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DIGESTIBILITY OF SOME COMMON FEEDSTUFFS IN SHE DONKEYS

(With 6 Tables)

By

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معاملات هضم بعض مواد العلف الشائعة فى إناث الحمير

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تم استخدام عدد ٥ من اناث الحمير تراوح عمرها من ٢-٣ سنوات ووزنها حوالى ٢٠٠ كجم. اشتملت التجربة على ٥ محاولات هضم لدراسة معاملات هضم العناصر الغذائية فى بعض مواد العلف الشائعة. سكنت هذه الحيوانات فى حظائر منفصلة وذلك لسهولة تقدير كمية الأكل وكمية البراز لكل حيوان على حدة. تم تقديم العليقة اليومية للحيوان الخاص به مع وجود الماء النقى بوفرة. العلائق المستخدمة فى تجارب الهضم الخمسة يمكن تلخيصها كالتالى: عليقة ١ مكونة من دريس البرسيم، عليقة ٢ مكونة من دريس البرسيم بنسبة ٣٥% وتبن القمح بنسبة ٦٥% ، عليقة ٣ مكونة من مخلوط مركزات ٣٠% (٤٠% كسب فول صويا ، ٣٠% ذرة بيضاء مجروشة ، ٣٠% ردة) وتبن القمح بنسبة ٧٠%،عليقة ٤ مكونة من ٩٠% عليقة ٣ + ١٠% ذرة بيضاء مجروشة وعليقة ٥ مكونة من ٩٠% عليقة ٣ + ١٠% ردة .غذيت الحيوانات على العلائق الخمسة لفترة تمهيدية ١٤ يوم، وتم تجميع البراز لفترة ٨ أيام. تم قياس كمية استهلاك كل حيوان يوميا وكذلك كمية البراز المخرجة يوميا الساعة التاسعة صباحا وتم أخذ عينة براز ممثلة لكل حيوان طوال فترة التجميع. تم تحليل العينات لقياس محتوياتها من العناصر الغذائية – تم حساب معاملات هضم دريس البرسيم بالطريقة المباشرة وتم حساب معاملات هضم التبن والذرة والردة وكسب فول الصويا بالطريقة الغير مباشرة تم اخذ عينات من دم هذه الحيوانات عند نهاية كل تجربة وذلك لتقدير نسب بعض مكونات الدم. وقد خلصت النتائج إلى أن كمية المادة الجافة المستهلكة من العلائق الخمسة بواسطة إناث الحمير تتراوح ما بين ٥ر٢-٩ر٢% من وزن الجسم الحى وان معاملات هضم العناصر الغذائية كانت تتراوح بين ٧٩ر٧١ - ٥٨ر٤٧% للمادة الجافة ، ٢٩ر٧٤ - ١١ر٤٨% للمادة العضوية ، ٢٨ر٨٥ - ٢٥% للبروتين الخام ، - ر٨٠% - ٦٧ر٤١% لمستخلص الاثير ، - ر٨٠ - ١٤ر٢٤% للألياف ، ٩ر٩٠ -٩٤ر٥٢% للكربوهيدرات الذائبة ، ٥ر٦٢ - ٣٥% للكالسيوم ، ٢٥ر٥٦ - ٧٣ر٣٢% للفوسفور ، ١١ر٧٢ - ٥١ر٣٩% لمجموع العناصر الغذائية المهضومة. كما أثبتت التجربة أن معاملات هضم العناصر الغذائية فى إناث الحمير وكذلك عناصر الدم التى تم قياسها كانت كثيرة الشبه لمثيلاتها فى الحصان بالمقارنة للحيوانات الأخرى.

