Egypt. J. Anim. Prod. 24. *No.* 1-2 pp. 261-272 (1984)

Comparative Study of the Evaluation of Protein Value of Some Common Egyptian Feeds Using Mature Sheep

Z.A., Motagally, A.K. Abou-Raya, and E.R.M., Abou Hussein

Laboratory of Animal and Poultry Nutrition, National Research Centre, Dokki, Cairo, and Animal Production Department, Anim. Nutr. Division, Fac. Agric., Cairo, Univ, Egypt.

APPARENT and true protein digestibility, nitrogen retention, biological value of protein and net protein value were studied using mature sheep. Fourteen nitrogen balance trials under similar conditions of digestion trials were adopted. Feeds were fed alone in 1st, 2nd and 3rd cut clover and two clover hay samples, or as mixture of 500 g hay along with green maize and nine concentrates including maize, barley and been grains, undec. and dec. cottonseed cakes, rice bran, coarse and fine wheat bran. The following ranges were obtained :—

29.23-81.41 % apparent N digestibility, 78.86-95.16 % true digestibility 0.649-7.029 g N retention/day, 5.10-33.53 % N retention from intake, 7.29—52.62 % protein apparent biological value, 36.12-76.25 % true biological value and 32.83-65.86 % net protein value.

With green maize and 9 concentrate indirectly fed, ranges were 56.52-86.05 % N apparent digestibility, 82.62-100 % N true digestibility, 0.826-4.180 g N daily retention and 7.44-56.16 % N retentin from intake.

True digestibilities appeared to express better the crude protein digestion among feeds producing much narrower range than apparent digestibilities which is seriously affected by metabolic faecal N. Some feeds like green clover, hay, bean mixtures or beans produced more N in the urine lowering N retention, biological value and net protein value. Results on N retention, biological value and net protein value express better protein nutritive value than digestibilities and digestible protein, but it was necessary to keep standard conditions of N-balance trials in order to obtain comparable results of biological value of protein among different feeds when their protein was used to provide maintenance requirements of mature animals.

It is a common practice in digestion trials to record the digestion coefficient and digestible content of crude protein of the feed, in question to express the availability of feed protein. Such data are used for calculating protein requirements in rations of livestocks. This might be true with monogastrics, but

with ruminants variable amounts of apparently digested feed nitrogen might be transformed to rumenal ammonia by rumen microflora, pass to the blood stream and finally escape to the urine. It was suggested by Chalmers and Synge, (1954), to determine the nutritive value of feed proteins for ruminants by nitrogen retention in balance trials. This procedure was fairly adopted by Abou-Akkada and Osman, 1967, with certain forages in Sudan using mature sheep.

The present study aimed to investigate the relation between results of protein evaluation as digestible protein in digestion trials and as retained N in balance trials with common Egyptian feeds either alone or along with certain amounts of clover hay as a basal ration in the feed mixture.

Material and Methods

Fourteen N- balance trials with duplicate adult rams were performed. The preliminary period was 14 days while the collection period was 10 days. Three cuts from green clover (Trifolium alexandrinum) and two clover hays (a and b) were tested as single rations. Other feeds were given along with hay as a basal ration to form a mixture of two feeds in each case. Constant level of 500 g hay was used along with green maize or other concentrates (maize grains, barley grains, beans, undecorticate and decorticated cotton-seed-cake, rice bran, coarse and fine wheat bran).

The consumption calculated as Starch value (S.V.) was calculated using recorded data by Abou-Raya (1967) except with clover, of which dry matter percent was used for calculation using the equation (Starch value % = 0·5× dry matter % + 1) recorded by Sultan, *et al.*, (1966).

