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Macro Nutrients, Amino Acid Composition and Price of Commercial Minced Meat

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Each year, each Belgian consumer buys approximately 3 kg of raw minced meat as such ("gehakt") or as sausage, representing about 5% of his total purchase of meat and meat products (Vandecatseye, 1984). In 1985 the Belgian Government issued a regulation, specifying fat content, protein content and collagen value of the protein in such products. (Anonymous, 1985). In line with our interest in the nutritive value of meat products (Vandekerckhove & Demeyer, 1975) (Demeyer et al, 1985) we have investigated the proximate composition of minced meat (pork or mixed meat) excluding ground beef (lean minced meat, or "Filet Américain") obtained in 63 butcher shops or supermarkets in the Ghent area. In 1984 we have repeated sampling and analysis on 26 out of the 63 sites. The data were investigated for variability in nutrient content and relation of nutritive value to price. The relation of collagen content of crude protein to essential amino acid content was confirmed.

Materials and methods

In 1978 (63 samples) and 1984 (26 samples), 100 g of minced meat (mixed or pork) was purchased from local butchers or supermarkets (list available on request) by laboratory staff. Samples were wrapped in aluminia foil vacuum packed (1984 only) and kept at -18°C until analysis.

Proximate analysis

Samples were analysed for dry matter, ash, crude protein and crude fat following official methods (Vandekerckhove and Demeyer, 1979). Total sugars and Ammonia-N were determined on 0,6 N $HClO_4$ extracts, sodium and phosphorous after ashing by flame photometry (Cottenie, 1955) and spectrophotometry (Fiśter, 1950) respectively.

Collagen and Amino-Acid Analysis

Amino Acids and hydroxyproline (collagen contains 12,5% w/w hydroxyproline) were determined after acid hydrolysis. In 1978, 5 g of sample was hydrolyzed in 25 ml HCl 6N under N_2 in closed glass tubes for 24 hr. at 110°C. (Bech-Anderson et al, 1979). Hydrolysis was preceded by extraction of crude fat with ether. (Soxhlet) or chloroform (treatment in hydrolysis tube). With this technique, hydroxyproline (collagen) analysis was subject to considerable variation. In 1984 samples were lyophylized and amounts equivalent to 100 mg crude protein were hydrolyzed under reflux with 100 ml HCl 6N for 24 hrs. Hydroxyproline was determined on the hydrolysates following an official method (ISO/DIS 3496.2) similar to the method described by Bessemans et al (1971).

All collagen determinations (including hydrolysis) were checked for recoveries, obtained using gelatin. Amino Acid Analysis was carried out on the hydrolysates, using a Technicon Autoanalyzer. Amino-Acid N accounted for 82,8 ± 9,4% and 94.0 ± 7,9% (mean values ± S.D.) of total N in 1978 and 1984 respectively.

Calculations

All calculations and statistics (correlation matrices and regressions) were carried out using a HP 86 Computer (Hewlett-Packard, Palo Alto) with the "Basic statistics and Data manipulation" software pack.

Results and discussion

Tables 1 and 2 show mean values with their standard deviations, for the 1978 and 1984 data respectively, as well as correlation matrices. The data indicate the obvious well documented relations between water, protein and fat contents. Some striking relations are apparent however :

- The positive correlations between P content, protein content in D.M. and water content (table 1). This may indicate the use of phosphates, also apparent from the average P_2O_5 content in crude protein : 3,22%.
- The negative correlation between water and sodium contents (table 1). This may indicate that salt and fat were used simultaneously.
- The negative correlation between protein content in dry matter and collagen value : more protein means better protein!

Price is clearly correlated with both protein content and protein quality (collagen value = % collagen in crude protein) for the 1978 samples. This is a conclusion similar to earlier data obtained for cooked ham (Demeyer et al, 1985). The same conclusion is not apparent for the 1984 samples however, where significance is approached for the relation of price to protein content only, but not for protein quality as expressed by its collagen content. When protein quality is expressed in terms of the molar proportions of essential amino acids, however, significance is again approached (table 2). This can be explained by the finding that price is related in opposite direction to fat content and essential amino acid content whereas collagen value is also related in opposite direction to fat content and essential amino acid content.

In any case, even for 1978, it should be noted that stepwise regression analysis retains protein quality (collagen value) only for the explanation of 19% of the variability in price following :

price = 161,8 - 3,72 (collagen value) $R^2 = 0,19$

It can also be mentioned that in 1978, 12 out of 63 samples (ca 20% of samples) exceed the present legal limit for fat content of 30% (Anonymous, 1985) whereas in 1984 this was 2 out of 25 (ca 10% of samples). In neither period however collagen values exceeding the present legal limit (18%) (Anonymous, 1985) were found. Protein contents below the limit of 14% were found in 15 and 6 samples for 1978 and 1984 respectively. The data indicate that samples obtained in 1984 contained on average less fat and lower quality protein than those obtained in 1978. This was confirmed by comparison of 1978 and 1984 samples, obtained from the same sites (table 3).

