MEAT HYBRID SAUSAGE BLENDED WITH RICE AND PUMPKIN PROTEINS

Marina Contreras[1-2*], Germana Barbieri[1], Monica Bergamaschi[1], Andrea Brutti[1], Jose Benedito[2], Jose V. Garcia-Perez[2], Roberta Virgili[1]

[1] Experimental Station for the Food Preserving Industry – Research Foundation (SSICA), Italy

[2]Research Institute of Food Engineering for Development, Polytechnic University of Valencia (UPV), Spain

*Corresponding author email: marina.contreras.guest@ssica.it

I. INTRODUCTION

Meat production presents a series of concerns including high environmental impact, animal welfare and public health issues, but simultaneously meat is considered an important source of high-quality proteins [1]. Over the last few years, there has been a steady increase in proteins alternative to meat, due to a growing demand for a more sustainable and plant–based diet [2]. In this sense, possible meat replacers have been tested to reduce meat consumption but bringing the consumer a healthy and nourishing product [3]. In this context, the main objective of the study was to formulate a hybrid meat product by using pumpkin seed proteins extracted from seed by-products and a commercial rice protein isolate, in order to replace up to 40% of meat in a pork cooked sausage.

II. MATERIALS AND METHODS

Hybrid cooked sausages were manufactured in the pilot plant of SSICA, using commercial rice protein (80% protein) and pumpkin seed protein (85.5% protein, prepared at SSICA) isolates, as meat replacers. By-products of pumpkin seeds, after oil extraction by a screw press, were minced and bleached with sodium bisulphite (0.1%), solubilised with NaCl 1 M and NaOH 2 M until pH = 9, precipitated by pH-shift and freeze-dried. Protein isolates were combined with pork minced meat (loin:neck muscles = 60:40) and salt (1.5%), according to a Full Factorial Mixture Design (Unscrambler V9.3, CAMO) with three mixture variables (meat, rice and pumpkin seed proteins), one discrete design variable (nitrite = 0 or 100 mg/kg meat), generating an axial design with end points (18 formulations). Meat content ranged from 100% to 60%, replaced by rice and/or pumpkin seed proteins, each one in the range 0 – 40%, or up to 27% when mixed. Vegetal protein percentages included the hydration water, according to their water holding capacity (WHC), as reported in Ghribi *et al.* [4]. Next, hybrid and meat minces were stuffed into cellulose casings, resulting in sausages of approximately 100 g each, which were cooked until 70 °C core temperature. Protein isolates and sausages were evaluated for protein content (Kjeldahl method, ISO 937:1991), colorimetric indices a* (redness index) and hue angle (relative amounts of redness and yellowness); sausages were tested for pH and texture parameters hardness (Newton) and springiness (adimensional), intended as the maximum force and recovery of sample height, respectively, in 30% sample height compression, in two cycles. Regressions between the response (y variables) and the formulations (x variables) were performed by PLS analysis. A comparison between response variables (estimated marginal means, EMMs) in formulations with or without nitrite, was made by General Linear Model (GLM) analysis (SPSS, ver. 22), including sausage pH as covariate.

III. RESULTS AND DISCUSSION

Figure 1 shows the sections of cooked sausages. Protein content of sausages was 26.3 ± 2.6%. Although the nitrite-free samples (Figure 1, A) appear pale and brownish when compared to the nitrite-added ones (Figure 1, B), colour development was homogeneous even in sausages with the highest meat replacement (40%). EMMs of samples with and without nitrite differ ($P < 0.05$) for a*, 5.78 vs 2.06, and hue, 68.7 vs 82.8, respectively. As shown in Table 1, nitrite is key to increase a* (range a* = -1.43 – 9.31) and lower hue (range hue = 50 – 94.7). Although treated with sodium bisulphite to remove the greenish colour, proteins obtained from pumpkin seeds (a* = -2.34) caused the decrease in a* and the increase in hue of the hybrid cooked sausages, while rice proteins (a* = 1.39) have a positive coefficient.

