus, the aim of this study was to evaluate the possibility of using date palm by-products in a meat product (pork liver pâté).

II. MATERIALS AND METHODS

Samples preparation: Campagne type pork liver pâtés were elaborated according to the traditional formula and adding 5, 10 and 15% of scalded date palm by-products paste (Confitera variety, khalal stage). The mixture was put in steel containers and cooked in an oven until 72°C were reached in the geometric centre of each container. Then, samples were cooled until reach the room temperature and stored at 1-4°C for 5 days. These were taken at day 0, 2 and 4 for analyses.

Physicochemical analysis: The CIELAB colour space (L*: lightness; a*: redness/greenness; b*: yellowness/blueness) was studied following the recommendations of the AMSA [6] by means of a spectrophotometer (Minolta CM-2600 illuminant D_{65}, 10° observer). The pH was determined with a Crison 507 pH-meter equipped with a combined electrode for solids. Moisture was determined by loss in weight after heating the pâtés to constant weight at 105ºC. Aw was measured at 25°C in an electrolytic hygrometer (Novasina TH-500). These analyses were also made for the date paste. Texture profile analysis was performed on day 1 with a Texture Analyser TA-XT2i at room temperature. Samples cut into cubes (1x1x1cm) were subjected to a 2-cycle compression to 80% original height with a speed of 5 mm/s. Cohesiveness, hardness, springiness, gumminess, adhesiveness, resilience and chewiness were estimated as Bourne [7].

Residual nitrite and sodium chloride: Residual nitrite level (mg/kg) and sodium chloride (g/100g) were determined by following standard ISO/DIS 2918.26 [8] and ISO/DIS 1841.27 [9] respectively.

Pigment and lipid oxidation: Lipid oxidation was assessed by the 2-thiobarbituric acid (TBA) method of Botsoglou, Fletouris et al. [10], and expressed as mg malonaldehyde (mgMA/kg). Heme iron was determined using the method of Hornsey [11] with acid acetone extraction. MMb (%) was obtained following the method of Ulu [12].

Sensory evaluation: Samples were evaluated by 30 non-trained testers from the AgroFood Technology Department. The analyses were performed according to the specifications of the ISO [13]. A test was carried out on day 1 using a structured 9-point hedonic scale (1: dislike extremely and 9: like extremely) for different attributes: colour, aroma, taste, particles detection, cohesiveness, hardness and juiciness, and to order the samples according to the overall preference.

Statistical analysis: They were carried out using the statistical package SPSS 19.0 (IBM SPSS Statistics, Chicago. Data from the samples and from assessors was analysed by Analysis of Variance (ANOVA) with two factors: time and treatments. The Tukey post hoc test ($P<0.05$) was used for comparison of means.

III. RESULTS

Physicochemical parameters: Values for all parameters are shown in Table 1. For the pH values, statistically were found significant differences (SD) ($P<0.05$) among the batches, decreasing according to the date paste concentration but the differences were very low. In general, pH tended to increase until day 2, and after decreasing for the control and pâtés with 5% of paste, but first and last values were very similar, all close to 6.3. Globally, aw was higher in the control ($P<0.05$); and only samples with 5% of paste increased enough on day 4 to show SD ($P<0.05$) respect to the others days. Conversely, moisture was minor in the control, existing SD ($P<0.05$) in general. No SD ($P>0.05$) appeared through the storage time, but in all batches the tendency was to increase. For colour parameters, nearly all of them were reduced by the date paste content, except a* with 15% date on day 0, though $P>0.05$. The differences among batches were greater on days 2 and 4. With regard to the evolution during storage time control values were more stable. Pâtés with 5% and 15% did not show SD ($P>0.05$) for L* values. It is also important to highlight that samples with date had more similar evolution, except for L*, where the 5% followed the control tendency.

Residual nitrite and sodium chloride: NaCl content was SD ($P<0.05$) for each batch, being reduced from 0.92g/100g (control) to 0.80g/100g with 15% of paste. However, residual nitrite did not show SD ($P>0.05$).

Lipid oxidation: The amount of MA showed SD ($P<0.05$) during storage time and between batches. On day 0 no SD ($P>0.05$) were found among the batches, but on day 2 and 4 the control showed the highest values ($P<0.05$), while samples with 10 and 15% of paste maintained the values of day 0, and the 5% pâté had intermediate values.

