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Relationship Between Net Protein Utilization (NPU) and Nitrogen Efficiency Ratio (NER)*

Beziehung zwischen Eiweißnutzwert und Wachstumswert

Relation entre l'utilisation nette des protéines (NPU) et le rapport d'efficience azotée (NER)

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During the last few years, a great deal of attention has been focused on the methods for the biological assessment of the protein value of foods. Among the new methods proposed, the measurement of Net Protein Utilization (NPU) has received the greatest attention (1). The primary function of dietary protein is to supply the organism with amino acids for the anabolism of tissue protein; furthermore, the relative amounts and proportions of dispensable and indispensable amino acids in a given protein will determine the magnitude of measurable biological responses. Therefore, all methods concerned with the evaluation of protein quality are directly or indirectly concerned with appraising the relative efficiency of different proteins in satisfying amino acid requirements. The methods differ primarily in the type of response chosen for study and in the experimental procedure employed. Ultimately, however, they all yield a numerical quantity which is used as an index of the nutritional value of different proteins, and which, independently of the method followed, usually results in a similar rank order for a given number of proteins.

The present paper shows that NPU and NER values for different proteins are so highly correlated with each other that NER data can be used to calculate NPU, and vice versa, with acceptable accuracy.

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Basic considerations. NPU has been defined as the ratio between nitrogen retained (NR) and nitrogen intake (NI):

$$\mathrm{NPU} = \frac{\mathrm{NR}}{\mathrm{NI}} \quad (1)$$

The nitrogen retained is obtained by the difference of values from the carcass analysis of a group of animals which consumed a nitrogen-free diet for 10 days and the data from a similar group of animals which consumed the test protein for an equal period of time, included at a 10% level in the diet (2). NER is defined as the ratio between the weight gained by a group of animals consuming the test protein over the amount of nitrogen consumed in the same period of time.

$$\mathrm{NER} = \frac{\mathrm{WG}}{\mathrm{NI}} \quad (2)$$

This measure is equal to PER, or protein efficiency ratio, if the amount of nitrogen consumed is converted to protein by multiplying nitrogen by a suitable factor, usually 6.25. Solving equations (1) and (2) for NI equations (3) and (4) are obtained:

$$\frac{\mathrm{NR}}{\mathrm{NPU}} = \frac{\mathrm{WG}}{\mathrm{NER}} \quad (3) \qquad \text{and} \qquad \frac{\mathrm{NR}}{\mathrm{WG}} = \frac{\mathrm{NPU}}{\mathrm{NER}} \quad (4)$$

$$\frac{\mathrm{NR}}{\mathrm{WG}} = \frac{\Delta \mathrm{N}}{\Delta \mathrm{A} + 6.25 \cdot \Delta \mathrm{N} + \Delta \mathrm{F} + \Delta \mathrm{C}} = \%\,\mathrm{N} \quad (5)$$

in carcass (Nc) weight gained[1] therefore,

$$\mathrm{NPU} = \%\,\mathrm{Nc} \cdot \mathrm{NER} \quad \text{or} \quad \mathrm{NER} = \frac{\mathrm{NPU}}{\%\,\mathrm{Nc}} \quad (6)$$

However, if percentage nitrogen of the carcass is to a large degree independent of dietary protein treatment, then formula (4) can be written:

$$\frac{\mathrm{NR}}{\mathrm{WG}} = \frac{\%\,\mathrm{Nc}\,(W_2 - W_0)}{W_2 - W_1} = \frac{\mathrm{NPU}}{\mathrm{NER}} \quad (7)$$

where W_0 is the weight of the animals on the nitrogen-free diet; W_1 is the initial weight, and W_2 the final weight.

Materials and Methods

In all experiments carried out, rats of 22–24 days of age of the Wistar strain of the INCAP colony were used. Eight rats, 4 males and

[1] ΔA change in carcass water content; ΔF change in carcass fat content; ΔC change in carcass ash content; 6.25 · ΔN change in carcass protein content.