True digestibility of N was calculated assuming an average of 0·5g N as metabolic faecal N (MFN) per 100g. dry matter intake (Maynard *et al*, 1979). Biological value (BV) of protein in single feeds or mixtures was calculated in two ways :-

a) percent of retained N (N-balance) from apparently digestible N according to the known simple equation:-

$$\frac{\text{(Feed N-Faecal N-Urinary N) 100}}{\text{(Feed N-Faecal N)}}$$

This will be designated as "apparent BV"

b) percent of retained N from truly digestible N designated as "true BV" according to the classical equation of Mitchel (1962).

$$\frac{\text{100 (Feed N-(Faecal N-MFN)-(Urinary N-EUM)}}{\text{Feed N-(Faecal N-MFN)}}$$

Endogenous urinary N (EUN) was taken as 0·093 g N/kg body weight.

Results and Discussion

Protein intake

Table 1 shows that crude protein in the 14 trials ranged between 77 and 156 g., the highest being with hay b + dec. cottonseed cake. followed by hay balance. Therefore, it appears that the protein level, in the routine digestion trials using clover hay alone or as a basal ration along with common feeds and concentrates was high in the majority of cases and expected to be higher than the requirements of mature sheep. Accordingly this affects the apparent digestion coefficients of protein as well as the N retention, the high N level usually raises the apparent digestion coefficients of crude protein and lowers the percentage of N retention.

Apparent and true digestion of nitrogen (crude protein)

Results on the apparent digestion of protein in tested feeds either directly fed (clover or hay, Table 1) or indirectly fed (darawa and concentrates, Table 2) are similar to those published in Egypt (Abou-Hussein, 1958 and Ministry of Agric., 1968). The apparent digestibility of N with darawa was the lowest (56·52%) being 60% with hays and 65% with rice bran. Results with other concentrates and clover were higher being between 71% and 75%in the majority of cases. It was 81 % wih 2nd cut clover and dec. cottonseed-cake and 86% with beans and barley.

With feed mixtures, the apparent digestion of total protein ranged between 58·44 and 74%. Inclusion of the hay in the mixtures tended to lower the apparent digestion of protein, assuming apparent digestion of protein in the hay remained constant as in the ordinary method applied for calculating apparent digestibility (or partial apparent digestibility' as designated by Kleiber (1961) by the difference method. In all the 9 cases studied here, the coefficients in each mixture was lower than that of the corresponding "partial" one of the tested feed.

The difference method, of calculating digestion coefficient is remaining questionable because the associative effect may lower or increase the N digestibility in the basal ration when mixed with the tested feed. Perhaps, with protein, such associative effect appeared to be more than could be ignored because several cases are known to be encountered in digestion trial producing impossibles apparent digestion coefficients with protein either negative or over 100. Moreover, the metabolic faecal protein is responsible for lowering the coefficients as dry matter intake increases and as N level decreases. This fact was realized by several workers and is confirmed here. With clover, the coefficient increases from 71·38 to 75·36 and 81.41% as crude protein increases from 77 to 92 and 102 g daily. The same holds with the three hay : grain mixtures, and with the two cottonseed-cakes, the higher N intake being associated with higher coefficient. When N intake was similar, higher dry matter intake lowered the coefficient by comparing hay 2 (898 g dry matter and 153 g crude protein intake) and dec. cottonseed-cake : hay mixture (630 g. DM and 156 g. protein), the cofficient being 60·23 against 70·52%. Similar results were reported by Robinson and Forbes (1966), Khafaji (1967) and Soliman (1969).

TABLE 1. Average digestibility and retention of N (or protein) in feeds.

	Dry matter intake g	Nitrogen intake g	Digestibility %		Digestible Protein Dm, %		retaine N d	
			Apparent	True	Apparent	True	g./day	intake
Single feeds :								
Clover 1st cut	525	14.753	75.36	93.61	13.24	16.44	0.815	5.10
2nd cut	455	16.380	81.41	95.16	18.32	21.42	2.809	17.16
3rd cut	470	12.254	71.38	90.55	11.64	14.77	0.649	5.30
Hay (a)	888	20.695	59.23	80.72	8.64	11.76	2.088	10.09
Hay (b)	898	24.820	60.23	78.86	10.26	13.41	6.010	23.24
Mixtures : hay : green maize or a concentrate								
a+green maize	777	14.772	58.44	84.74	6.94	10.07	2.734	18.13
b+maize	808	17.828	63.67	86.37	8.79	11.93	5.977	33.53
a+barley	808	20.509	72.43	92.23	11.50	14.65	2.602	12.67
a+beans	715	22.444	73.75	89.63	14.48	17.59	1.945	8.67
b+undec. cottonseed cake	721	23.955	65.02	79.98	13.65	16.80	7.029	29.34
b+dec. cottonseed cake	630	25.113	70.52	83.04	16.26	19.15	6.886	27.42
a+rice bran	713	17.361	61.62	82.17	9.36	12.48	2.431	14.01
a+coarse wheat bran	800	20.675	65.73	85.05	10.60	13.72	1.871	9.06
a+Fine wheat bran	709	17.824	85.86	85.69	10.33	13.44	2.273	12.76