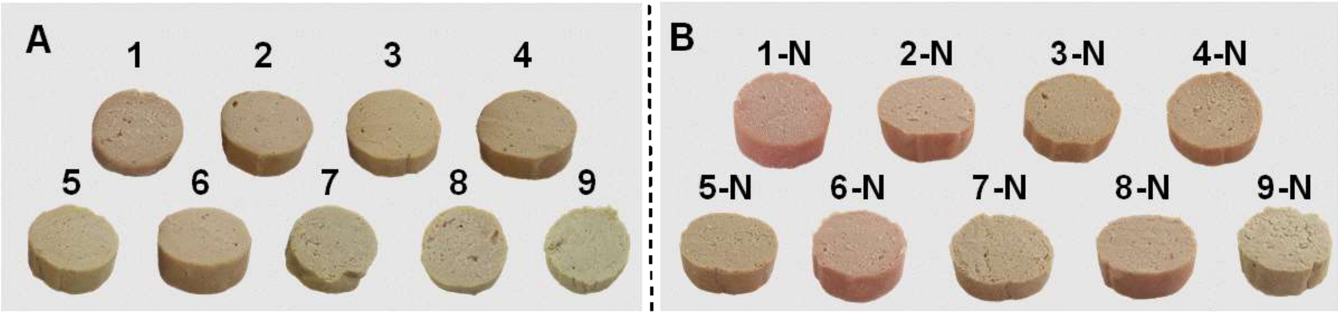

Figure 1. Cooked sausages manufactured following the 18 formulations. 1=M100, 2=M80-R20, 3=M60-R40, 4=M67-R27-P6, 5=M60-R20-P20, 6=M87-R7-P6, 7=M67-R6-P27, 8=M80-P20, 9=M60-P40 (M, R and P refer to meat, rice and pumpkin seed proteins, respectively, while numbers indicate composition percentage). Sausages in section B marked with letter N correspond to nitrite added formulations.

Table 1. PLS regression coefficients (weighted).

	X variables					
	Mixture			*Design*		
	Meat	Rice protein	Pumpkin seed protein	Nitrite	R^2	% Explained Y variance
Y variables						
a*	0.29	0.17	-0.46	0.69	0.96	94.6
hue	-0.36	-0.08	0.43	-0.67	0.92	93.0
hardness	0.38	0.25	-0.64	0.04	0.89	85.9
springiness	0.16	0.39	-0.55	< 0.001	0.72	60.9

The hybrids with an increasing meat replacement with proteins from pumpkin seeds showed a decrease in hardness (range = 8.09 – 22.8 Newton) and springiness (range = 0.74 – 0.95). The pH of cooked sausages (pH range = 5.29 – 6.07), included in the GLM model as covariate, is significant ($P < 0.05$) for response variables, positive for a*, hardness and springiness, negative for hue. Protein isolate obtained from pumpkin seeds by pH-shift until pH = 4 caused the pH decrease in hybrid cooked sausages, according to its amount in the mixture, affecting colour and texture indices.

IV. CONCLUSION

Nitrite addition (100 mg/kg meat) to hybrid cooked sausage is effective to develop a colour similar to conventional cooked meat products, even in the case of meat replacement with protein from pumpkin seeds, which retained traces of green radiance. Additionally, pumpkin seed proteins caused a decrease in pH, which impaired colour and texture indices; to eliminate this drawback, the preparation of this protein isolate should include washing steps after the pH-shift phase to recover a meat-like pH.

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REFERENCES

1.Godfray, H. C. J., Aveyard, P., Garnett, T., Hall, J. W., Key, T. J., Lorimer, J., Pierrehumbert, R.T., Scarborough, P., Springmann, M. & Jebb, S. A. (2018). Meat consumption, health, and the environment. Science 361: 1-8.
2.Aschemann-Witzel, J., Gantriis, R. F., Fraga, P. & Perez-Cueto, F. J. A. (2021). Plant-based food and protein trend from a business perspective: markets, consumers, and the challenges and opportunities in the future. Critical Reviews in Food Science and Nutrition 61: 3119–3128.
3.Munialo, C.D., Stewart, D., Campbell, L. & Eustond, S.R. (2022). Extraction, characterisation and functional applications of sustainable alternative protein sources for future foods: A review. Future Foods 6: 100152.
4.Ghribi, A. M., Amira, A.B., Gafsi, I.M., Lahiani, M., Bejar, M., Triki, M., Zouari, A., Attia, H. & Besbes, S. (2018). Toward the enhancement of sensory profile of sausage 'Merguez' with chickpea protein concentrate. Meat Science 143: 74-80.