4 females, were distributed per group in such a way that all groups had the same average initial weight. Care was taken to match as much as possible the initial individual rat weight in all groups and not more than three proteins were tested at one time. The variation in initial weight between rats of the same sex, never exceeded 3 g. Likewise, the variation in the initial weight between sexes exceeded 3 g in only one case. In the entire study, 23 proteins of animal and vegetable origin and representing a wide range in nutritive value were tested. The basal diet consisted of: Salt mixture (3), 4%; refined cottonseed oil, 5%; cod liver oil, 1%; cornstarch, 45%, and dextrose, 45%. The protein source provided 10% protein in the diet, and it replaced equal parts of dextrose and cornstarch. A complete vitamin supplement was added to all diets (4). The rats were placed in individual all-wire screen cages with raised screen bottoms. In each of the tests, one group of rats was fed individually the basal nitrogen-free diet and the rats of all groups were fed the test protein, *ad libitum*, for 10 days. Water was available at all times. Spilled food was collected daily and taken into consideration to calculate food intake. All test proteins and diets were analyzed for nitrogen content by the macro Kjeldahl method.

At the end of the experimental period, the animals were weighed, sacrificed and placed in a convection oven at 80°C until constant weight, usually 4–5 days. After weighing, the animals were ground and defatted with ethyl ether in a continuous extraction apparatus for 3 days. Fat content of the animals was calculated by difference. The defatted carcass was ground again to 20 mesh, and samples were taken for nitrogen and ash analyses (5). Net Protein Utilization (NPU) was then calculated according to the formula of *Miller and Bender* (2) and nitrogen efficiency ratio (NER) was calculated by dividing the weight gained in 10 days by the nitrogen intake in that period of time.

Results

The results of the initial phase of the study are shown in Table I. Of the proteins tested, soybean flour had the highest NPU and NER, while peanut flour showed the lowest values. A relatively high NER value was found for rice protein. Female rats gave higher NPU and

Table I

The NPU and NER of several proteins in male and female rats
Eiweißnutzwert und Wachstumswert einiger Eiweisse bei männlichen und weiblichen Ratten
Valeurs NPU et NER de diverses protéines chez des rats mâles et femelles

Test protein	Sex of rats	Weight initial g	Weight final g	Fresh carcass N %	Carcass water %	Carcass N/H_2O ratio	N intake g	NPU	NER
N-free group	M	53	45	3.01	66.7	0.04	–	–	–
	F	47	40	3.06	67.5	0.04	–	–	–
	MF	50	42	3.03	66.6	0.05	–	–	–
Soybean flour	M	52	95	2.97	66.3	0.04	2.27	62.4	18.3
	F	47	88	2.98	67.0	0.04	2.35	61.6	17.8
	MF	50	91	2.98	67.0	0.04	2.31	62.0	18.0
N-free group	M	47	39	2.94	69.5	0.04	–	–	–
	F	46	36	2.90	69.3	0.04	–	–	–
	MF	47	38	2.92	69.4	0.04	–	–	–
Sunflower flour	M	47	73	2.79	69.8	0.04	2.07	43.0	12.4
	F	46	68	2.73	68.5	0.04	1.96	41.4	11.2
	MF	47	71	2.76	69.1	0.04	2.02	42.2	11.8
Prepress solvent cottonseed flour	M	47	80	2.73	70.3	0.04	2.02	51.7	16.3
	F	46	73	2.76	70.6	0.04	1.98	47.8	13.1
	MF	47	77	2.75	70.4	0.04	2.00	49.8	14.7
N-free group	M	51	38	2.95	69.9	0.04	–	–	–
	F	48	43	3.01	68.1	0.04	–	–	–
	MF	49	40	2.98	69.1	0.04	–	–	–
Peanut flour	M	51	71	2.79	69.0	0.04	1.98	32.5	10.5
	F	48	67	2.80	67.8	0.04	1.82	43.7	10.1
	MF	49	69	2.79	68.4	0.04	1.90	38.1	10.3
Press extracted cottonseed-flour	M	51	86	2.84	67.2	0.04	2.46	52.6	13.8
	F	48	72	2.90	68.5	0.04	2.02	39.1	11.9
	MF	49	79	2.86	67.8	0.04	2.24	47.1	12.9
N-free group	M	46	39	2.84	70.3	0.04	–	–	–
	F	44	37	2.71	70.4	0.04	–	–	–
	MF	45	38	2.78	70.3	0.04	–	–	–
Rice flour	M	46	66	2.30	69.1	0.03	1.03	35.5	17.9
	F	44	60	2.49	68.0	0.04	1.14	42.6	15.0
	MF	45	63	2.40	68.6	0.04	1.09	39.0	16.4
Whole buckwheat flour	M	45	68	2.54	69.3	0.04	1.47	46.7	18.1
	F	45	74	2.51	69.5	0.04	1.23	55.7	20.0
	MF	45	71	2.53	69.4	0.04	1.35	51.2	19.0