When true digestion coefficients of N (protein) were calculated, results showed a different trend, although figures were higher than apparent digestion coefficients. The range in apparent coefficients was relatively wide in lower apparent coefficients so that calculated true coefficients became closer. With clover the true coefficients rose up to 90.55 - 95.16 with a range of less than 5 percent degrees while the corresponding apparent coefficients were 71.83-81.41 with a range of 10 percent degrees being more than double. With the three hay : grain mixtures the range with true coefficients (86.37 - 92.23%) was almost half that with apparent ones (63.67 - 73.75). The range in the

digestion trials (5 single roughages and 9 feed mixtures) with apparent digestion was 23 percent degrees (81·91 - 58·44) while the corresponding range with true coefficients was 15 percent degrees (95·16 - 79·88). With partial true digestibilities, the range was also narrower (82·62 - 103·95) than with partial apparent digestibilities (56·52 - 86·05).

Results with true digestibilities appeared to be more conclusive and would represent the protein quality of feeds more accurately than apparent digestion. It was clear that crude protein in green clover and darawa as well as grains was almost completely truly digested by ruminants, digestion being over 90%. With clover hay, rice bran and undec. cottonseed-cake, digestion was between 80 and 84 %. Other by-products have few percent degrees higher ranging between 87-92% (dec. cake, coarse and fine wheat bran). With hay concentrate mixture, true digestion in all cases was 80% or more up to 92% (with barley + hay mixture), the average with the 8 cases being 85·6%. Therefore, it was suggested to replace "apparent digestion" of crude protein by "true digestion" to avoid the very low apparent digestion figures of protein even from the same source of plant material when at a low level along with another feed devoid of protein or very poor in it. In such cases the "true digestion" appeared not to be changed, as well as the percentage of true digestible crude protein in the feed.

Relation betweeen "apparent" and "true" digestion coefficient

Assuming 0·5g N as daily metabolic faecal N per 100g DM intake with ruminats, this would equal 3·125g. crude protein (0·5 × 6·25).

If in each 100g dry matter eaten by the food, × is the percentage crude protein and y the percentage apparent digestible crude protein (recorded in tables of digestion trial data).

Therefore, the percentage true digestible crude protein would equal:

$$y + 3 \cdot 125 \qquad \text{Equation 1}$$

The "apparent digestion coefficient"

$$A = \frac{100\ y}{\times}$$

and "true digestion coefficient,,

$$T = \frac{100\ (y + 3 \cdot 125)}{\times}$$

$$= A + \frac{312 \cdot 5}{\times} \qquad \text{Equation 2}$$

Therefore, the difference between

$$A,\ T\text{-}A = \frac{312 \cdot 5}{\times} \qquad \text{Equation 3}$$

With such simple mathematical relation, it is easy to know the 'true digestion coefficient' and 'true digestible crude protein' (per 100g. DM of the feed) from already recorded data on digestion trials, recording apparent digestion coefficients and apparent digestible crude protein. In fact this was found to be so even with digestion coefficients obtained indirectly using the difference method *i.e.* "partial digestion coefficient''.