SUMMARY

Five adult female donkeys of average 3 years old and averaged 200±5.22 Kg body weight were used for performing five digestibility trials which were planned to determine the digestibility of nutrients in some common feeds. They were housed individually in separate pens in order to record the feed consumption and fecal excretion. Each animal was offered the weighed daily ration in its respective manger and has free access to clean water. The rations tested in the five digestibility trials can be summarized as follow: Ration 1 (basal-a): composed of berseem hay, Ration 2: composed of berseem hay 35% and wheat straw 65%, Ration 3 (basal-b): composed of concentrate mixture 30 % (soybean meal, 40%, white corn, 30% and wheat bran, 30%) and wheat straw 70%, Ration 4: composed of 90% ration 3 and 10% white corn and Ration 5: composed of 90% ration 3 and 10% wheat bran. The animals were fed the tested rations for a preliminary period of 14 days. The fecal matter of each animal was collected daily at 9.0 A.M. for a period of 8 days. The daily feed intake and fecal matter output were recorded for each animal and daily representative samples of fecal matter from the five animals were dried, thoroughly mixed and ground. Then the obtained composite sample for each animal was chemically analyzed for proximate components. The digestibility of hay was measured in the first trial by direct method and wheat straw digestibility could be determined by the by difference method of calculation in the second trial. The other trials were performed to get the digestibility of the other feeds (corn, wheat bran and soybean meal) by the indirect method. Blood serum was analyzed for some biochemical parameters. The obtained results indicated that, dry matter intake by she donkeys ranged from 2.5-2.9% of the body weight, however the digestion coefficient of the different nutrients in the tested feeds and rations ranged from 71.79-47.58% for DM, 74.29-48.11% for OM, 85.28-25.0% for CP, 80.0-41.67% for EE, 80.0-22.35% for CF, 90.9-52.94% for NFE, 62.5-35.0% for Ca, 56.25-32.73% for P and 75.51-39.51% for TDN. The data concerning digestion coefficients of the nutrients and that of blood parameters measured were greatly similar to that of horses and ponies.

Key words: *Digestibility, feedstuffs, nutrients, she-donkeys.*

INTRODUCTION

Digestibility data are used extensively in animal nutrition for potential evaluation of feedstuffs or study of nutrient utilization. It is important to recognize that digestibility is variable; that is, the same feedstuff given to the same animal is not always digested by the same extent. Several factors may alter the extent of digestion; these include level of feed intake, digestive disturbances, frequency of feeding, feed processing and associative and interactive effects of feedstuffs (non-additive effects of combining different feedstuffs). Marked differences also exist in the ability of different animal species to digest a particular feedstuff, particularly roughages. This information reflects the inherent differences among animal species in their ability to utilize fibrous feeds, clearly indicating in advantage of ruminants and horses over swine, rabbits and guinea Pigs (Atkins, 1999 and Pond *et al.*, 2005).

In many instances, it is desirable to evaluate the digestibility of a feedstuff when fed in a mixture with one or more other feeds. Examples include protein supplements or single feedstuffs that are normally never used as a complete diet by themselves. In this situation it is necessary to determine digestibility by difference. With this method a basal diet is fed, and the basal plus the test feed are fed at one or more levels. If time and number of animals permit, more valid estimates can be obtained if all animals are fed alternately the basal and basal+ test feeds, although this is often not the practice (Pond *et al.*, 2005). A common phenomenon observed with digestibility data is that mixtures of feedstuffs do not always give results that would be predicted from digestibility values of the individual components of the mixtures. This response is referred to as a non-additive or an associative effect. Note that digestibility, calculated by difference, of the nutrient in the supplement (test feed) may be greater than 100%. Obviously this is not possible. What has happened is that the addition of the supplement to the diet stimulated digestion of the basal diet so that the mixture was more digestible than when the basal diet was fed alone. This type of response is often observed, particularly for herbivorous animals that depend to a great extent on microbial fermentation. Components of the test feed that stimulate fermentative activity are usually responsible for the increased digestibility (Crozier *et al.*, 1997, LaCasha *et al.*, 1999 and pond *et al.*, 2005). Experimental feedstuffs used in these trials considered as the most popular feeds in Egypt and are commonly used in feeding different farm animals. These feeds represent basal feeds, ground white corn and

protein supplement, soybean meal, and also wheat bran as a laxative feed besides its richness in phosphorus, in addition, berseem hay and wheat straw which are used as bulky feeds.