Table 1. All parameters analysed of the four sample batches with SD and of the date paste (mean values±standard error).
[A,B,C] Values with different letters in the same column are significantly different (P<0.05).
[a,b,c] Values with different letters in the same row are significant different (P<0.05)

		Time (days)	CONTROL	5% DATE PASTE	10% DATE PASTE	15% DATE PASTE	DATE PASTE
Physico-chemical parameters	pH	0	$^{A}6.34\pm0.00^{c}$	$^{A}6.32\pm0.00^{bc}$	$^{A}6.30\pm0.00^{ab}$	$^{A}6.28\pm0.00^{a}$	5.93±0.07
		2	$^{B}6.36\pm0.00^{c}$	$^{B}6.34\pm0.00^{c}$	$^{B}6.32\pm0.00^{b}$	$^{A}6.29\pm0.00^{a}$	
		4	$^{AB}6.35\pm0.00^{b}$	$^{A}6.31\pm0.00^{a}$	$^{B}6.32\pm0.00^{a}$	$^{A}6.31\pm0.00^{a}$	
	aw	0	$^{A}0.956\pm0.00^{b}$	$^{A}0.949\pm0.00^{a}$	$^{A}0.950\pm0.00^{a}$	$^{A}0.949\pm0.00^{a}$	0.941±0.03
		2	$^{A}0.953\pm0.00^{a}$	$^{A}0.950\pm0.00^{a}$	$^{A}0.947\pm0.00^{a}$	$^{A}0.948\pm0.00^{a}$	
		4	$^{A}0.952\pm0.00^{b}$	$^{B}0.952\pm0.00^{b}$	$^{A}0.949\pm0.00^{ab}$	$^{A}0.947\pm0.00^{a}$	
	Moisture (%)	0	$^{A}44.67\pm1.16^{a}$	$^{A}48.62\pm1.29^{a}$	$^{A}49.38\pm1.00^{a}$	$^{A}47.68\pm1.69^{a}$	66.4±0.54
		2	$^{A}47.83\pm0.73^{a}$	$^{A}48.92\pm0.21^{a}$	$^{A}49.80\pm0.26^{a}$	$^{A}49.29\pm0.32^{a}$	
		4	$^{A}47.99\pm0.72^{a}$	$^{A}49.66\pm0.11^{ab}$	$^{A}51.33\pm0.54^{b}$	$^{A}50.07\pm0.41^{ab}$	
	NaCl (%)	0	0.90 ± 0.00^{a}	0.87 ± 0.00^{c}	0.84 ± 0.00^{b}	0.80 ± 0.00^{a}	
Colour parameters	L* Lightness	0	$^{A}61.96\pm0.55^{b}$	$^{A}59.52\pm0.69^{a}$	$^{B}60.42\pm0.43^{ab}$	$^{A}59.42\pm0.41^{a}$	65.75±0.33
		2	$^{B}64.18\pm0.42^{c}$	$^{A}61.42\pm0.42^{b}$	$^{A}58.62\pm0.57^{a}$	$^{A}59.60\pm0.36^{a}$	
		4	$^{AB}62.34\pm0.58^{b}$	$^{A}61.62\pm0.70^{b}$	$^{A}57.83\pm0.45^{a}$	$^{A}58.10\pm0.64^{a}$	
	a* Redness	0	$^{A}2.93\pm0.13^{ab}$	$^{B}2.19\pm0.15^{a}$	$^{B}2.89\pm0.18^{ab}$	$^{B}3.24\pm0.32^{b}$	3.51±0.03
