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RESEARCH NOTE

Evaluating protein quality of meats using collagen content

S. N. El

Ege University, Engineering Faculty, Food Engineering Department, 35100 Bornova, İzmir, Turkey

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Nutritional quality of protein was studied using a regression equation for predicting protein efficiency ratio (PER) of meats from the chemical analysis of collagen content. Estimated PER values for all meat samples, calculated from the amounts of collagen, ranged from 2·22 to 2·91, which are in close agreement with reported rat PER values. The results showed that the collagen content can be employed to provide a rapid, inexpensive and easily adaptable assay for the estimation of protein quality of meats.

INTRODUCTION

Since the protein efficiency ratio (PER) test, a biological assay of protein quality described by the AOAC, is both time-consuming and costly, many investigators have worked to develop methodology for a faster and cheaper way to determine the PER. The US Department of Agriculture's Food Safety and Inspection Services (FSIS, 1984) evaluated an extensive amount of data including that on digestibility versus collagen content, as well as correlations between estimated protein nutritional value and various indices of collagen content. They recommended the use of accurate protein, amino acid and connective tissue data of meat and poultry products as a simple and practical method for assessing their protein quality (FSIS, 1984). Their recommendation is based on two major findings: a statistically significant correlation exists between the PER values and the contents of the essential amino acids of a protein (Alsmeyer *et al.*, 1974; Happich *et al.*, 1975; Lee *et al.*, 1978) and the content of collagen of meats is highly negatively correlated (R = 0·99) to rat PER values in meats, poultry, and their products (Lee *et al.*, 1978; Pellett & Young, 1984). An increase in the specific ratio of collagen in meat products reduces the absolute number of essential amino acids and disturbs their balance, thus impairing the quality of the protein system (Laser-Reutersward *et al.*, 1982; Rogov *et al.*, 1992; Zarkadas, 1992; El & Kavas, 1993).

The purpose of the present study is to determine the collagen contents of beef, sausage, lamb, fish, bovine liver and chicken to see if it could be used as an accurate measure of their protein nutritional quality.

MATERIALS AND METHODS

Fish (sardine), lamb, bovine liver and chicken (skin free leg) were supplied from local markets of İzmir. One hundred percent beef sausage and beef were kindly supplied by Ege University Food Engineering Department, İzmir. All samples were homogenised using an Edmund Bühler 7400 homogeniser. Nitrogen (N) was determined by Kjeldahl method and percent protein was calculated from Kjeldahl nitrogen multiplied by a factor of 6·25. Hydroxyproline content was determined in triplicate on acid-hydrolysed samples by the method of Woessner (1961). Collagen content, as a percentage of protein, was calculated from hydroxyproline content according to the formula of Laser-Reutersward *et al.* (1982). Protein quality of samples, as estimated PER were evaluated using the equation developed by Lee *et al.* (1978):

$$\text{Estimated PER} = -0{\cdot}02290x + 3{\cdot}1528$$

where x is the collagen content expressed as % of protein.

RESULTS AND DISCUSSION

Nitrogen, protein, hydroxyproline, collagen contents and estimated PER of the meat samples are shown in Table 1.

The highest contents of hydroxyproline and collagen were determined as 0·664/100 g and 40·5% of the protein, respectively, in sausage. Fish has the lowest content of hydroxyproline (0·338%) and chicken has the lowest collagen content (10·3% of protein). Rogov *et al.*

Table 1. Nitrogen, protein, hydroxyproline, collagen contents and estimated PER values of meat samples (mean ± SD, $n = 6$)

Sample	Nitrogen (%)	Protein (N × 6·25)	Hydroxyproline (%)	Collagen % of protein	Estimated-PER[a]
Beef (lean)	3·32 ± 0·03	20·8 ± 0·15	0·571 ± 0·03	20·5 ± 0·23	2·68
Bovine liver	2·69 ± 0·00	16·8 ± 0·04	0·460 ± 0·02	20·3 ± 0·15	2·68
Chicken	3·89 ± 0·03	24·3 ± 0·17	0·342 ± 0·01	10·3 ± 0·04	2·91
Fish	3·22 ± 0·04	20·1 ± 1·07	0·338 ± 0·01	13·8 ± 0·04	2·83
Lamb (lean)	3·15 ± 0·04	19·8 ± 0·26	0·650 ± 0·02	24·7 ± 0·15	2·58
Sausage	1·92 ± 0·07	12·0 ± 0·44	0·664 ± 0·03	40·5 ± 0·51	2·22

[a] $y = -0{\cdot}02290x + 3{\cdot}1528$; y = estimated-PER; x = collagen content.

(1992) noted major differences in meat and meat products containing connective tissue proteins within a range of 2·5% to 25% of the protein. The age of an animal can influence the quantity of intramuscular collagen. Also, the relative proportions of connective tissue and muscle fibres vary between muscles (Rogov *et al.*, 1992).

Estimated PER values for all meat samples, calculated from the amounts of collagen, ranged from 2·22 to 2·91 (Table 1), which are in close agreement with rat PER values reported (FAO, 1970). Pellett and Young (1984) indicated that the low collagen beef sample which contained 2·11 g/16 g N of hydroxyproline had quite satisfactory rat PER (2·58). Lee *et al.* (1978) reported collagen content (% of protein), rat PER and estimated PER for beef as 18·8, 2·60 and 2·72, respectively. Hydroxyproline (g/16 g N) and rat PER of beef were found to be 3·46 and 2·62, respectively, by Babji *et al.* (1980). These findings are in accordance with the present results for beef. The highest value of estimated PER, 2·91, was obtained for chicken and agrees with the value reported as 2·97 by Lee *et al.* (1978). Laser-Reutersward *et al.* (1982), Rogov *et al.* (1992) and Zarkadas *et al.* (1993) suggested that connective tissue contents of meats can be useful indices for evaluating their protein quality. Advantages of using collagen determinations to predict PER of meat samples are (1) no sophisticated instrument such as an amino acid analyser is needed; (2) it is simpler and less expensive; and (3) small processors can easily perform this analysis in their quality-control laboratory.

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