Much less information is available on intake, digestibility and utilization of nutrients in most feeds by donkeys and the search of the literature failed to reveal information on the nutritional value of such feeds for donkeys. Our objectives were to determine voluntary intake and apparent digestibility of nutrients in berseem hay, wheat straw, white corn, wheat bran and soybean meal by she donkey.

MATERIALS and METHODS

Five adult female donkeys (about 3 years old and averaged 200±5.22 Kg body weight) were used in performing five digestibility trials which were planned to determine the digestibility of nutrients in some common feeds and rations and to add some to the fundamentals on which the nutrition of this animal is based. The animals appeared healthy and parasitological examination revealed no gastro-intestinal infestation. The five animals as a group were used in five digestibility trials alternating in intentionally testing sequence. In order to record the feed consumption and fecal excretion, the animals were individually housed in separate pens belonging to the experimental farm of faculty of veterinary medicine, Assiut university. Each animal was offered the weighed daily ration in its respective manger and has free access to clean water.

The tested rations in the five digestibility trials can be summarized as follow:

Ration 1 (Trial 1): Berseem hay (basal-a)

Ration 2 (Trial 2): Berseem hay 35% (basal-a) and Wheat straw 65%

Ration 3 (Trial 3): Concentrate mixture 30 % (soybean meal 40%, white Corn 30% and wheat bran 30%) and wheat straw 70% (basal-b)

Ration 4 (Trial 4): composed of 90% ration 3 and 10% white corn

Ration 5 (Trial 5): composed of 90% ration 3 and 10% wheat bran

Diets for horses at maintenance should contain at least 7.2 % protein, 0.21 % calcium and 0.15 % phosphorus plus adequate amount of vitamins and trace minerals (NRC, 1989).The formulated rations provide the donkeys with digestible energy, crude protein, calcium and

phosphorus according to the above recommendation of NRC (1989) for horses due to the shortage of published data concerning these values for donkeys. In addition, vitamin AD_3E, mineral mixture and common salt were added to the rations.

Donkeys were offered rations free choice to determine voluntary feed intake and were then fed restricted amounts for the digestibility portion. The amount fed was based on the lowest intake observed when the ration was not restricted.

The animals were fed the tested rations for a preliminary period of 14 days. The fecal matter of each animal was collected daily at 9.0 A.M. for a period of 8 days. The daily feed intake and fecal matter output were recorded for each animal and daily representative samples of faecal matter from the five animals were dried, thoroughly mixed and ground. Then the obtained composite samples for each animal was chemically analyzed for proximate components according to the official method A.O.A.C. (1990).

Blood samples were taken before the morning's meal at the end of each trial from jugular vein in a dry, clean and sterile centrifuge tubes. The samples were allowed to clot at room temperature. The clotted blood was centrifuged at 3000 rpm for 20 minutes. Clear, non-haemolysed sera were separated by Pasteur pipette and transferred into a clean, dry and sterile stoppered glass vials till the biochemical analysis.

Calculation of digestion coefficient:

The digestion coefficients for the nutrients of the feedstuffs or rations were calculated by one of the following: -

i- Direct method b- Indirect method

The direct method for measuring digestibility was applied for basal feeds (Hay or concentrate ration), while indirect one was used for the other feedstuffs which could not be fed alone.

The digestibility of hay, which is the most suited basal ration, was measured in the first trial and with wheat straw, the digestibility of the last was determined by difference method of calculation (trial 2). The other trials were performed to get the digestibility of the other feeds, corn, wheat bran and soybean meal.

Hay as a basal feed was substituted by a mixed ration composed of 30% concentrate mixture (soybean meal 40%, white corn 30% and wheat bran 30%) and 70% wheat straw (third trial), while in the fourth and fifth trials, the digestibility of corn and wheat bran were determined by using the one step indirect method when each replaced 10 % of the

ration respectively. The digestibility of soybean meal was calculated using the results of the other feeds.

