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Variation of body nitrogen – body water ratio of Sprague-Dawley rats as a function of the dietary protein quality and quantity

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With 1 table

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Several authors (2, 3, 6) have concluded that body water and body nitrogen protein are a constant proportion of the body when measured on a fat-free basis. Therefore the nitrogen content of the body can be derived from the water content and the age of the rat. This easy way of estimating carcass nitrogen is an important time-saving factor in the carcass-nitrogen method of protein evaluation.

Later Dreyer (4) reported an observed difference between the $N : H_2O$ ratios of male and female animals and reported separate regression equations for each sex. The $N : H_2O$ constants are assumed to be independent of the nutritional status.

The objective of this paper is to present further findings on the stability of the relationship between body water and body nitrogen ratio under different dietary protein levels and qualities.

Materials and methods

The animals used in this experiment were of the Sprague-Dawley weanling male rats obtained from the Central Laboratory of Serum and Vaccine. The animals were pretreated three days with a diet containing equal amounts of the seven different experimental diets as recommended by Forbes and Yohe (5). This pretreatment tended to provide the animals with uniform nutritional condition at the start of the test period. According to the same authors an inadequate balance of carcass nitrogen at the beginning of the test period will introduce an additional source of error after this preliminary feeding period.

The animals were divided into eight groups of similar weight, each group consisting of six rats. One group was killed at the start of the experiment. Its body water and body nitrogen were determined, the percentage body water and body nitrogen were calculated. Another group received non-protein diets, three groups received diets containing 4.06, 8.12 and 11.63% casein (BDH) corresponding to 3.5, 7.0 and 10.0% protein respectively. Synthetic dl-methionine was supplemented at a level of 0.3, 0.3 and 0.5 dl-methionine respectively to the three casein diets.

French (caviar) bread prepared from wheat flour (72% extraction) was fed to three groups of rats at three different levels to supply 3.5, 7.0 and 10.0% protein. The amount of protein in each diet was determined by the semi-micro Kjeldahl method (1). The protein-free diet was found to contain 0.2% protein.

Table 1. Effect of different dietary protein levels derived from casein or French bread on the body composition of rats.

Dietary protein source	Protein level %	Body nitrogen (G)		Body water (G)		Body nitrogen : water ratio*)		Correlation coefficient R	Regression equation $\hat{Y} = a + bx$
		Mean	SEM	Mean	SEM	Mean	SEM		
Non-protein	1.3	0.43	0.11	21.3	1.38	0.021 ^a	0.006	-0.2701	19.87 + 3.30x
Casein	K 3.2	0.89	0.03	27.3	1.34	0.033 ^{a,b}	0.005	0.9140	4.78 + 36.01x
	L 7.2	1.90	0.20	46.0	1.65	0.041 ^{b,c}	0.003	0.6773	35.42 + 5.56x
	M 9.7	2.14	0.14	52.2	2.41	0.041 ^{b,c}	0.002	0.7418	25.83 + 12.36x
French bread	3.5	0.75	0.11	24.9	1.52	0.029 ^a	0.010	0.8102	16.71 + 10.97x
	6.6	1.00	0.03	30.7	0.79	0.032 ^a	0.001	0.8624	10.77 + 19.94x
	10.0	1.23	0.03	38.1	1.65	0.033 ^a	0.001	0.5280	5.06 + 26.73x

*) Means are statistically different; if they do not have the same alphabet (P < 0.05)

The feeding experiment corresponded nearly with the experimental procedure described by the German group of Protein Evaluation (7).

Carcass analysis

Rats were killed on the 21st day, weighed and dried at 95 °C until constant weight was obtained. The carcasses were then milled and the percentage dry matter was obtained by drying at 105 °C, body nitrogen was also determined by the semi-micro-Kjeldahl method (1).

Results and discussion

Table 1 presents the mean body nitrogen and body water of rats maintained on protein-free diet. This diet contained 1.37% crude protein by semi-micro-Kjeldahl analysis (1). The body nitrogen : body water ratio was quite low and had a mean value of 0.02 l. There was a non-significant negative correlation coefficient between body nitrogen and body water.

The groups fed diets based on french bread proteins had body nitrogen : body water ratios, which were not statistically different from those of rats on the protein-free diet (t-test).

The body nitrogen : body water ratios of rats maintained on the reference casein diet were much higher in comparison to ratios obtained for rats maintained on protein-free diet. The ratio was significantly higher in rats maintained on dietary protein level of 7.2 or 9.7% ($P < 0.05$), compared to those on similar protein levels derived from French bread.

Significant correlation coefficients were obtained between body nitrogen (X) and body water (Y) among the different groups maintained on diets based on either French bread or casein.

Among groups fed either casein or French bread diets at specific protein level, a significant positive correlation ($P < 0.05$) was obtained ranging between 0.5280 and 0.9140.

The regression equations predicting body water (\hat{Y}) from the slope of the line of body nitrogen was computed by the method of best fitness, and the regression equations are included also in table 1.

The present result indicates that the ratio of body nitrogen : body water is not consistent, it varies according to the quality and protein level of the diet. This result does not agree with the reports of Dreyer (3), who suggested that N : H₂O constants are independent of the nutritional status. Conclusions drawn from this work are that errors can be introduced into determination of net protein value when the carcass nitrogen content is obtained by relying upon the predetermined N : H₂O ratio. A conclusion that suggests variation in these constants.

Summary

Forty-two male Sprague-Dawley rats aged 45 days were analyzed for total body nitrogen and body water, and the correlation between the body nitrogen : body water ratio according to the type and level of protein was found lowest body nitrogen : body water ratios (0.021-0.033) in rats maintained on protein-free diet, or in diets in which protein was derived from French bread.

Highest body nitrogen : body water ratios were found in rats maintained on either 7.2 or 7.9% or diets, based on casein protein + dl-methionine.

References

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