NER values in 3 out of the 7 proteins tested, usually for those of known lower nutritive value. The correlation between NPU and NER for this group of proteins was r = 0.95. The table also shows that the percentage of nitrogen in the carcass varied from 3.03–2.40% for all groups, including those rats fed the nitrogen-free diets.

Tables II and III present the chemical composition, initial and final weight of the rats used in the main part of this study, while Table IV shows the pooled data. The average nitrogen percentage for

Table II

Chemical composition of male rats
Chemische Zusammensetzung männlicher Ratten
Composition chimique des rats mâles

Test group	Water	Fat	Ash	Nitrogen	Protein	Weight from chemical analysis	Weight by weighing
	g/100 g					g	g
Initial	71.06	8.65	3.35	2.71	16.94	54.32	53.5
Initial	72.40	8.48	2.98	2.58	16.15	47.31	48.6
N-free diet	72.96	8.74	3.44	2.62	14.86	38.90	40.0
N-free diet	72.40	8.56	3.60	2.47	15.44	45.58	46.0
Defatted whole egg	70.93	9.65	3.02	2.62	16.36	92.73	96.0
Dried skim milk	70.18	10.34	3.25	2.60	16.22	90.33	94.0
Fish flour	68.96	11.25	3.29	2.63	16.47	83.94	86.0
Cooked black beans	73.04	8.47	2.92	2.50	15.59	60.25	62.0
Cooked black beans + DL-methionine	73.31	8.85	2.60	2.43	15.24	79.12	83.0
Torula yeast	69.24	13.52	2.63	2.34	14.64	70.79	75.0
Corn masa flour	72.26	8.16	3.40	2.58	16.15	57.56	59.0
Corn masa flour + L-lysine	74.13	5.86	3.53	2.64	16.48	58.01	60.0
Soybean flour	71.82	9.30	2.76	2.58	16.11	95.51	97.0
Rolled oats	66.13	17.64	2.80	2.14	13.40	83.04	84.4
Whole wheat flour	71.75	10.53	3.05	2.35	14.69	62.24	65.0
Casein	69.95	10.54	2.77	2.67	16.74	96.62	98.5
Corn gluten	66.74	13.87	3.13	2.60	16.22	53.92	54.0
Wheat gluten	67.60	13.80	3.14	2.46	15.47	52.89	54.0
Wheat germ	69.92	12.51	2.55	2.33	14.98	86.32	88.0
N-free diet	72.87	7.87	3.74	2.48	15.52	35.82	37.2
N-free diet	67.68	9.00	4.34	3.03	18.96	41.66	43.0
Sesame oil meal	72.76	9.54	3.04	2.34	14.65	60.60	62.2

all animals was 2.54, for those fed the nitrogen free diet, 2.71, for those fed the proteins tested, 2.51, and the nitrogen content of rats sacrificed upon weaning was 2.57%. Body fat varied from 6.04–18.49 for all groups. Body moisture and ash were relatively constant.