From the analysis of feed and fecal matter, the digestibility of any nutrient was calculated using the following equation:

$$\text{Digestion coefficient} = \frac{\text{Digested portion}}{\text{Eaten portion}} \times 100$$

(Maynard, 1979)

Total digestible nutrients of the different feeds and rations were calculated according to Morrison (1959).

Biochemical parameters:

Blood urea nitrogen and blood serum minerals were determined using standard kits supplied by Bio-Merieux (Baines / France).

Statistical analysis:

Statistical analysis of the crude data were carried out according to the procedures of completely random design, SAS (1995).

RESULTS

The current study was designed to give an overview on the efficiency of donkeys to digest some of the commonly used feedstuffs and rations. It included five digestibility trials and the results are presented in tables (1-6). The chemical analysis of the experimental feedstuffs and rations are presented in Tables (1&2).

The values concerning dry matter intake, fecal matter excreted, blood parameters and digestion coefficients for the different nutrients of berseem hay are presented in Tables (3-6).

Table 1: Chemical composition of the experimental feeding stuffs.

Feeding stuffs	Nutrient, % (DMB)									DE* (Mcal/KgDM)
	DM	OM	CP	EE	CF	NFE	ASH	Ca	P	
White corn, ground	88.0	97.5	10.9	3.8	3.5	79.3	2.5	0.04	0.30	3.84
Soybean meal	91.0	93.1	48.2	2.5	7.2	35.2	6.9	0.35	0.71	3.73
Wheat bran	89.0	93.0	15.8	4.7	13.8	58.7	7.0	0.11	1.31	3.30
Berseem hay	88.0	89.5	14	6.0	37.0	32.5	10.5	3.2	0.35	2.22**
Wheat straw	90.0	81.4	3.6	0.9	37.5	39.4	18.6	0.2	0.07	1.62
Con.mixture***	89.5	94.4	27.3	3.53	8.07	55.5	5.6	0.26	0.91	3.63

*NRC (1989) for horses
** Calculated
***Concentrate mixture composed of 30% white corn, 30% wheat bran and 40% soyabean
Concentrate mixture was calculated from the data of the chemical composition of feedstuffs

Table 2: The calculated chemical composition of the experimental rations.

Ration *	Nutrient, % (DMB)									DE (Mcal/KgDM)
	DM	OM	CP	EE	CF	NFE	ASH	Ca	P	
1	88.0	89.5	14.0	6.0	37.0	32.5	10.5	3.20	0.35	2.22
2	90.7	84.2	7.2	2.7	37.3	37.0	15.8	1.25	0.17	1.83
3	89.9	85.3	10.7	1.7	28.7	44.2	14.7	0.22	0.32	2.22
4	89.7	86.5	10.7	1.9	26.2	47.7	13.5	0.20	0.29	2.38
5	89.8	86.1	11.2	2.0	27.2	45.7	14.0	0.21	0.42	2.33

*1 Berseem hay
2 Berseem hay 35% and wheat straw 65%
3 Concentrate mixture 30% and wheat straw 70%
4 Composed of 90% ration 3 and 10% white corn
5 Composed of 90% ration 3 and 10% wheat bran

Table 3: Dry matter intake by donkeys during the five digestibility trial

Items	Experimental trials				
	1	2	3	4	5
DMI (Kg/day)	5.81± 0.16	5.39± 0.20	5.04± 0.35	4.86± 0.30	4.82± 0.29
DMI (% BW)	2.91	2.70	2.52	2.43	2.41
DMI(g/Kg BW)	29.05	26.95	25.2	24.3	24.1
DMI (g/Kg BW $^{0.75}$)	109.2	101.3	94.8	91.4	90.6

Table 4: The chemical composition of the faecal matter excreted in the five digestibility trial.