		2	$^{A}2.90\pm0.13^{b}$	$^{A}1.34\pm0.12^{a}$	$^{A}1.27\pm0.05^{a}$	$^{A}1.63\pm0.26^{a}$	
		4	$^{A}2.52\pm0.15^{b}$	$^{A}1.27\pm0.13^{a}$	$^{A}1.29\pm0.18^{a}$	$^{A}1.22\pm0.21^{a}$	
	b* Yellowness	0	$^{A}15.82\pm0.13^{b}$	$^{B}14.05\pm0.33^{a}$	$^{B}14.75\pm0.39^{ab}$	$^{C}14.29\pm0.53^{a}$	28.64±0.23
		2	$^{A}15.29\pm0.22^{b}$	$^{A}12.18\pm0.30^{a}$	$^{A}12.16\pm0.20^{a}$	$^{B}12.64\pm0.22^{a}$	
		4	$^{A}15.31\pm0.18^{c}$	$^{B}13.65\pm0.48^{b}$	$^{A}12.01\pm0.49^{ab}$	$^{A}10.69\pm0.46^{a}$	
Pigment oxidation	MMb (%)	0	$^{A}32.78\pm1.35^{a}$	$^{A}38.63\pm1.19^{b}$	$^{A}35.84\pm0.19^{ab}$	$^{A}38.61\pm1.21^{b}$	
		2	$^{A}37.10\pm0.82^{a}$	$^{A}39.26\pm0.10^{a}$	$^{B}39.95\pm0.80^{a}$	$^{A}39.41\pm0.73^{a}$	
		4	$^{B}42.70\pm1.33^{a}$	$^{A}42.56\pm1.21^{a}$	$^{C}42.88\pm0.10^{a}$	$^{A}41.63\pm0.62^{a}$	
	Heme iron (ppm)	0	$^{A}3.45\pm0.14^{b}$	$^{A}3.00\pm0.21^{ab}$	$^{A}2.85\pm0.00^{ab}$	$^{A}2.57\pm0.13^{a}$	
		2	$^{A}3.19\pm0.24^{a}$	$^{A}2.84\pm0.00^{a}$	$^{A}2.79\pm0.31^{a}$	$^{A}2.54\pm0.02^{a}$	
		4	$^{A}3.00\pm0.15^{b}$	$^{A}2.93\pm0.00^{ab}$	$^{A}2.89\pm0.00^{ab}$	$^{A}2.61\pm0.05^{a}$	
Lipid oxidation	TBARs (mg MA/kg)	0	$^{A}0.59\pm0.11^{a}$	$^{A}0.58\pm0.11^{a}$	$^{A}0.47\pm0.00^{a}$	$^{A}0.47\pm0.00^{a}$	
		2	$^{B}1.86\pm0.00^{c}$	$^{B}1.45\pm0.17^{b}$	$^{A}0.47\pm0.00^{a}$	$^{AB}0.48\pm0.00^{a}$	
		4	$^{B}1.83\pm0.00^{c}$	$^{B}1.29\pm0.25^{b}$	$^{A}0.49\pm0.00^{a}$	$^{B}0.48\pm0.00^{a}$	
Texture parameters	Hardness	1	259.21 ± 39.26^{a}	381.48 ± 16.18^{b}	287.94 ± 13.90^{ab}	274.94 ± 21.68^{ab}	
	Gumminess	1	65.02 ± 11.01^{a}	102.10 ± 7.75^{b}	67.43 ± 3.12^{ab}	61.16 ± 7.84^{a}	
	Chewiness	1	250.71 ± 42.46^{a}	397.37 ± 30.93^{b}	261.90 ± 8.11^{ab}	234.12 ± 32.09^{a}	
Sensorial analysis	Colour	1	5.94 ± 0.43^{b}	4.61 ± 0.40^{ab}	4.39 ± 0.43^{ab}	3.89 ± 0.50^{a}	
	Preference	1	2.39 ± 0.30^{a}	2.44 ± 0.28^{a}	2.22 ± 0.29^{a}	2.39 ± 0.30^{a}	