Table V shows the NPU and NER values derived from the experiments and the calculated values for male and female rats, using the formula derived from the respective definition of NPU and NER and the average carcass nitrogen percentage of 2.54. It can be seen

Table III

Chemical composition of female rats
Chemische Zusammensetzung weiblicher Ratten
Composition chimique des rats femelles

Test group	Water	Fat	Ash	Nitrogen	Protein	Weight from chemical analysis	Weight by weighing
		g/100 g				g	g
Initial	71.39	11.56	2.85	2.27	14.19	44.82	46.1
Initial	70.60	9.02	3.34	2.72	17.03	49.43	50.5
N-free diet	67.37	10.23	4.46	2.87	17.95	38.60	40.0
N-free diet	72.48	8.19	3.78	2.48	15.53	41.52	42.0
Defatted whole egg	70.06	9.84	3.08	2.72	16.97	89.17	92.0
Dried skim milk	69.26	11.33	3.31	2.58	16.14	84.06	87.0
Fish flour	70.53	10.09	3.34	2.57	16.06	71.19	74.0
Cooked black beans	71.29	10.23	2.92	2.49	15.54	60.30	61.0
Cooked black beans + DL-methionine	73.07	9.68	2.63	2.34	14.58	77.97	82.0
Torula yeast	69.23	12.00	2.99	2.52	15.77	67.89	72.0
Corn masa flour	71.90	9.01	3.49	2.49	15.59	54.38	55.0
Corn masa flour + L-lysine	74.52	6.07	3.53	2.54	15.88	54.35	54.0
Soybean flour	71.31	8.04	3.20	2.79	17.45	75.59	76.0
Rolled oats	65.16	19.33	2.54	2.07	12.93	79.53	81.0
Whole wheat flour	69.95	12.81	3.02	2.28	14.22	62.82	64.5
Casein	69.08	11.53	2.94	2.65	16.48	96.74	99.5
Corn gluten	66.71	14.67	3.73	2.39	14.91	50.98	51.0
Wheat gluten	66.06	15.84	3.25	2.38	14.87	51.66	54.0
Wheat germ	69.89	11.32	2.87	2.54	15.89	79.03	82.0
N-free diet	70.41	11.50	3.67	2.30	14.42	38.70	40.0
N-free diet	70.93	8.32	3.90	2.70	16.85	36.67	37.7
Sesame oil meal	71.78	10.46	3.01	2.35	14.73	65.01	67.4

that the agreement between calculated and experimental values for NPU calculated from NER, or vice versa, is high. Correlation coefficients between NPU and NER experimental and calculated in all combinations ranged from r = 0.74 to r = 0.94. NER values for the same protein between sexes were similar. However, in the case of NPU, female rats gave, in the majority of cases, slightly but not significantly higher values. The differences tended to decrease when calculated NPU values between sexes are compared. Fig. 1 shows the

Table IV

Chemical composition of male and female rats
Chemische Zusammensetzung männlicher und weiblicher Ratten
Composition chimique des rats et des rattes