Rations	Nutrient, % (DMB)						
	OM	CP	EE	CF	NFE	Ca	P
1	86.9± 1.4	10.2±1.2	3.7±0.45	56.9±2.81	16.1±0.45	5.55±0.31	0.58±0.08
2	82.2±1.02	6.1±0.67	1.8±0.24	55.9±1.7	18.4±0.37	1.66±0.22	0.21±0.01
3	83.2±1.57	8.2±0.83	1.6±0.15	47.8±1.67	25.0±1.16	0.27±0.03	0.46±0.03
4	84.0±2.15	8.3±0.96	1.7±0.12	45.0±1.57	29.0±1.09	0.28±0.01	0.41±0.02
5	83.2±1.67	9.6±1.27	1.8±0.17	46.7±2.18	25.1±0.87	0.35±0.02	0.60±0.04

Table 5: Blood serum minerals and BUN of the experimental animals.

Items	Experimental trial				
	1	2	3	4	5
Calcium (mg %)	11.9 ± 0.23^{a*}	11.5 ± 0.27^{a}	11.7 ± 0.19^{a}	11.3 ± 0.41^{a}	11.9 ± 0.30^{a}
Phosphorus (mg %)	8.6 ± 0.37^{a}	8.5 ± 0.20^{a}	8.9 ± 0.25^{a}	9.7 ± 0.29^{a}	9.2 ± 0.15^{a}
Magnesium (mg %)	1.7 ± 0.11^{a}	1.6 ± 0.18^{a}	1.7 ± 0.22^{a}	1.9 ± 0.13^{a}	1.5 ± 0.32^{a}
BUN (mg %)	25.28 ± 1.07^{a}	23.9 ± 1.35^{a}	20.7 ± 0.9^{a}	22.21 ± 1.1^{a}	22.3 ± 1.67^{a}

*Figures in the same row having the same superscripts are not significantly different ($P<0.05$)

Table 6: Digestion coefficient of the nutrients and nutritive value of the tested feedstuffs and rations

Feed & Ration	DM	OM	CP	EE	CF	NFE	Ca	P	TDN (%)
White corn	71.79 ±3.47	71.05 ±3.01	72.50 ±2.71	60.00 ±2.34	80.00 ±2.33	70.97 ±1.72	35.00 ±1.37	41.67 ±2.12	72.11 ±2.63
Soyabean meal	66.67 ±1.33	71.11 ±3.24	85.28 ±2.85	41.67 ±3.49	68.57 ±1.2	52.94 ±1.77	62.50 ±2.75	45.16 ±1.21	67.01 ±1.26
Wheat bran	73.68 ±2.81	74.29 ±1.78	50.00 ±2.49	80.00 ±3.52	42.00 ±3.18	90.90 ±2.65	40.23 ±1.07	34.80 ±1.23	75.51 ±2.75
Conc. mixture	70.24 ±3.2	71.05 ±2.14	75.76 ±3.25	50.00 ±1.59	40.00 ±3.04	73.13 ±2.9	38.71 ±1.09	32.73 ±0.85	68.42 ±1.62
Berseem hay*	64.04 ±2.99	65.10 ±0.85	73.58 ±3.13	78.26 ±3.19	44.68 ±3.29	82.26 ±2.25	37.78 ±1.37	38.46 ±0.08	64.13 ±1.41
Wheat straw	47.58 ±1.07	48.11 ±2.37	25.0 ±2.71	50.00 ±2.67	22.35 ±2.66	74.16 ±3.19	40.00 ±2.4	56.25 ±1.01	39.51 ±2.18
Ration 2	53.30 ±2.07	54.42 ±2.22	60.30 ±1.63	66.67 ±2.17	30.00 ±2.81	76.92 ±1.8	37.50 ±1.2	43.33 ±1.9	48.02 ±1.96
Ration 3	54.46 ±1.00	55.65 ±2.73	65.12 ±1.26	57.04 ±3.22	24.14 ±3.85	73.74 ±1.45	39.60 ±0.95	36.70 ±1.7	48.67 ±2.33
Ration 4	56.22 ±1.33	57.49 ±2.07	65.85 ±2.75	57.14 ±1.58	24.75 ±2.47	73.51 ±2.36	39.80 ±2.01	37.85 ±1.35	51.4 ±1.63
Ration 5	56.28 ±1.66	57.75 ±3.49	62.79 ±0.78	62.50 ±2.49	25.00 ±3.12	75.86 ±3.56	39.50 ±0.77	36.15 ±2.1	51.31 ±1.26

