TEXTURE OPTIMISATION OF NOVEL RESTRUCTURED BEEF STEAKS SUITABLE FOR ELDERLY PEOPLE USING CLEAN LABEL PLANT PROTEINS AND PIVAC

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Abstract – A central composite design (CCD) experiment was used to investigate the effects of clean label plant proteins and transglutaminase enzyme (TG) on texture of restructured beef steaks developed using PiVac technology. Four factors [(TG, pea protein isolate (PPI), rice protein (RP), lentil flour (LF)] were assessed in 30 formulations. Models showed that RP inclusion correlated positively with protein content while PPI and LF correlated with improved texture. Beef steaks with acceptable textural parameters and protein content of 28g in a 100g portion were achieved. Optimal beef steak formulations were defined based on the significant dependent variables (e.g. protein, TPA). Optimised portion-controlled protein-enriched beef steaks could assist in enhancing nutritional status and promote healthy ageing.

Key Words – Healthy ageing, PiVac technology, Response surface methodology, nutrition

I. INTRODUCTION

Healthy ageing is an important challenge. Today's ageing generation is more health-conscious and may embrace enriched meat products aimed at promoting vibrant longevity. Innovative meat products tailored for better oral experience (soft, easily and safely swallowed), yet which are nutritious and tasty, may compensate their nutritional needs, mitigate age-related muscle loss (sarcopenia), improve bone health and thereby enhance quality of life among older adults [1]. The aims of this study were: 1) to model the effect of pea protein isolate the (PPI), rice protein (RP), lentil flour (LF) and tranglutaminase (TG) on protein content and texture parameters of restructured beef steaks, 2) to use the desirability function as multicriteria tool to identify an optimal formulation.

II. MATERIALS AND METHODS

Restructured steaks preparation: Coarsely ground beef chucks was mixed for 2 min at a speed of 250 rpm 1/min (Stephan Mixer, SohneGmbH & Co, 3250 Hamln, Germany); half of the chilled water was incorporated and mixed again for 2 min. Activa$_{®}^{EB}$ (TG) (Ajinomoto Europe, Hamburg, Germany), was dissolved in remaining water, added to the mixture and mixed for 3 min. Finally, a premix [selenium, vitamin A, zinc, vitamin B_6, vitamin B_{12}, vitamin K_1, vitamin E, folic acid, vitamin C] (Vitablend, Wolvega, The Netherlands) (20mg/100g of meat) was added and mixed for 1 min. Using a hand crank filler, each formulation was stuffed in a plastic casing of 100 mm in diameter (Food Processing technology, Tallaght, Ireland). Once stuffed, it was clipped at both ends and PiVac was applied. Meat logs were then placed in a chill environment (4°C for 16-18hr) to develop adequate bind and subsequently stored in a freezer (-20°C for 24 hr) prior to slicing into steaks (1.5 cm thick, ~ 107 g). Restructured beef steaks were individually vacuum packed and stored frozen (-20°C) until use.

Protein analysis: Protein (N x 6.25) was determined by LECO Nitrogen Determinator, (LECO® Corporation, MI USA) according to AOAC official method 992.15, 1990.
Texture profile analysis (TPA): TPA was applied on cooked product based on a method described by Baugreet *et al.* (2016) [1]. It was performed on an Instron Universal Testing Machine (Instron Model 5543 (UK) Ltd, High Wycombe, UK).

Statistical analysis: The Response Surface Methodology with CCD, optimization and contour plots were performed using Design Expert 10 (Stat-Ease, USA).

III. RESULTS AND DISCUSSION

All cooked restructured beef steaks exhibited protein content of 22-28g/100g portion after the cooking process, exceeding the current recommended dietary allowance (RDA) (0.8g/kg/day). An average intake of 25-30g (1.2-1.5g/kg/day) of high quality protein per meal has been suggested in recent literature, to maximise muscle protein synthesis and maintain muscle mass in the elderly [2].
All ingredients significantly affected aspects of texture in restructured beef steaks. Hardness, cohesiveness and gumminess response surfaces are presented in Figure 1. A significant interaction effect was observed for PPI*LF, where PPI (>7%) increased hardness at low levels of LF (<2%) but minimised hardness in the presence of LF (>3%) (Fig. 1a). A previous study shows that beef patties enriched with PPI increased product hardness [1]. Cohesiveness is a measure of the degree of difficulty in breaking down the internal structure of meat. A complex interactive relationship with RP*LF was observed for cohesion (Fig. 1b). Gumminess was only influenced by LF and this trend decreased in a linear fashion with LF inclusion (Fig. 1c). Lentil has lower protein content compared to other ingredients and contains carbohydrate which may contribute to a weaker gel structure in the cooked product. Adebiyi and Aluko (2011) [3], found that pea protein isolate forms a paste instead of a rigid gel structure in products. This may explain why the interaction of PPI and LF produced an enhanced softening effect in the restructured beef steaks. The optimal formulation was predicted to contain TG: 2.0%, PPI: 8.0%, RP: 9.35%, LF: 4.0% and had a predicted protein content of 27g/100g per restructured beef steaks.

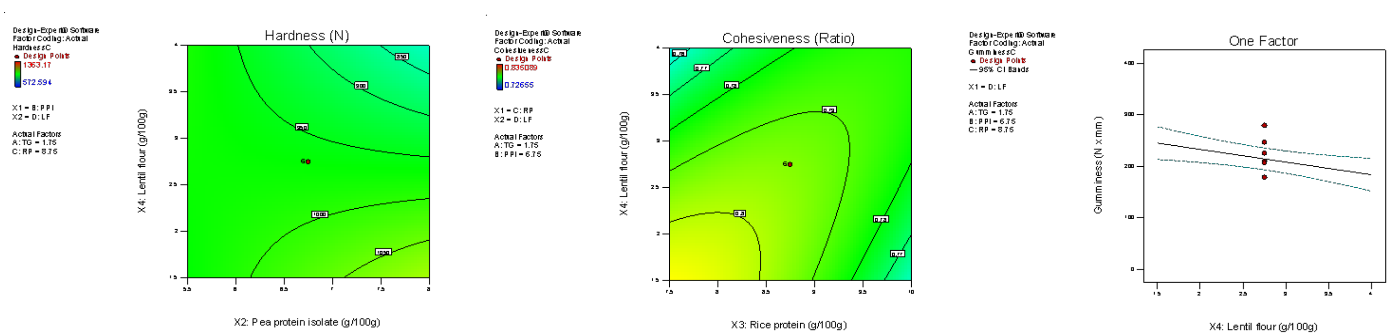

Fig. 1 Representation of the response surface models for hardness (a), cohesiveness (b) and gumminess (c)

IV. CONCLUSION

The development of novel restructured beef steaks presenting acceptable textural characteristics (soft, palatable) combined with functional protein ingredients will help achieve targeted protein requirements (1.2-1.5g/kg/day) and maximise muscle protein synthesis in the older cohort.

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