Metmyoglobin: MMb content showed SD (P<0.05) during storage time and between storage conditions, with a tendency to increase through the time and with the addition of date. No SD (P>0.05) were found among batches on day 2 and 4, only SD (P<0.05) were shown on day 0; the control and 10% pâté with more similar and lower values, while the 5% and 15% presented nearly the same values and tendency.

Heme iron: Its content showed SD (P<0.05) due to date content, but not (P>0.05) due to storage time.

Texture: Only hardness, gumminess and chewiness presented important SD (P<0.05) for pâté with 5%. In general, addition of date made increase hardness (P<0.05) and adhesiveness (P>0.05); and the rest of parameters were reduced when the added paste was 15%, but increased when it was 5%.

Sensorial analysis: Only SD (P<0.05) were found for the colour parameters. The control colour was the most accepted, and increasing the paste concentration the colour was more rejected. The texture parameters were affected positively by the addition of 5%,

although no SD (P>0.05) were detected. The order of preference was, from minus to more acceptability: 10% paste, control, 15% paste and 5% paste.

IV. DISCUSSION

pH decrease was related with date paste content. This could be due to the pH of the date paste (5.92), lower than the control pH (6.35). The pH tendency was to increase until day 2; but then, the control and 5% pâté decreased again, although the differences were in the range of 0.01-0.03. Globally, aw differed between control and pâtés with date, what could be due to the date fibre. Equally, fibre may be responsible of the increased moisture in samples with date, since dates show high water holding capacity [14].

Nearly all colour parameters decreased by date addition, although they were higher in the date paste. Any content of date darkened the pâté, even when a higher moisture is related to higher L* values [14]. Except for day 0, a* was reduced nearly in 2 units, therefore redness decreased independently of date content, what may be due to the formation of MMb. The b* presented a similar behaviour, but on day 4, b* decreased according to the date concentration.

Dates decreased the salt content and lipid oxidation, probably due to the less proportion of the other ingredients, and also date antioxidants decreased the oxidation. Heme iron content was lower in samples with dates, but more stable during storage time. Only a 15% date reduced significantly its content, probably because less liver is incorporated and also due to interactions of iron with the antioxidant compounds of dates. Pâtés were very well accepted, many panellists preferred samples with dates, the mix of sweet and salty tastes, together with a good texture was agreeable. Only colour was visually affected with 10% and 15% of date greatly, giving a more greyish colour.

IV. CONCLUSIONS

Using date by-products offers pâté processors the opportunity to improve their nutritional and health qualities at low-cost. Moreover, adding ingredients considered beneficial for health could aid to the reduction of components considered harmful, such as lipid oxidation products. Also, they keep the sensory acceptability, being the unique drawback a darker colour, what could be improve with the date content.

ACKNOWLEDGMENTS

The support of the CAM, the AECID (A/030696/10), and IBEROFUN (110AC0386) are gratefully acknowledged.

REFERENCES

1. Jiménez-Colmenero F, Carballo J, Cofrades S (2001) Healthier meat and meat products: their role as functional foods. Meat Sci 59:5-13
2. Martín-Sánchez A, Navarro C, Kuri V et al. (2009) Eccoeficiency in the food industry. AET 247:52-57
3. Vilella J (2008) Problemática de la producción del dátil d'Elx para su comercialización, XXXV Congreso Nacional PARJAP Proc., Alicante, communication 1-9
4. Yousif O, Osman M, Alhadrami G (1996) Evaluation of dates and date pits as dietary ingredients in tilapia diets differing in protein sources. Bioresource Tech 57:81-85
5. Al-Farsi M, Lee, C (2008) Nutritional and functional properties of dates. Crit Rew Food Sci Nutr 48:877-887
6. Hunt M, Acton, J, Benedict, R, et al. (1991) Guidelines for meat colour evaluation. AMSA, Chicago
7. Bourne M (1978) Texture profile analysis. Food Tech 72:31:62
8. ISO (1975) Meat and meat products: determination of nitrite content. ISO/DIS 1841:198
9. ISO (1981) Meat and meat products: determination of chloride content. ISO/DIS 1841:1981
10. Botsoglou N A, Fletouris D J, Papageorgiou G E et al. (1994) Rapid, sensitive, and specific TBA method for measuring lipid peroxidation in animal tissue, food, and feedstuff samples. J Agric Food Chem 42:1931-1937
11. Hornsey H C (1956) The colour of cooked cured pork. I. Estimation of the nitric oxide-haem pigments. J Sci Food Agric 7:534-540
12. Ulu H (2004) Effect of wheat flour, whey protein concentrate and soya protein isolate on oxidative processes and textural properties of cooked meatballs. Food Chem 87:523-529
13. ISO (1985) Sensory analysis. Methodology. General guidance. ISO-DP 6658.
14. Sánchez-Zapata E, Fernández-López, J, Peñaranda, M, et al. Technological properties of date paste obtained from date by-products and its effect on the quality of a cooked meat product. Food Res Int DOI 10.1016/j.foodres.2010.04.03