* Ration 1

DISCUSSION

Dry matter intake was greater for berseem hay than the other four rations when expressed as either kilograms of dry matter per day, as a percentage of BW or as grams per kilogram of $BW^{0.75}$ (Table 3)

Dry matter intake of berseem hay in the present study (2.9 % BW and 109 g/Kg $BW^{0.75}$) was greatly similar to that reported by Crozier *et al.,* (1997) and LaCasha *et al.,* (1999). They found that, mature Arabian geldings had a voluntary intake of alfalfa hay of 2.8 % and 3.1 % of BW and 122.4 and 133.9 g/Kg $BW^{0.75}$, respectively. However the dry matter intake seems to be more than that recorded by Aiken *et al.,* (1989) of 2.5% BW for yearling horses and 2 % BW for mature horses.

The digestibility of berseem hay was determined by the direct method as this feedstuff could be fed alone to such an amount, which satisfied the digestive tract of the animal. The mean apparent digestion coefficient for different nutrients of berseem hay were 64.04 % for dry matter, 65.10 % for organic matter, 73.58 % for crude protein, 78.26 % for ether extract, 44.68 % for crude fibre, 82.26 % for NFE, 37.78 % for calcium and 38.46 % for phosphorus.

The dry matter digestibility of berseem hay by the she donkey in the present study was greatly similar to that observed by Vander-Noot and Gilbreath (1970) and Hussein *et al.* (2004). They found that, horses digest 61 % and 63 % of the dry matter in alfalfa hay, respectively.

Koller *et al.* (1978) and Anderson and Matches (1983) found that, in vitro dry matter digestibility (IVDMD) of high quality alfalfa was similar by microbes obtained from ruminally fistulated cows and cecally fistulated ponies. In another study using the cecal fluid from cecally fistulated gelding, the IVDMD of alfalfa and grass hays was 68 % and 35 %, respectively after 48 h incubation period (McDaniel *et al.,* 1991).

Darlington and Hershberger (1968) fed alfalfa at different stage of blooming to ponies. They found that, apparent DM digestibility of 57.3 to 61.7 % for the different stages of hays.

Hintz *et al.,* (1973), Kandil, (1984), Bhattacharya *et al.,* (1988), and Gihad *et al.,* (1988), studied the digestibility of berseem, alfalfa and leucerne hays in camels and they found that, the digestibility varied from 56.5 to 71.5 % for dry matter, 63.88 to 74.7 % for the crude protein, 54.18 to 62.65% for the crude fibre and 63.44 to 68.91% for the NFE. Also the digestion coefficient in sheep varied between 59.54 to 68.42%

for dry matter, 55.57 to 68.34% for crude protein, 46.69 to 56.0% for ether extract, 49.0 to 72.41% for crude fiber and 64.99 to 68.2 % for NFE (Abou-Raya, 1967 and Abd-Ellah, 1983). Our results agreed and disagreed in some nutrients digestibility with that previously reported in camels (63 % DM, 64 % OM, 55 % CP, 66 % CF, 52 % EE and % NFE), in buffaloes (69.33 % CF and 63.47 CP %) and in goats (56.75 % CF, 63.16 % EE and 70.15 % NFE) by Abdel-Raheem, (1994), Chauhan *et al.*, (1987) and Attia (1972), respectively. Our results are in the same range in the DM and CP digestibility, higher in the EE and NFE digestibility and lower for CF digestibility. In addition, Our results are higher in the digestion coefficient of the different nutrients of berseem hay which recorded in cattle, sheep and buffaloes by Gupta *et al.* (1983), and a higher DM, OM and ADF digestibility than the ponies when the animals are allowed ad libitum access to hay and straw (Pearson and Merritt, 1991) and at both level of feeding (ad libitum or restricted to about 70 % ad libitum intake of hay or oat straw) compared with the ponies (Pearson *et al.*, 2001). On the other hand, the donkeys appear to digest cell wall constituents as efficiently as Bedouin goats when fed on low quality roughage. but less efficient when fed alfalfa hays. The donkeys high energy digestibility is related to its capacity to digest soluble food components more efficiently than the ruminants (Izraely *et al.*, 1989).