Nitrogen retention (N-balance) in digestion trials and their significance

Results in Table 1 with 5 single feeds and 9 mixtures indicated that with a daily N intake ranging from 12·25 to 25·11 g a postivie N balance was obtained ranging from 0·645g and 7·029 g The percentage retention from N intake ranged between 5·10 and 33·53% being the highest with hay: maize grain mixture and the lowest with lst cut clover. This indicated that usually N - intake in digestion trials with clover, hay, hay : darawa or hay: concentrate mixtures appeared to be higher than minimum requirements for maintenance.

Results with clover indicated that retention increased as its level increased being 0·649, 0·815 and 2·809g for a corresponding intake of 12·254 14-753 and 16·380 g in *3nd, 1st* and *2nd* cut, respectively. It was also observed that urinary N with clover was 2-3 times as much as that excreted in the faeces. Results with hay indicate that the urinary N was almost equal or slightly greater than feacal N. In the former case the protein appeared to be more soluble and more rapidly fermented in the rumen resulting in more waste of N as blood ammonia and urinary N and being less utilized as indicated by Chalmers and Synge (1954) El-Shazly, (1958) and Mahmoud (1976).

Retention with hay : green maize mixture was similar to that with 2nd cut clover, although N intake was lower. With hay : grain mixtures, N retention was the highest with maize (5·977 g), next with barley (2·602g) and the lowest with beans (1·945 g), although N intake was the highest with beans and lowest with maize either as N apparent digestible protein (71, 93 and 104 g and true digestible protein (96, 118 and 126 g wih maize, barley and bean mixtures, respectively). This might indicate clearly that there is more waste in absorbed N from beans than barley and with barley than with maize more likely related to the higher solubility and succeptibility to fermentation in the rumen of bean N than that of barley followed by that of maize. This was confirmed by the fact that with bean mixture, urinary N was the highest being more than double that of faecal N while with maize mixture, urinary N was the lowest and was even less than faecal N as follows :-

	Average urinary N (g)	*Average faecal N(g)*
Hay : beans	14·597	5·902
Hay : Barley	12·273	5·638
Hay : Maize	5·381	6·470

More waste as urinary N would occur with beans reducing accordingly N retention. This was obvious when the 'partial' retention of the three grains was indirectly obtained by 'difference' as in Table 2. While the crude protein intake was 34·81, 63·53 and 75·62 g. with maize barley and beans, respectively, which was almost 100 % truly digested, the corresponding retained N was 3·128, 1·557 and 0 900 g being the lowest with beans, the percentage retention from N intake being 56·16, 15 32 and 7·44· % Although. high N intake than required by the animal usually results in more waste in N materials, but it should not reduce the amount of retained N per day to the extent found with beans unless there is another source of waste. This source is most likely from the relatively fast attack of rumen flora to bean N material raising rumen ammonia, blood urea and urinary N. In this connection, El Shazly, (1958) found that bean N is more attacked leading to less retention attributing this to the more solubility of bean protein when compared with those of the cottonseed.

The results herewith hay : undec. and dec. cottonseed cake mixtures and those with hay : bean mixture appeared to confirm those postulated above. The retention and relative retention (% from intake) was much higher with cottonseed cake. Moreover., the partial retention with the two cakes was much greater than with beans, although N intake in the three cases was approaching one another.

With hay : rice bran, hay coarse wheat bran and hay : fine wheat bran, N retention was positive being 2·431, 1·871 and 1·871 g N respectively, the percentage retention being 14.01, 9·06 and 12·76. It seems that rice brans and fine wheat bran N are similarly utilized as that of barley and more utilized than that of beans. Coarse wheat bran N is similarly utilized like beans Table 1. Data on partial retention confirmed the foregoing results with the feed mixtures.

Results with N retention indicated clearly that conditions generally applied for performing digestion trials with mature sheep, are not best suitable for comparative study of N retention among different feeds. Although useful informations were obtained yet, better design would be more useful. Perhaps, using wheat straw as a basal ration along with different concentrates could reduce N intake to a more suitable level as already used by El-Shazly, 1958 (12 g N). Using true digestible N level for comparison appeared to be more useful . It is suggested to run several trials with N levels near neutrality to find minimum level for zero retention. Such levels could be taken as an index for protein qualities in different feeds for maintenance requirements, for the particular tested animal species. Such design was tested by soliman, (1969), using clover- hay: maiye starch mixtures with mature sheep ascending N levels from 16 to 39, daily

TABLE 2. Average "partial" digestibility and partial retention of N darawa or green maize and common concentrates.