Table 1 : Proximate Composition and price of minced meat (1978) : mean values and correlation matrix

	water[1]	Crude Protein[2]	Fat[2]	Ash[2]	Sugars[3]	NH_3-N[3]	P[3]	Na[3]	Collagen[4]	Price[5]
Water	-	0.91*	-0.87*	0.40*	0.06	0.19	0.38*	-0.33*	-0.48*	0.23*
Cr. Protein		-	-0.89*	0.42*	-0.04	0.19	0.54*	-0.27*	-0.44*	0.28*
Fat			-	-0.01	-0.24*	-0.18	-0.40*	0.16	0.45*	-0.27*
Ash				-	0.14	0.09	0.30*	0.69*	-0.26	-0.03
Sugars					-	-0.05	-0.29*	0.11	-0.04	0.03
NH_3-N						-	0.44*	-0.07	-0.03	-0.07
P							-	-0.06	-0.37*	0.22
Na								-	0.21	-0.26*
Collagen									-	-0.44*
Mean	56.1	34.6	57.9	4.8	0.70	14.0	136.2	461.4	10.2	122.4
SD	5.0	6.7	8.6	1.0	0.46	6.1	17.5	115.1	2.5	20.7

[1] as% [2] % of dry matter [3] mg/100g [4] collagen as% of crude protein (44 samples only) [5] Belgian F/Kg

* Significant at least at $p <= 0,05$

Table 2 : Proximate Composition and price of minced meat (1984) : mean values and correlation matrix.

	water[1]	crude protein[2]	Fat[2]	Ash[2]	Sugars[3]	Collagen[4]	Ess. Amino Acids[6]	Price[5]
water	-	0.82*	-0.85*	0.58*	-0.21	-0.21	0.42*	0.17
Cr. protein		-	-0.84*	0.56*	-0.08	-0.20	0.43*	0.19
Fat			-	0.36*	-0.12	0.30	-0.39*	-0.23
Ash				-	0.05	-0.17	0.21	-0.06
Sugars					-	-0.02	-0.29	0.06
Collagen						-	-0.58*	-0.07
Essent. Amino acids							-	0.21
Mean	58.5	35.9	53.4	5.1	0.76	13.33	34.79	162.9
SD	3.7	4.4	6.1	1.0	0.45	2.51	1.12	19.5

1, 2, 3, 4, 5 * See footnotes table.

[6] Molar % in total amino acids of (Lys + Thr + Val + Met + Leu + Ileu + Phe)

Table 3 : Difference in composition between minced meat samples obtained in 1978 and in 1984 from the same sites (mean values ± S.E.)

	% water	crude protein (%)	Fat (%)	Collagen[1]	Prize
1978	55.8 ±1.0	14.6 ±0.3	26.2 ±1.2	10.0 ±0.6	116 ±4
1984	58.5* ±0.7	14.8 ±0.2	22.3* ±0.9	13.3* ±0.6	163 (150)[2] ±4

[1] 18 samples only analyzed

[2] () = Price corrected for difference in salary index between 1978 and 1984.

* at least $p < = 0.05$

Such shift is suprising in view of the fact that average price increased more than calculated from the salary index ratio january 1978/january 1984 (0.77). This finding may reflect a better valorisation of muscle tissue in other products than minced meat. This obviously involves a better separation of muscle and connective tissue by butchers. Price however is not lowered accordingly possibly because the decrease in protein quality is associated with a decrease in fat content. The relationship price/fat content in DM/essential amino acid content of protein/collagen value (table 2) was discussed above. It should be noted that from a nutritional point of view substitution of fat for water, even associated with a lowered protein quality can be accepted (Demeyer et al, 1985). Protein quality as indicated by the collagen value of the protein reflects the essential amino acid content. Table 4 shows that in confirmation of earlier work (Demeyer, 1980) (Demeyer et al, 1985) significant regression equations could be calculated between collagen value and the molar % of (Lys + Thr + Val + Leu + Ileu + Met + Phe) in total amino acids (fig 1).

Table 4 : Regression equations predicting the molar % of essential amino acids (Lys + Thr + Val + Leu + Ileu + Phe + Met)(Y) from collagen value of the protein (X)

Reference		Equation	R^2
Demeyer (1980)		Y = 40.92 - 0.27 X	0.84 (n=54)
Demeyer et al (1985)		Y = 39.85 - 0.31 X	0.65 (n=32)
This work :	1978	Y = 37.56 - 0.30 X	0.25 (n=45)
	1984	Y = 38.23 - 0.26 X	0.33 (n=25)

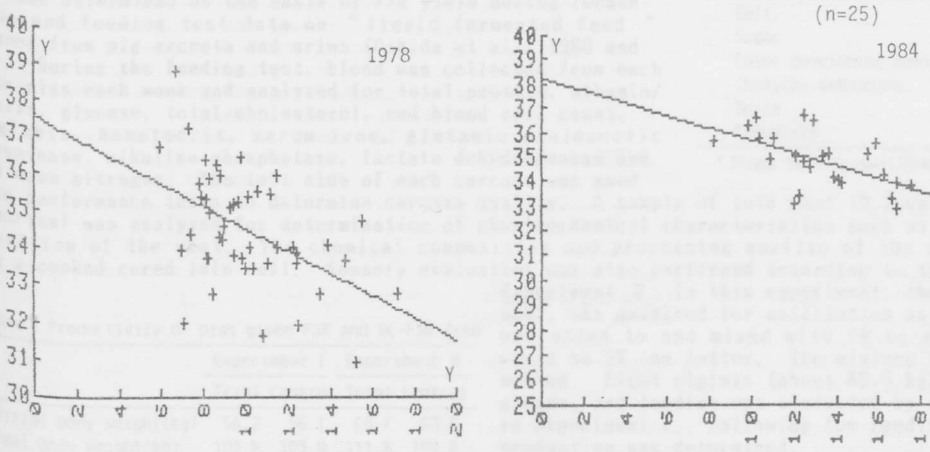

Fig 1 : Relation between molar % of (Lys+Thr+Val+Met+Leu+Ileu+Phe) in total amino acids (y) and collagen value of crude protein (X) (equations in table 4).

Finally the great variability in results should be stressed : coëfficients of variation for fat and protein content are close to 20% (tables 1 & 2) meaning that actual values may differ 80%. Because of such findings the relevance of composition tables listing single values for fat and protein content in minced meat (Anomymous, 1980) can be questioned.

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