A primary difference in chemical composition among the five diets was crude protein concentration. This was expected because berseem hay is generally higher in crude protein than the other four diets. The difference in CP intake largely explained the observed differences in apparent CP digestibility among the five diets (Crozier *et al.*, 1997).

The apparent OM and CP digestibility may have been influenced by the percentage of sulfur in berseem hay. Sulfur requirements for horses have not been established, but 0.15 % in the diet was considered adequate (NRC, 1989). Berseem hay supplied more than twice the recommended S in the diet (0.33%). Buttrey *et al.*, (1986) and Ahmad *et al.*, (1995) demonstrated that, OM digestibility and CP utilization were increased by S fertilization of grass silages fed to sheep. More information is needed to understand the relationships among dietary S, DM digestibility and CP utilization in the equine diet.

The values for CP (73.58 %) digestibility of berseem hay was greatly similar to that previously reported for alfalfa (73.9 %) by Crozier *et al.* (1997) and (75.4 %) by Vander-Noot and Gilbreath (1970) in

donkeys and at the same time was lower than that reported for alfalfa (83 %) by LaCasha *et al.* (1999) in ponies, (79.5 %) by Pagan and Jackson (1991) in horses.

Apparent crude fibre digestibility was not affected by protein intake (low protein diet, 42.9 ± 4.03 ; high protein diet 38.1 ± 1.14) in ponies (Rey *et al.*, 2001).

Digestibility of wheat straw was determined by the indirect method. It was fed with berseem hay as this feedstuff could not be fed alone in such an amount, which supplied the nutritional requirements of the animal. The digestion coefficient of the different nutrients of wheat straw are presented in Table (6) as 47.58 % for dry matter, 48.11 % for organic matter, 25 % for crude protein, 50 % for ether extract, 22.35 % for crude fibre, 74.16 % for NFE, 40 % for calcium and 56.25 % for phosphorus. From the obtained results, it appears that donkeys are less able than other ruminants in the digestion of wheat straw. This was very clear when the coefficient for the crude fibre, crude protein and nitrogen free extract were compared. Goats recorded higher value for crude protein digestibility (45.34 %) and very high for NFE (92.46 %) as reported by Attia (1972). Abdouli and Kraiem (1990) recorded higher figures in camels 55%, 58%, 42% and 65% for dry matter, organic matter, crude protein and crude fibre, respectively.

Digestibility of basal-b (30% concentrate mixture and 70 % wheat straw) was determined by the direct method and the mean apparent digestion coefficient for different nutrients were 54.46% for DM, 55.65% for OM, 65.12% for CP, 57.04% for EE, 24.14% for CF, 73.74% for NFE, 39.6% for Ca and 36.70 for P (Table 6). A result which are higher in all nutrients, except in CF digestibility, than that reported by Abdel-Raheem, 1994 in camels who found that, the values for digestibility of Basal diet (concentrate 28% + wheat straw 72%) were 46.13%, 47.99%, 59.78%, 39.68%, 41.95%, and 48.95% for DM,OM, CP, EE, CF and NFE, respectively.

The ration 4 of this experiment was composed of 90 % basal-b (30 % concentrate mixture and 70 % wheat straw) and 10 % ground white corn. The digestion coefficient of this ration was determined by the direct method while that of white corn was calculated by indirect method (Table 6).