	Dry matter intake g	Nitrogen intake g	Digestibility %		Digestible Protein in DM, %		Retained	
			Apparent	True	Apparent	True	g/day	% intake
Green maize	333	4.427	56.52	94.15	4.86	7.04	1.689	38.15
Maize	359	5.570	71.15	102.77	6.87	9.65	3.128	56.16
Barley	364	10.164	86.03	103.95	14.98	17.41	1.557	15.32
Beans	271	12.099	86.05	97.26	24.05	27.18	0.900	7.44
Undec.cottonseed cake	272	11.697	70.97	82.62	19.04	22.19	4.180	35.74
Dec.cottonseed cake	181	12.855	80.74	87.79	35.79	38.92	4.037	31.40
Rice bran	269	7.016	65.12	84.31	10.62	13.75	1.386	19.75
Coarse wheat bran	356	10.330	72.15	89.39	13.07	16.19	0.826	8.00
Fine wheat bran	565	7.479	74.85	92.58	13.16	16.28	1.228	16.42

Biological value of proteins in feeds in digestion trials with mature sheep and their significance

Results in Table 3 with seperate roughages and hay : green maize and concentrate mixtures indicate that the apparent biological value (% N balance from apparently digested N) varied from 7·29 % with 1st cut clover and 52·62% with hay : maize mixture . When N-balance becomes neutral, such value would be zero which is biologically meaningless. Using Thomas-Mitchel equation to calculate the true biological value raise the figures to minimum 36·12 with 1st cut clover and a maximum of 76·25% with hay: maize mixture. These figures denote the percentage of truly utilized N from that truly digested (absorbed). Such figures of BV is superior to N-balance data for representing protein nutritive value.

The truly utilized N is composed of retained N (N balance) + endogenous urinary N and metabolic faecal N. Results indicated that the lowest utilization of truly digestible N was with clover, bean mixture and coarse wheat bran mixture, being gradually higher with hay : barley (46%) followed by hay: fine wheat bran (49·5%) , hay a (50%), hay : rice bran (56·5%) and hay : dec. cotton seed cake (59%). Figures over 60%were obtained with hay b, hay: undec. cotton seed cake and hay: green maize; the highest being with hay : maize.

TABLE 3. Average biological value and net protein value of N (or protein) in feeds.

Feeds	Biological value %		net protein value % of intake
	Apparent	true	
Single feeds :			
Clover 1st cut	7.29	36.12	33.81
2nd cut	21.10	43.16	41.07
3rd cut	7.42	41.72	37.78
Hay (a)	17.02	50.32	40.62
Hay (b)	39.84	62.61	49.37
Mixture, hay : green maize or a con-centrate :			
a+green maize	31.67	66.58	56.42
b+maize	52.62	76.25	65.86
a+barley	17.49	45.85	42.29
a+beans	11.78	36.63	32.83
b+Undec.cotton seed cake	45.06	63.66	50.92
b+Dec. cottonseed cake	38.90	58.77	47.08
a+rice bran	22.72	56.44	46.38
a+coarse wheat bran	13.77	43.18	36.72
a+Fine wheat bran	19.38	49.45	42.37

With a standard sheep (45.3 kg), taking 800 g dry matter intake, the amount of endogenous urinary N could be taken as 1.627 gr N (as obtained by Soliman 1969), and the metabolic faecal N as 4 g N, both amounting to 5.627 g N. Therefore, the true BV would be :

$$\frac{(5.627 + \text{N balance})\ 100}{\text{absorbed N}}$$

At N equilibrium, the BV would be 5·627 X100 /absorbed N. In practical determination of the BV under such conditions, it is preferable to get the average BV of the feed protein at several levels producing N balance at the vicinity of neutrality. Such data would give better insight on the relative biological value of feed protein for maintaining ruminants.