Test group	Water	Fat	Ash	Nitrogen	Protein	Weight from chemical analysis	Weight by weighing
		g/100 g				g	g
Initial	71.93	9.96	2.91	2.43	15.20	46.05	47.4
Initial	70.88	8.82	3.33	2.71	16.97	51.92	52.0
N-free diet	67.53	9.59	4.39	2.96	18.47	40.12	41.0
N-free diet	72.40	8.48	3.77	2.47	15.44	43.64	44.0
Defatted whole egg	70.51	9.75	3.06	2.66	16.68	90.90	93.5
Dried skim milk	69.74	10.82	3.28	2.59	16.17	87.19	90.5
Fish flour	69.69	10.71	3.30	2.60	16.28	77.61	80.1
Cooked black beans	72.08	9.39	2.93	2.50	15.60	60.07	61.8
Cooked black beans + DL-methionine	73.38	9.22	2.60	2.37	14.82	78.88	83.0
Torula yeast	69.25	12.75	2.81	2.93	15.17	69.47	74.0
Corn masa flour	72.12	8.57	3.45	2.54	15.85	56.01	57.0
Corn masa flour + L-lysine	74.28	6.04	3.54	2.58	16.15	56.28	57.0
Soybean flour	71.57	8.75	2.96	2.67	16.71	85.50	86.9
Rolled oats	65.72	18.49	2.61	2.12	13.18	81.24	81.0
Whole wheat flour	69.73	13.06	2.99	2.27	14.23	63.54	64.5
Casein	69.48	11.02	2.85	2.66	16.61	96.68	99.5
Corn gluten	66.71	14.26	3.43	2.50	15.59	52.46	53.0
Wheat gluten	66.84	14.81	3.19	2.41	15.17	52.28	54.0
Wheat germ	69.90	11.94	2.71	2.43	15.41	82.69	85.0
N-free diet	71.19	10.02	3.52	2.46	15.32	39.11	38.6
N-free diet	71.89	8.11	3.81	2.59	16.22	36.25	40.4
Sesame oil meal	72.24	10.06	3.02	2.36	14.84	62.83	64.8

regression equations between NPU and NER for male, female rats and for all sexes.

Discussion

Biological methods for the assessment of protein quality are carried out with one or two objectives in mind. One is to classify or to screen

Table V

Experimental and calculated NPU and NER values of several proteins for male and female rats

Versuchswerte und Rechnungswerte einiger Eiweisse für männliche und weibliche Ratten

Valeurs expérimentales et valeurs calculées de NPU et NER pour différentes protéines chez les rats et les rattes

Protein tested	Male rats				Female rats			
	experimental		calculated[1]		experimental		calculated[1]	
	NPU	NER	NPU[2]	NER[3]	NPU	NER	NPU[2]	NER[3]
Defattet whole egg	70.9	28.0	81.6	24.4	86.3	28.3	82.7	29.6
Dried skim milk	63.3	23.4	71.4	22.6	68.0	24.2	71.6	23.1
Fish flour	50.3	19.1	57.4	16.7	51.7	17.8	56.3	16.4
Cooked black beans	19.6	9.0	35.0	5.0	32.0	10.4	38.3	8.7
Cooked black beans + DL-methionine	39.1	19.6	58.0	13.6	48.1	21.2	64.9	14.1
Torula yeast	24.0	15.2	46.8	7.8	39.5	14.5	47.7	12.0
Corn masa flour	48.9	7.1	42.9	6.0	58.1	8.0	58.7	7.9
Corn masa flour + L-lysine	56.7	8.8	48.3	10.3	47.4	5.1	42.3	5.7
Soybean flour	54.3	21.1	63.3	18.1	63.8	12.9	46.9	17.5
Rolled oats	32.2	15.2	46.2	10.6	33.5	15.4	45.9	11.2
Whole wheat flour	25.3	10.2	36.3	7.9	31.2	10.4	35.6	9.1
Casein	76.5	24.5	70.8	26.5	78.8	25.0	71.0	27.7
Corn gluten	29.5	7.1	36.1	5.8	23.9	5.5	32.3	4.1
Wheat gluten	21.0	5.2	27.9	3.9	24.3	6.6	29.3	5.5
Wheat germ	48.2	18.4	55.0	16.1	57.4	18.5	54.9	19.3
Sesame oil meal	29.6	10.0	33.9	8.7	25.5	10.4	34.9	7.6
Average	42.5	15.1	50.7	12.8	48.1	14.6	50.8	13.7
Standard error	4.8	1.8	3.9	1.8	4.9	1.8	3.9	2.0

[1] Formula used for all calculations: $\frac{NPU}{NER} = \frac{2.54\ (W_2—W_0)}{W_2—W_1}$

[2] Calculated from experimental NER.

[3] Calculated from experimental NPU.

