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Proteins, isoleucine, lysine and methionine content of bovine, porcine and poultry blood and their fractions

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Abstract

Studies carried out in bovine blood proteins pointed out that they are excellent sources of lysine (Lys), but deficient in isoleucine (Ile) and methionine (Met). The purpose of this investigation was to determine and compare the content of proteins, Lys, Ile and Met in whole blood, red cells and plasma of bovine, porcine and poultry species. Blood from the different species were centrifuged for their separation in plasma and red cells. Proteins, Lys, Ile and Met content in blood and their fractions were determined. Results showed that protein content in bovine and porcine blood and plasma were significantly higher than those for poultry. Red cells and plasma proteins from poultry posses superior levels of Ile than bovine and porcine red cells and plasma. Lys content was high for all blood and fraction species. Met was low in all the species under study.

Keywords: Proteins; Isoleucine; Lysine; Methionine; Protein; Animal blood

1. Introduction

Blood and their fractions (plasma and red cells) from bovine represent a potential source of high amount of edible nutritional proteins and essential amino acids. This recognition alone, with their capability of having functional properties, has contributed to its incorporation in some foods (Barboza, Márquez, Gómez, & Rangel, 1997; Bates, Wu, & Murphy, 1974; Caldironi & Ockermann, 1982; Márquez, Barboza, Izquierdo, & Torres, 1997; Wismer-Pedersen, 1988). However, isoleucine and methionine deficiency has been reported in bovine blood protein (Bourgeois, 1986; Duarte, Carvalho Simoes, & Sgarvieri, 1999; Gómez Juárez, Castellanos, Ponce Noyola, Calderón Salinas, & Figueroa, 1999; Shahidi, Naczk, Rubin, & Diosady, 1984; Wismer-Pedersen, 1979; Wismer-Pedersen, 1988). In experiments carried out with rats and chicks, bovine blood supplemented with D-L-isoleucine increased protein efficiency ratio (PER) for the first ones and corporal weight and conversion for the second ones (Young, Lewis, Landmann, & Dill, 1973).

Proteins and essential amino acids content of porcine blood, poultry blood and their fractions are also of singular importance. The recuperation and utilization of these proteins is of utmost importance if we consider the amount of porcine and poultry that are slaughtered annually and the high levels of protein deficiencies in the world. Addition of poultry blood plasma to bread increased PER value from 0.87 to 2.02 (Del Rio de Reys, Constantinides, Sgarbieri, & Dash, 1980).

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The objective of this investigation was to evaluate and establish comparisons with regard to the content of protein, lysine (Lys), methionine (Met) and isoleucine (Ile) in blood, red cells and plasma of bovine, porcine and poultry species.

2. Methods and materials

2.1. Sampling

A total of 45 samples of animal blood, 15 per species (bovine, porcine and poultry) were gathered from different slaughter houses of the Maracaibo city, in Zulia State, Venezuela. Blood was collected in a solution of sodium trypoliphosphate as anticoagulant at 2% for bovine and porcine blood and at 1% for poultry blood (Rangel, Archile, Castejón, Izquierdo, & Márquez, 1995). Half of the blood sample for each specie was centrifuged at 3000 rpm for 20 min to separate the corpuscular and plasmatic fraction.

2.2. Chemical analysis

Protein and moisture percentages were determined for blood, red cells and plasma from the different species following the method of Macro–Kjeldahl and oven drying standard, respectively (AOAC, 1997). Amino acids were analyzed by high performance liquid chromatography. A Shimadzu model LC-6A HPLC equipped with a FLD-6A fluorescent detector, two LC-6A pumps, a SCL-6B auto injector, a CTO-6A column oven and a CR4A chromatopack integrator was used throughout the experiments. An altex ultra sphere ODS, C-18, 15 cm length × 4 mm ID, 5 μm column was used. Two solvent systems were used: solvent A was composed of acetate buffer (0.05 M), methanol and tertrahydrofurane (80:19:1) and solvent B was composed of methanol and acetate buffer (80:20). A Sigma laboratory standard solution 50 μmol/mL amino acid concentration was used as a reference. A precolumn derivatization of the amino acids was performed. Samples of 0.02 mL were injected into the column. Flow rate was 1 mL/min. Fluorescence was read at 470 μm with an excitation wave length of 350 μm. Peak areas were used for quantitative calculations.

2.3. Statistical analysis

Data obtained were subjected to ANOVA technique using SAS PROC GLM (SAS PROC GLM, 1997). For each response, the average value for main effects of the different treatments was subjected to pairwise comparison procedures using the least significant difference (LSD) and Duncan's multiple range test procedures (Duncan, 1985). Differences were declared at the 5% level of probability.