The values for digestion coefficient of white corn nutrients are 71.79 % for dry matter, 71.05 % for organic matter, 72.5 % for crude protein, 60 % for ether extract, 80 % for crude fibre, 70.97 % for NFE, 35 % for calcium and 41.67 % for phosphorus. Comparing the

digestibility of white corn in donkey and other ruminants, the data indicated that corn nutrients were the same as for cattle and sheep (71.8% and 71.6 %) but higher for buffaloes (76.4 %) as reported by Gupta *et al.* (1983). The coefficient for organic matter are higher than the value recorded by Wilson *et al.* (1973) who mentioned that organic matter digestibility of ground white corn in cows was 58 %.

The digestibility of ration 5 (10 % wheat bran and 90 % basal-b), was determined by the direct method, while the digestibility of wheat bran was calculated by indirect one as shown in (Table 6).

The mean values for the apparent digestion coefficient of the nutrients in wheat bran are 73.68 % for dry matter, 74.29 % for organic matter, 50 % for crude protein, 80 % for ether extract, 42 % for crude fibre, 90.9 % for NFE, 40.23 % for calcium and 34.8 % for phosphorus.

The soybean meal was part of the concentrate mixture fed to the donkeys in ration 3 and the digestibility of the latter was calculated previously and those of ground white corn and wheat bran were already calculated, it was easy to calculate the digestion coefficient for nutrients in soybean meal used in the present experiment. The values were 66.67%, 71.11%, 85.28%, 41.67%, 68.57%, 52.94%, 62.5% and 45.16% for DM, OM, CP, EE, CF, NFE, Ca, and P, respectively as shown in table 6. In the same way, comparing these values for donkeys with ruminants, the results indicated that, donkeys have higher digestibility of CP (85.28%) than camels (64.61%) and ruminants (52%) as that reported by Abdel-Raheem, (1994) and Sampath (1987).

The total digestible nutrients in donkeys was higher for berseem hay, but greatly similar in the other four diets to that reported previously by Abdel-Raheem (1994) in camels (55.69 %), Abd-Ellah (1983) in sheep (53.0 %) and those stated by Morrison (1959) in other ruminants (51.9 %).Total digestible nutrients were also reported by Gupta *et al.* (1983) and the values were 54.95%, 54.85% and 56.46% in cattle, buffaloes and sheep, respectively.

The total digestible nutrients of wheat straw in our study (39.51) was higher than in camels (27.37) as reported by Abdel Raheem (1994) while, TDN of ground white corn in donkeys (72.11%) was lower than that reported for camels (81.24%) by Abdel-Raheem (1994).

Regarding the total digestible nutrients of wheat bran, the result confirmed that donkeys (75.51%) were nearly similar as camels (76.14%) as reported by Abdel-Raheem, (1994), while higher than other ruminants (66.9%) as stated by Morrison (1959).

The value of TDN of soybean meal in this experiment confirmed what was cited by Morrison (1959) for the superiority of ruminants (79.4%) than donkeys (67.01%).

All blood components measured in our study (Table 5) were within normal ranges for horses at all times (Pond *et al.*, 2005). Even though intake differed for each of these minerals among first, second and other last three diets, there were no differences in apparent absorption of Ca and P as a percentage of intake. The result would be expected because homeostatic levels of serum Ca and P are maintained through hormonal mechanism. Serum Mg level was not affected in the different trials. Serum concentration of urea N (mg /100 ml) were detected for the five diets and the values were 25.28, 23.9, 20.7, 22.21 and 22.3, respectively. A result which are in agreement with that reported by Hussein *et al.* (2004) in horses consuming alfalfa cubes

Further digestibility studies with other forages and concentrates and possibly different roughage to concentrate ratios would probably be helpful in evaluating our present results. In addition, determination of both rate of fluid and particular matter passage in the ceacum and colon would provide insight into the interpretation of our digestibility results in donkeys.

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