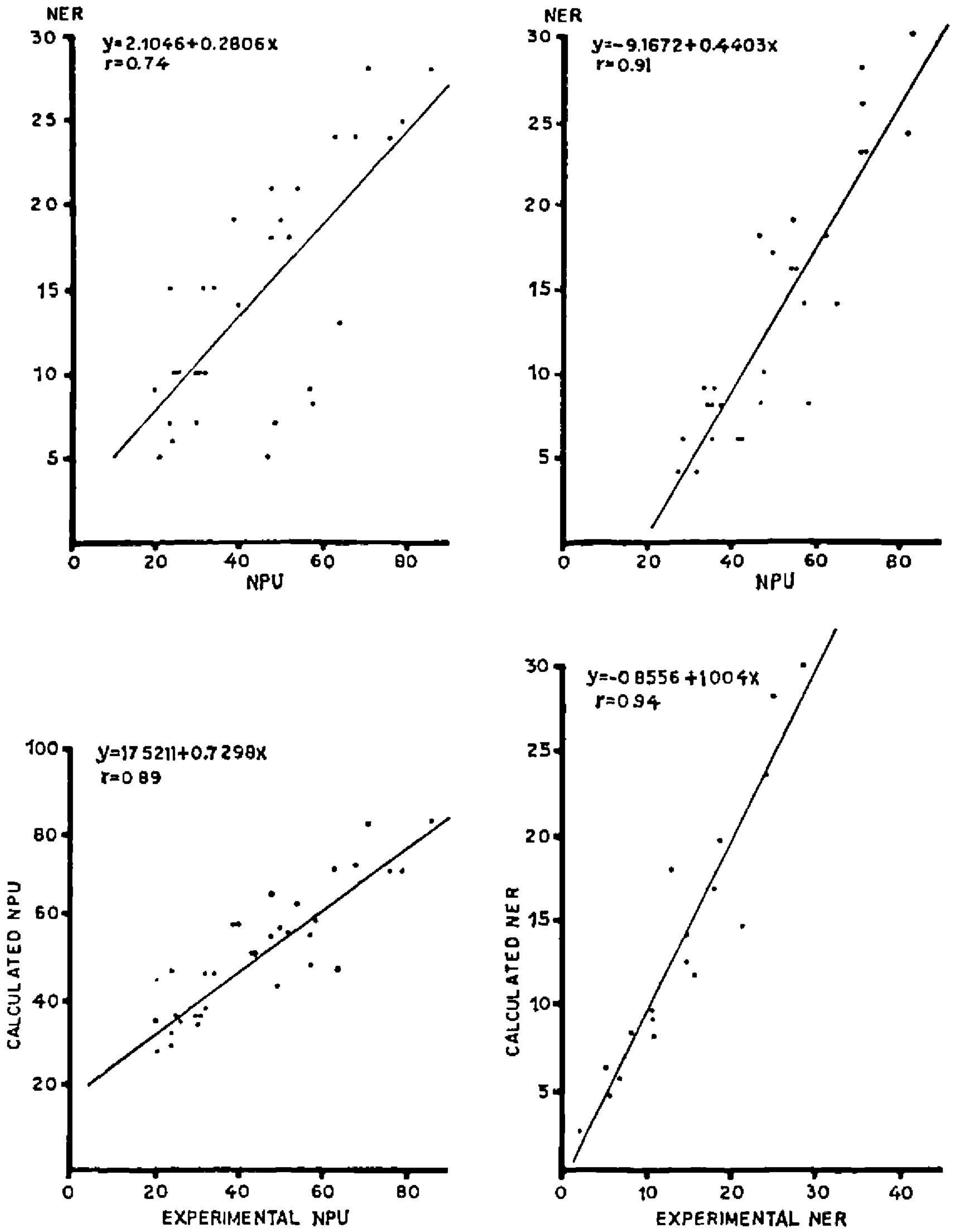

Fig. 1. Correlations between NPU and NER. (a) Between experimental NPU and NER; (b) between calculated NPU and NER; (c) between experimental and calculated NPU; (d) between experimental and calculated NER.

