BEEF LUNG PROTEIN POWDER AS A FUNCTIONAL INGREDIENT TO ENHANCE PROTEIN AND IRON CONTENT OF PLANT-BASED DIETS

S. Reshan Jayawardena[1]*, James D. Morton[1], Charles S. Brennan[1], Zuhaib F. Bhat[1] and Alaa El-Din A. Bekhit[2]

[1]Department of Wine Food and Molecular Biosciences, Lincoln University, Lincoln 7647, Christchurch, New Zealand

[2]Department of Food Sciences, University of Otago, P.O. Box 56, Dunedin 9054, New Zealand

*Corresponding author email: Reshan.JayawardenaMudiyanselage@lincolnuni.ac.nz

I. INTRODUCTION

Efficient beef production is required to meet the increasing global demand for protein but has a large financial and environmental impact. High meat production in developed countries is associated with a low demand for co-products including beef lungs as human food while developing countries suffer from inadequate protein and haem iron intake leading to malnutrition and anaemia. The use of low demand edible offal to fortify cereals could fill this gap. The objective of this research is to evaluate the processing potential of beef lungs, a low demand co-product of meat production, as a nutritional supplement in food applications. Therefore, lungs powder was used to fortify semolina pasta and the nutritional value and physicochemical characteristics of the fortified pasta were determined compared to non-treated control.

II. MATERIALS AND METHODS

Beef lungs were sliced and dried 32 hours at 60˚C using an air oven drier and ground into powder. Mineral profile of the beef lung powder (BLP) was determined by Inductively Coupled Plasma Optical Emission Spectrophotometry. Pasta was prepared according to [3] by mixing BLP and semolina and cold extrusion to produce pasta with 0%, 10%, 15%, and 20% BLP. Elasticity, firmness and elongation of the generated pasta was measured using a texture analyser (TA.XT2; Stable Micro System, Godalming, UK). The amino acid profile of the best semolina pasta and beef lung powder formulation was analysed by HPLC to calculate indispensable amino acid scores (IAAS). Statistical analysis was done by using one-way ANOVA using Tukey's comparison test for pairwise comparison of means.

III. RESULTS AND DISCUSSION

The BLP had a protein content of 87%. The mineral content of BLP showed that 8 to 17 g of beef lung powder was sufficient to fulfil the daily requirement for iron (Table 1) It also had a high level of phosphorus and potassium.

Table 1: Comparison of beef lung powder with RDI/AI values

Element	Amount (mg)/ g (beef lung powder)	RDI/ AI value (mg) (lowest to highest)
Ca	0.48± 0.002^{de}	500-1300
Fe	1.07± 0.007^{d}	8-18
K	10.92± 0.77^{a}	2000-3800
Mg	0.63± 0.008^{de}	80-420
Na	7.30± 0.08^{c}	200-920
P	9.26± 0.03^{b}	460-1250
Zn	0.092± 0.005^{e}	8-14

*RDI, recommended daily intake (Ca, Cr, Cu, Fe, Mg, P, Zn); AI, adequate intake (K, Mn, Na). Source of RDI /AI values: [4]. RDI/ AI values range includes all life stage requirements except infant, pregnant and lactation periods. Results are means (± SD) of triplicate samples (n=3)

Adding BLP significantly ($P < 0.05$) increased the firmness of the pasta (Control, 215.04±9.10^{c} g: 10%, 323.69±17.11^{b} g: 15%, 409.42±16.25^{a} g and 20%, 418.85±8.52^{a} g) improving its quality [2]. The elastic limit did not change significantly ($p>0.05$) but elongation was decreased with control was the highest and 20% pasta was the lowest as 45.77±4.53^{a}, 29.59±4.96^{b}, 24.29±3.57^{c} and 17.17±4.04^{d}, respectively.

The optimal beef lung incorporation was determined as 10% based on cooking characteristics. Table 2 shows the amino acid profile of beef lung powder, control pasta and 10% pasta. Amino acid ratios (AAR) and amino acid scores (AAS) was calculated according to the reference pattern [1]. Incorporation of 10%BLP increased the IAAS of pasta from 0.48 to 0.91. Lysine was the limiting amino acid in control pasta but 10% BLP incorporation met the lysine requirement and histidine became the limiting amino acid.

Table 2. Amino acid ratios and indispensable amino acid scores (IAAS) of BLP and 10% BLP pasta

Amino acid	Beef lung powder (mg/g protein)	control pasta (mg/g protein)	*10% Beef lung powder pasta (mg/g protein)	Older child, adolescent & adult reference pattern	*Beef Lung powder AAR	*control pasta AAR	*10% pasta AAR
Tryptophan	24.77 ± 3.34	15.51 ± 0.02	19.69	6.6	3.75	2.35	2.98
Threonine	43.51 ± 2.16	28.70 ± 0.03	35.17	25	1.74	1.15	1.41
Isoleucine	34.71 ± 1.13	36.50 ± 0.04	35.71	30	1.16	1.22	1.19
Leucine	88.72 ± 4.21	70.90 ± 0.06	78.68	61	1.45	1.16	1.29
Lysine	81.06 ± 4.95	22.99 ± 0.01	48.38	48	1.69	0.48	1.01
SAA	30.08 ± 0.97	23.71 ± 0.12	26.49	23	1.31	1.03	1.15
AAA	69.47 ± 3.02	66.72 ± 0.24	67.91	41	1.69	1.63	1.66
Valine	59.90 ± 3.01	38.42 ± 0.08	47.81	40	1.50	0.96	1.20
Histidine	21.59 ± 2.08	9.00 ± 0.14	14.51	16	1.35	0.56	0.91
IAAS					1	0.48	0.91

Reference pattern adopted from [1]; AAR, amino acid ratios; SAA, sulphur amino acid (methionine + cysteine); AAA, aromatic amino acid (phenylalanine + tyrosine), BLP, beef lung powder
Results are means (± SD) of triplicate samples (n=3)
*Denotes calculated values

IV. CONCLUSION

Beef lungs have the potential to be processed into a powder that could deliver protein and iron and improve the nutritional quality of protein-poor, carbohydrate-rich food.

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