Dief *et al.* (1968) studied the relation between absorbed N and N retention, to obtain "N retention index for the absorbed N" denoted by K, a term which is in a way similar to the biological value of Mitchell used above. Allison, (1949) cited in Dief *et al.*(1968) prefered this term as k has been proved to be constant and not affected by the degree of N reserves in the body. A linear relation between absorbed N and N retention round neutrality was found; the step would determine K which is the retained fraction of the absorbed N. Studies on similar lines should be undertaken for the relative comparison of the protein qualities of different feeds.

The net protein value in feeds in digestion trials with mature sheep

This term in percentages, are presented in Table 3. It denotes the percentage of actually retained (utilized) N from that of the feed.

Results showed variation from 32·83% with hay : bean mixture up to 65·86 with hay : maize mixture. The results in each case were specific because of different levels of N intake. They cannot be taken as measures for comparison of feeds and feed mixtures.

There is no doubt that the apparent digestibility or true digestibility of the protein might give a false picture of its utilization. Results from true digestibilities, are more reliable.N- retention, biological value and net protein value appear to assess more accurately the nutritive value of protein but should be done under controlled conditions to render results comparable among feeds. For testing proteins qualities in concentrates fed indirectly to sheep, it is recommended to use a basal ration very low or free of protein as wheat straw or cellulose fodder "from alkali treated roughages" in order to avoid the associative effect of proteines from hay which is generally applied by Egyptian workers in digestion trials.

References

Abou— Akkada, A.R. and Osman, H.E. (1967) The use of ruminal ammonia and blood urea as an index of the nutritive value of protein in some feed-stuffs. J. Agric-sci 69.25

Abou-Hussein, E.R.M. (1958) Economical feeding of dairy cows and buffaloes for milk production in Egypt. *Ph. D. Thesis, Cairo Univ.*

Abou-Raya, A.K. (1967) "*Animal and Poultry Nutrition*", 1st eddition,Dar-El-Maarif, Cairo.

Association of Official Analytical Chemists (1970) "Official Method of Analysis".*9th E*

Chalmers, M.I. and Synge, R.L.M., (1954) The digestion of protein and nitrogenous compounds in ruminants. *Adv. Protein Chem.* 9, 93.

Dief, H.I., El-Shazly, K. and Abou-Akkada, A.R.A. (1968) The biological evaluation of urea, casein and gluten in the diets of sheep. *Brit. J. Nutr.*, **22**, 451.

El-Shazly, K., (1958) Studies on the nutritive value of some common Egyptian feeding-stuffs I-Nitrogen retention and ruminal ammonia curves. *J. Agric. Sci.* **51**, 2, 149.

Khafagi, Miss, E.A.E. (1967) "Some comparative studies on the chemical constituents of food stuffs and their nutritive value". *M. Sc. Thesis*, Cairo Univ.

Kleiber, M. (1961) "The Fire of Life". John Wiley and Sons, Inc., New York.

Mahmoud, S,. Abou—Raya, A.K. and Abou—AKKada, A.R. (1976) Nitrogen retention of some common animal feeds. Alex. J. Agric. Res **24** (3).

Maynard, L.A., Loosli, J.K., Hintz, H.S. and Warner, R.G.(1979). "*Animal Nutrition*" 6th Ed., Mc Graw-Hill Co. Inc., New York

Ministry of Agriculture, Department of Animal Research, U.A.R. (1968) "*Animal and Poultry Nutrition*". (In Arabic).

Mitchel, H.H. (1962) Comparative Nutrition of Man and Domestic Animals. Vol. *I* New York and London Academic.

Robinson, J.J. and **Forbes, T.J.** (1966) A study of the protein requirements of the mature breeding ewe. Maintenance requirements of the non pregnant ewe. *Brit. J. Nutr.* **20**, 363. (*Nutr. Abst.*, 37, 270, 1976).