Abb. 1. Beziehungen zwischen Eiweißnutzwert und Wachstumswert. a) Experimentell; b) berechnet; c) experimenteller und berechneter Eiweißnutzwert; d) experimenteller und berechneter Wachstumswert.

Fig. 1. Corrélations entre NPU et NER. a) Valeurs expérimentales, b) valeurs calculées, c) corrélations entre a et b, d) entre valeurs expérimentales et calculées de NER.

proteins according to their nutritive value and the second is to apply the information to human diets. The purpose of this work was to show that the biological methods for the determination of the nutritive value of proteins are related and that by using the appropriate formula, one can be calculated from the other, and vice versa. The information is not to be classified as a new method but rather as a means of simplifying the determinations used in some methods for the evaluation of the nutritive value of a protein. It is realized that the factor used in this paper may not be the same for other breeds of rats, other laboratories, and other conditions. Within each laboratory it is possible, however, to obtain the factor and apply it in the calculations of the nutritive value of food proteins. That the factor is not much different from the one presented here is shown in Table VI, where percentage carcass nitrogen, as reported in the literature by several workers, is recorded. It is evident that as long as a given protein approaches a carcass nitrogen percentage of 2.54 the more accurate NPU will be predicted. It is obvious that carcass nitrogen values different from 2.54 will give NPU values different from determined NPU. This, however, does not render the proposed method invalid, and on the contrary, it gives more value to the method as a screening technique for protein quality.

Donoso and Yañez (6) reported recently that NPU could be calculated from nitrogen values derived from the relationship between age, carcass weight and nitrogen as well as from N values derived from age, and the ratio of N/H_2O. The agreement of NPU values calculated from both N values was high. As seen from the values presented, the constancy of the percentage of body nitrogen of rats fed different diets is rather good. However, higher values usually occurred when the animals were fed protein-free diets, obviously because the animals restricted their food intake, did not fill their calorie needs, and lost body fat.

Several abnormally high NPU values, which cannot be explained, were obtained for corn masa flour alone and supplemented with lysine. However, *Braham et al.* (7) who first applied the NPU method for the determination of the nutritive value of proteins in chicks, found that with this experimental animal, the NPU for corn protein was also high.

During the last few years, several views have been expressed on the relative merits of the NPU and PER methods. The results presented in this report indicate that a very good correlation exists between the results from the two methods. *Chapman et al.* (8) and *Morrison et al.* (12) found a good correlation between the two methods and could not confirm the lower precision of PER data as reported by *Bender* (9), *Bender and Doell* (10); *Oser* (11) also found the variance to be nearly the same. There is little doubt, therefore, that PER and NPU data within most experiments are closely correlated and one set of results may normally be predicted with considerable accuracy from the other. Better predictions would be obtained if both methods were highly standardized with each other. It is known that the NPU method used animals of 31–33 days of age, while the PER method used animals of 21–23. This is an important difference since *Morrison and Campbell* (13) have shown that the age of the animal affects PER. The same

Table VI

Nitrogen in the carcass of rats fed different proteins
Stickstoffgehalt des Rattenkörpers bei verschiedener Eiweißfütterung
Azote de la carcasse des rats recevant des protéines différentes

Nitrogen in carcass, % (wet weight)	Breed	Type of protein fed	Amount of protein in diet, %	Experimental period days	Reference
2.74	albino rat	fish meal	10	7–10	(1)
2.40	albino rat	defatted eggs	10	7–10	(1)
2.73	albino rat	casein	10	7–10	(1)
2.94	albino rat	mixed	1.5	14	(2)
3.23	albino rat	mixed	45	14	(2)
3.00	albino rat	mixed	16	14	(2)
2.87	Sprague-Dawley	wheat flour	10	28	(3)
3.02	Sprague-Dawley	wheat flour + 1% lysine	10	28	(3)
2.61	Ch. River	wheat farina	8	28	(4)
2.80	Holtzman	amino acid mixture	–	21	(5)

(1) *Bender, A.E. and Doell, B.H.:* Brit. J. Nutrition *11:* 140–148 (1957).
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would be expected with regard to the NPU method, particularly for the group of rats fed the nitrogen-free diet. A further difference between the two methods is the length of the experimental period, which in the case of PER is 28 days, while NPU is carried out for 10 days. Furthermore, NPU is corrected by the use of the nitrogen-free diet fed group, while no such correction is applied to the PER values. These factors should, therefore, be taken into consideration. Furthermore, it would be advantageous to modify PER assays to NER, carried out for a shorter period of time, and using nitrogen percentage rather than protein for its calculation.