3. Results

Mean values for protein, Ile, Met and Lys content in blood, red cells and plasma of the different species studied are shown in Table 1. Poultry blood presented the lowest ($P < 0.05$) protein (12.77%) and the highest moisture (86.39%) content when compared to bovine blood (19.18% and 80.17%) and porcine blood (19.07% and 80.09%). Red cells from bovine showed the lowest ($P < 0.05$) protein (27.11%) and the highest moisture content (73.27%) in comparison with porcine (31.32% and 69.15%) and poultry (31.53% and 68.96%) species. Poultry plasma differed ($P < 0.05$) on its protein (3.46%) and moisture (95.11) content when compared to bovine (7.21% and 90.96%) and porcine (6.65% and 91.50%) plasma.

Blood, red cells and plasma proteins from poultry were high enough in Ile and Lys to accomplish the FAO/WHO/UNU (1985) requirements for a highly nutritional protein for children 6–12 years old (Table 1). Blood and red cells proteins from bovine and porcine were high in Lys but deficient in Ile. Plasma proteins for all the species were high in Lys and Ile. Blood, red cells

Table 1
Proteins, isoleucine, lysine and methionine content in blood, red cells and plasma proteins from different species

Parameter	Blood			Red cells			Plasma			FAO/WHO/UNO[A]
	Bovine	Porcine	Poultry	Bovine	Porcine	Poultry	Bovine	Porcine	Poultry	
Protein[B]	19.18[a]	19.07[a]	12.77[b]	27.11[a]	31.32[b]	31.53[b]	7.21[a]	6.65[a]	3.46[b]	
Ile[C]	0.93[a]	0.69[a]	2.75[b]	1.08[a]	0.28[b]	2.65[c]	2.56[a]	2.25[a]	2.87[a]	2.8
Lys[C]	8.68[a]	5.84[b]	7.50[a]	9.10[a]	5.33[b]	7.51[c]	7.18[a]	6.12[a]	5.87[a]	4.4
Met[C]	0.28[a]	0.96[a]	0.64[a]	0.39 [a]	0.75[a]	0.73[a]	0.21[a]	0.53[a]	0.51[a]	2.2[D]

[a–c] Means on a row and within a treatment bearing different superscripts differ significantly ($P < 0.05$) as indicated by LSD procedure.
[A] Minimum amount (g/100 g protein) of these amino acids in protein to be considered a highly nutritional protein for children at school age (6–12 years).
[B] Protein content expressed as g/100 g of sample.
[C] Isoleucine (Ile), Lysine (Lys), Methionine (Met), expressed as g/100 g of proteins.
[D] This value corresponds to methionine + cysteine.

and plasma proteins from the different species studied seemed to be deficient in Met when compared to the FAO/WHO/UNO requirements; however, it is important to mention that the value expressed by FAO/WHO/UNO corresponds to methionine plus cysteine, in our study we did not look for cysteine.

4. Discussion

The high protein content found in blood and red cells fraction makes them attractive to be incorporated in some food formulations; however, their strong color and odor represent a limitation to the amount to be used. Plasma, on the other hand, is widely used in the meat industry because it does not introduce color nor odor in the meat products (Márquez et al., 1997).

The high levels of Lys observed in protein blood and plasma from bovine are in agreement with those reported by Young et al. (1973) and Tybor, Dill, and Landmann (1975).

The high amount of Lys in blood, red cells and plasma of the different species studied is important if we consider that Lys is one of the totally indispensable amino acids. No metabolic precursors can substitute for this amino acid; omission from diet can lead to serious nutritional and metabolic effect (Laidlaw & Kopple, 1987).

Demand for high quality foods makes us have better use for animal sub products. It has been reported that Lys is the limiting amino acid in a diet based on cereals, as it is in developing countries (Young & Pellett, 1990). Results of this study indicate that the incorporation of proteins from blood or their fractions on the diet will provide for Lys. Addition of poultry plasma to bread increased PER value from 0.87 to 2.02 (Del Rio de Reys et al., 1980). Bovine plasma was used to mix with wheat flour to formulate cookies with highly nutritious protein content (Márquez et al., 1998).

In experiences carried out with rats and chicks, bovine blood supplemented with D-L-isoleucine increased the protein efficiency ratio (PER) for the first ones and corporal weight and conversion of the last ones (Young et al., 1973). Addition of bovine plasma into the formulation of meat emulsion type products allowed for substitution of meat, decreasing cost while keeping the quality of the final products (Márquez et al., 1997). Proteins from poultry blood or their fractions seem to be a better alternative because of its high content of Ile and Lys.

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