Artificial tenderization of camel meat using Algerian endemic plant proteases (ficin, capparin and calotropain) recovered using Three Phase Partitioning system: a sustainable development example

Mohammed Gagaoua[1], Amira Leila Dib[2], Melisa Lamri[3], Nedjoua Lakhdara[2]

[1] Food Quality and Sensory Science Department, Teagasc Food Research Centre, Ashtown, Dublin, Ireland
[2] GSPA Research Laboratory, Institute of Veterinary Sciences, Université des Frères Mentouri Constantine, Constantine, Algeria
[3] Université Mouloud Mammeri, Tizi-Ouzou, Algeria

Introduction: Many biomolecules of interest can be recovered in a sustainable manner from raw materials of plant by-products including fruits, from which the most important economically include proteases extensively used as meat tenderizing agents (Gagaoua et al. 2021). In addition, in the last decade, growing interest has emerged toward plant proteases and their application in peptide synthesis/production. In this context and in line with the 2030 Agenda for Sustainable Development, our objective is to first use the latex of Ficus carica, capsules of Capparis spinosa and leaves of Calotropis procera as resources to recover their proteases (ficin, capparin and calotropain, respectively) using Three Phase Partitioning (TPP) system (Gagaoua et al. 2014; Gagaoua, 2018). Then, we aimed to apply the recovered enzymes to tenderize tough camel meat and characterize the protein hydrolysates produced under three tenderizing treatments.

Materials and methods: At an optimized amount of 75 ppm, the three proteases were applied to improve the texture of the inside round muscles (Adductor) of camel meat sampled from a 5 years old male dromedary. Treatments including pulverization of the meat pieces (3 × 2×1 cm, length × width × thickness); injection using a syringe at 5 different points and marinade were applied following the procedure described previously (Hafid et al., 2020). A control for each condition was performed. After an incubation time of 24h at 4°C, the samples were assessed for muscle proteolytic breakdown (Myofibrillar Fragmentation Index, MFI); drip loss,%; collagen solubility,%; degree of hydrolysis (DH,% = (10% TCA soluble nitrogen /Total nitrogen)x100%)) and peptide content calculated based on a calibration curve (Gly-Leu as standard). Protein hydrolysates were tested for ACE-inhibitory activity and for the antioxidant activity based on 3 methods: DPPH Radical Scavenging Activity, Ferric Reducing Antioxidant Power Assay (FRAP) and Oxygen Radical Absorbance Capacity Assay (ORAC) Borrajo et al. (2020).

Results: From the results of this trial, marinade was the best tenderizing method using the 3 enzymes as evaluated by MFI and collagen solubility. Collagen content was hydrolyzed significantly by ficin and calotropain whatever the treatment compared to capparin. The 3 proteases allowed promising antioxidant activities, which were related to the high levels of low molecular mass peptides associated to high antioxidant activity. The antioxidant parameters DPPH and ORAC were high for marinade irrespective of the enzyme, followed by injection for the 3 enzymes. These were followed by pulverization with greater efficiency for capparin compared to ficin and calotropain. Even tough, dromedary meat seems to have good potential for developing new healthy foods, in addition of acting as natural antioxidants. The enzymes impacted weakly drip loss, which is in agreement with earlier results using TPP papain (Hafid et al. 2020).

Conclusion: This trial showed that Algerian plant proteases recovered by TPP system has the ability to be used in a sustainable manner to improve the texture of tough camel meat. This can be a valuable strategy to develop locally tender camel and healthier and functional food products that contain bioactive peptide hydrolysates with antioxidant activities. Further studies are needed to assess the tenderness using trained sensory and shear force using Warner-Bratzler method.

Literature:

Borrajo, P.; Pateiro, M.; Gagaoua, M.; Franco, D.; Zhang, W.; Lorenzo, J.M. Evaluation of the Antioxidant and Antimicrobial Activities of Porcine Liver Protein Hydrolysates Obtained Using Alcalase, Bromelain, and Papain. Applied Sciences 2020, 10, 2290.

Gagaoua, M.; Boucherba, N.; Bouanane-Darenfed, A.; Ziane, F.; Nait-Rabah, S.; Hafid, K.; Boudechicha, H.-R. Three-phase partitioning as an efficient method for the purification and recovery of ficin from Mediterranean fig (Ficus carica L.) latex. Separation and Purification Technology 2014, 132, 461-467

Gagaoua, M. (2018) Chapter 8 - Aqueous methods for extraction/recovery of macromolecules from microorganisms of atypical environments: A focus on Three Phase Partitioning. Methods in Microbiology. pp. 203-242. Academic Press.

Gagaoua, M., Dib, A.L., Lakhdara, N., Lamri, M. Botineştean, C. & Lorenzo, J.M. (2021). Artificial meat tenderization using plant cysteine proteases. Current Opinion in Food Science, 38, 177-188.

Hafid, K., John J., Sayah, T.M., Domínguez, R., Becila, S., Lamri, M., Dib, A.L., Lorenzo, J.M. & Gagaoua, M. (2020). One-step recovery of latex papain from Carica papaya using Three Phase Partitioning and its use as milk-clotting and meat-tenderizing agent. International Journal of Biological Macromolecules, 146, 798–810.