It is recognized that weight gain does not necessarily mean normal deposition of body protein along with normal amounts of other constituents. Among the proteins tested, rolled oats gave exceptionally higher levels of body fat, while the rest of the proteins tested caused body fat deposition in nearly the same magnitude. Consequently, by the use of the formula developed here, the NPU calculated from NER will underestimate or overestimate some proteins, according to the degree of fat deposition. Studies are under way on the possibility of overcoming this difficulty by correcting the weight gained through a density factor or by carrying the tests with slightly older rats, since it has been found that most fat accumulation occurs during the first 7–10 days after weaning.

Summary

A formula was derived which enables the calculations of NPU values from rat growth data, and a factor which is equal to the percentage of nitrogen of the carcass of the animal. To evaluate the accuracy of the formula, 23 proteins of animal and vegetable origin and representing a wide range in nutritive value were subjected to NPU and NER assays. The correlation between experimentally determined NPU and NER values was 0.95. The average carcass nitrogen percentage for all animals fed all proteins was 2.54. Animals fed nitrogen free diets contained 2.71% nitrogen, while those analyzed after weaning had a 2.57% nitrogen content. Using the 2.54 factor in the formula, close agreement was found between calculated and experimental values for NPU calculated from NER or vice versa. The correlation coefficients between NPU and NER experimental and calculated in all possible combinations ranged from 0.74 to 0.94.

Zusammenfassung

Aus den gemessenen Wachstumswerten der Ratte wird eine Formel entwickelt, welche es möglich macht, den Eiweißnutzwert zu berechnen und zugleich einen Faktor zu bestimmen, der den Stickstoffgehalt des Tierkörpers angibt. Um den

Aussagewert der Formel zu ermitteln, wurden Eiweißnutzwert und Wachstumswert von 23 Eiweißstoffen animaler und vegetabiler Herkunft von verschiedenem Nährwert untersucht. Die Beziehung zwischen Eiweißnutzwert und Wachstumswert war in den Versuchen 0,95. Der durchschnittliche Stickstoffgehalt aller Tiere, aller Proteinfütterungen betrug 2,54%. Tiere mit stickstofffreier Kost enthielten 2,71% N, nach Abstillen 2,57%. Mit dem Faktor 2,54 wurde eine gute Übereinstimmung der berechneten und gefundenen Werte festgestellt, und zwar sowohl bei Eiweißnutzwert als auch bei Wachstumswert als Ausgangslage. Der Korrelationskoeffizient beider Größen lag zwischen 0,74 und 0,94.

Résumé

Une formule est établie permettant le calcul des valeurs de NPU d'après les données sur la croissance des rats et un facteur égal au pourcentage d'azote de la carcasse de l'animal. Pour apprécier l'exactitude de cette formule, 23 protéines d'origine animale ou végétale ont été testées. La corrélation entre les valeurs expérimentales de NPU et celles de NER est de 0,95. Le pourcentage moyen d'azote de la carcassse pour tous les animaux recevant tous les protéines était de 2,54. Les animaux pris à des régimes sans azote contenaient 2,71% d'azote, tandis que ceux analysés après sevrage avaient une teneur en azote de 2,57%. En utilisant le facteur 2,54 dans la formule on trouve un accord étroit entre les valeurs expérimentales de NPU et celles calculées à partir de NER et vice versa. Les coefficients de corrélation entre valeurs expérimentales et valeurs calculées de NPU et NER varient de 0,74 à 0,94 dans toutes les combinaisons possibles.

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