Soliman, I.M. (1969) A study on the maintenance requirement of energy and digestible protein for sheep. *M. Sc. Thesis, Cairo Univ*

Sultan, M.F., Abou-Raya, A.K. and **Raafat, M.A.** (1966) Comparative study of the feeding value of Miskawy and Wafeer clover with reference to the effect of the dry matter of the clover. *Proc. Sec. Anim. Prod. Conf.*, Cairo, 2. 721 - 730. (1963).

دراسة مقارنة عن تقييم البروتين فى مـواد العلف المصرية الشائعة مع الأغنـام تامة النمـــو

ظباء محمد زكى عبد المتجلى ، احمد كمـال ابو رية والسيد رفعت محمود ابو حسين

المركز القومى للبحوث وكلية الزراعة ـ جامعة القاهرة ـ مصر

أجريت ١٤ تجربة على ميزان الأزوت على الأعلاف الشائعة مع الغنم تامة النمو لتقدير معاملات الهضم الظاهرية والحقيقية للأزوت وكمية الأزوت المحتجز ، والقيمة الحيوية والصافية للبروتين تحت الظروف العادية لاجراء تجارب الهضم، وغذيت أعلاف وحدها فى الجشة الأولى والثانية والثالثة للبرسيم الأخضر وفى عينتين من دريس البرسيم وغذيت فى مخاليط علف من ٥٠٠ جم دريس مع الدراوة أو المركزات من حبوب الذرة والشعير والفول وكسب القطن بنوعية مقشورة ورجيع الأرز والردة الناعمـة والخشنة وكانت مدى النتائج لهـذه التقديرات فى الأعلاف المدروسة هى :

٢٣ر٢٩ ــ ٤١ر٨١/لمعامل الهضم الظاهرى ، ٨٦ر٧٨ ــ ١٦ر٩٥/لمعامل الهضم الحقيقى ، ٦٤٩ر٠ ــ ٧ر٠٢٩ جم للأزوت المحتجز يوميا ، ١٠ر٥ ــ ٥٣ر٣٣ للنسبة المئوية للأزوت المحتجز من الأزوت المأكول ، ٢٩ر٧ ــ ٥٢ر٦٢ للقيمة الحيوية الظاهرية ١٢ر٣٦ــ٧٦ر٢٥ للقيمة الحيوية الحقيقية ، ٨٣ر٣٢ــ٦٥ر٨٦ للقيمة الصافية للبروتين وكان مدى النتائج مع الدراوة والمركزات فى التغذية الغير مباشرة هو ٥٢ر٥٦ ــ ٠٥ر٨٦ لمعامل الهضم الظاهرى ٦٢ر٨٢ ــ ١٠٠ لمعامل الهضم الحقيقى ، ٨٢٦ر٠ ــ ١٨٠ر٤ جم للأزوت المحتجز يوميا ، ٤٤ر٧ ــ ١٦ر٥٦ للنسبة المئوية للأزوت المحتجز ٠

ووضح أن معاملات الهضم الحقيقية أفضل من الظاهرية لتعبر عن هضم البروتين بين الأغذية المختلفة حيث كان مداها أضيق من معاملات الهضم الظاهرية التى تتأثر بأزوت الروث التمثيلى ، واتضح أن بعض الأغذية كالبرسيم الأخضر ومخلوط الدريس مع الفول تنتج فقد أكبر من الأروت فى البول مما يخفض الأزوت المحتجز والقيمة الحيوية والصافية للبروتين فى هذه الأغذية ٠ كما وضح أن نتائج احتجاز الأزوت أو قيمته الحيوية أو الصافية تكون أكثر وصفا لقيمة البروتينات فى الأغذية عن معاملات هضم البروتين فيها أو نسبة البروتين المهضوم بها ، ولكنه يجب توحيد الظروف التى تجرى فيها تجارب ميزان الأزوت حتى يمكن الحصول على نتائج يمكن مقارنتها عن القيمة الحيوية للأغذية المختلفة لتغطية الاحتياج الحافظ من البروتين للحيوانات التامة النمو ٠