

PROTEINS FROM THE MEAT PROCESSING CHAIN – ENHANCING VALUE OF CO-PRODUCTS

Liana Drummond¹, Carlos Alvarez¹ & Anne Maria Mullen^{1*}

¹Department of Food Quality and Sensory Science, Teagasc Food Research Centre, Ashtown, Dublin 15;

*Corresponding author email: anne.mullen@teagasc.ie

Abstract – Demand for protein is continuously increasing and despite advances on research and development of alternative protein sources, animal protein still holds a key role in the supply of this essential nutrient. Approximately half of the live weight of animals raised to produce meat (circa 54-56% of the bovine and 48% of the porcine) is categorized as “the fifth quarter”, commanding lower market values than prime meat cuts. From the sustainability as well as from the protein quality points of view, it makes sense to explore the available sources of high quality protein already available, but not utilized to its fullest potential. We summarise here current opportunities for aggregating value to some of these protein-rich co-products from the meat processing chain, underpinned by research advances on both technical and social aspects. The work is part of a large research initiative looking at the exploration of Irish meat processing streams for recovery of high value protein based ingredients for food and non-food uses – the ReValueProtein (www.revalueprotein.com) project.

Key Words – animal protein, bioactives, legislation, techno-functional, extracting value

I. INTRODUCTION

Current demands for sustainable food production have highlighted the need for more efficient and complete use of our natural resources. Sustainable production systems can maximise return on investments and reduce waste. Boned meat is the primary product arising from the meat processing chain but 40 to 60% of the animal carcass is also generated, what the industry generally calls “the fifth quarter” [1]. Fifth quarter products include items such as hearts, liver, tongue, kidneys and tripe, as well as other edible and valuable parts such as lung, feet, testicles and pancreas. In Europe, most of these products are marketed at low(er) values despite their high nutritional value [2]. Their potential for generating compounds with nutritional and techno-functional properties, and in some cases bioactivity (antioxidant, anti-microbial, etc.) is attracting attention from academic and industrial sectors. Recovery of value from the meat processing chain can enhance the economic performance and improve the environmental impact of the meat industry.

II. PROTEIN APPLICATIONS IN HIGHER VALUE PRODUCTS

The most significant compound to be recovered from animal sources is, undoubtedly, protein. Apart from their physiological role in the structure, function, and regulation of the body's tissues and organs, some proteins also exhibit techno-functional properties adding or improving the texture, stability, appearance and palatability of foods and beverages. Extracted proteins can also be employed in the manufacture of nutrition products, to boost the protein intake of target groups such as athletes, the elderly or physically active consumers in search of protein supplementation. Other high value applications include the use of natural biomaterials, such as collagen, as raw materials in tissue engineering, for wound repair and tissue scaffolds. Peptides from animal protein also display bioactivity, bioavailability, and health-promoting properties that may be employed in the formulation of functional products (e.g. antioxidant, antihypertensive and probiotics), or incorporated into packaging materials (e.g. antioxidant/antimicrobial biofilms).

III. RESULTS AND DISCUSSION

The ReValueProtein project has successfully established and optimised protocols to extract, characterise and test proteins and peptides from selected beef and pork fifth quarter products and meat processing side streams for their techno-functional and bioactive properties. Co-products have so far included lung, tongue, heart; blood; tendons and pancreas. Side streams included exudates, glue water, cook out and brine solutions. After sampling, proximate analysis was carried out (protein, fat, moisture, ash content) followed by protein extraction and evaluation of techno-functional properties (solubility, emulsifying ability, gelling capacity and oil and water holding capacity). Table 1 provides an overview of proximate analysis results obtained for co-products and side streams analysed.

Table 1 Proximate composition of co-products and side streams

Co-products / streams	Protein (%)	Moisture (%)	Fat (%)	Ash (%)	Protein (dry basis)
Lung*, heart*, blood*	18 – 20	77 – 87	<0.1 - 2	<2	84 – 90
Tongue*	15 - 16	64 - 66	16 - 17	<1	42 - 47
Glue water	1 - 2	96 - 98	<0.1	1 – 2	43 - 45
Exudates	11 – 13	85 – 86	<0.1	<1	85 – 86
Brine solutions	1 - 2	86 - 87	<0.5	10 - 15	13 – 15

*average from bovine and porcine

Processing has a great impact on functional properties. In order to recover proteins from diluted liquid streams, these samples were concentrated and when necessary desalinated by membrane filtration. A summary of qualitative results for techno-functional properties analysed is presented in Table 2.

Table 2 Techno-functional properties of proteins from co-products and side streams

Co-products / streams	Emulsifying	Solubility	Gelling	WHC	OHC
Glue water	+++	Medium-High	+++	+++	+
Exudates	+++	Low within 4-7 pH	+++	++	++
Brines solution acid extraction	+++	Low within 4-7 pH	-	+	-
Brine solutions dialyzed	+++	Low within 4-7 pH	-	+++	++
Plasma	+++	High	++	++	++

WHC: water holding capacity. OHC: oil holding capacity

Peptides obtained from blood protein fractions using papain enzyme exhibited ACE-I, renin and DPP-IV inhibitory properties (in vitro) [3]. As one of the guiding principles of the ReValueProtein project is to reduce generated waste, after extraction of the soluble protein fraction, the remaining insoluble fractions were also tested for generation of bioactive peptides. Proteinaceous residues from protein lung extraction exhibited immunomodulatory potential and reduction of DNA damage [4].

IV. CONCLUSION

Opportunities clearly exist for extracting additional value from meat processing chains. The ReValueProtein project aims to expand the knowledge base and generate technical know-how to support protein recovery from meat co-products and for development of new added-value ingredients. As well as ensuring optimal use of protein rich materials, this approach supports sustainable practices across the sector by exploring resources already available. However, science and technology driven approaches must be in tandem with market, legislative and consumer knowledge for successful marketing of new products and ingredients.

ACKNOWLEDGEMENTS

This work forms part of the ReValueProtein Research Project (Grant Award No. 11/F/043) supported by the Department of Agriculture, Food and the Marine (DAFM) under the National Development Plan 2007–2013 funded by the Irish Government.

REFERENCES

1. Marti, D. L., Johnson, R. J., & Mathews Jr, K. H. (2012). Where's the (not) meat? Byproducts from beef and pork production. *Journal of Current Issues in Globalization*, 5 (4), 397.
2. Mullen, A. M. & Álvarez, C. (2015). Offal. Types and Composition. In Caballero, Finglas & Toldrá, *Encyclopedia of Food and Health*, Academic Press, Elsevier.
3. Lafarga, T., Rai, D. K., O'Connor, P. and Hayes, M. (2016). Generation of Bioactive Hydrolysates and Peptides from Bovine Hemoglobin with In Vitro Renin, Angiotensin-I-Converting Enzyme and Dipeptidyl Peptidase-IV Inhibitory Activities. *Journal of Food Biochemistry* 40 (5), 673–685.
4. O'Sullivan, S.M., Lafarga, T., Hayes, M. and O'Brien, N.M. (2016). Potential bioactivity of hydrolysates derived from bovine lung. *Proceedings of the Nutrition Society* 75 (OCE3), E168. doi: 10.1017/S002966511600183X