مقارنة بين التغذية للشبع والتغذية المحدودة على الكتاكيت النامية

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الملخص

أجريت التجربة بمزرعة الدواجن بالدقى بوزارة الزراعة حيث تم تجنيس ٣٦٠ كتكوت فيومى ورود ايلاند أحمر حديثة الفقس وبعد فصل الذكور والاناث غذيت كما يلى :

(أ) تغذية للشبع .
(ب) ٨٥٪ من الشبع .
(جـ) ٧٠٪ من الشبع .

فكان تأثير مستوى التغذية على متوسط الوزن الحى عند عمر ١٦ أسبوع معنويا بدرجة كبيرة احصائيا (على مستوى ١ر٠) وتأثير السلالة كان معنويا (على مستوى ٥ر٠) ولم يوجد فرق يذكر احصائيا (على مستوى ٥ر٠) بالنسبة للجنس . وكان التأثير المتبادل بين السلالة والمستوى الغذائى ذو فرق معنوى (على مستوى ٥ر٠) وبين الجنس والمستوى الغذائى كان التأثير معنويا بدرجة كبيرة (على مستوى ١ر٠) بينما لم يوجد تأثيرا متبادلا يذكر احصائيا بين السلالة والجنس .

وتدل نتائج هذه الدراسة على أن تحديد الغذاء الى ٧٠٪ من الشبع قد خفض بصفة عامة الوزن الحى بشكل واضح للسلالتين المختبرتين عن مثيلاتهما فى حالتى التغذية للشبع أو ٨٥٪ من الشبع .

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THE EFFECT OF DIETARY SUPPLEMENTATION OF COTTON SEED OIL ON THE GROWTH AND PERFORMANCE OF BALADI WHITE CHICKS

By

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This experiment was carried out in the Poultry Nutrition Farm, Faculty of Agriculture, Cairo University, to study the performance of growing Baladi White (B.W.) chicks when fed rations containing graded levels of cotton seed oil (CSO) up to 17.5% of the ration. The total number used was 318 chicks of three of weeks old, the experiment lasted for 18 weeks. Comparative feeding study was undertaken in six groups offered different levels of CSO (0.0–17.5%) having approximately the same digestible protein level (15.1%). The oil level in the experimental rations was associated with an increase of the feeding value of the rations, expressed as starch value, (68.8 up to 94.7).

Results showed that the addition of CSO at a level up to 10% of the ration had no deterimental effect on growth, but higher levels, up to 17.5%, caused depression on growth. The efficiency of feed utilization of groups fed rations containing from 0.0 to 10% CSO (as judged from the G.M.) was practically the same, but groups fed rations containing higher level of CSO appeared to be less efficient in utilizing the feeds. The feed consumption was reduced as the starch value of the ration was increased by the addition of CSO. Mortality rate was high when chicks were given ration supplemented with CSO at level of 10.0% or higher. Therefore, CSO may be added to chick ration at level lower than 10%.

Some workers showed that the addition of fats in poultry rations improved growth and feed conversion, while others found different results. Henderson and Irwin 1940, as well as Fraps 1943, mentioned that rations containing higher than 10% oil level had a deleterious effect on the chick growth. Also, Kummerow *et al*, 1949, found that 25% linseed oil depressed growth in chicks. Dam *et al.*, 1959, reported that 3-10% oil in the ration promted growth, but higher levels did not affect it. Runnels 1955 and Siedler *et al.*, 1955, found that rations having 3—6% fat had no effect on growth rate. Isaack *et al.*, 1960, concluded that the growth response was correspondingly related to the percentage of soybean oil in the ration (10—30%). El-Abbady *et al.*, 1968, showed that the addition of cotton seed oil at a level not more than 10% had no ill effect on the growth of B.W. chicks. Rand *et al.*, 1958, showed that the best overall performance was obtaind when the fat contributed between 20—38% of the total metabolizable energy of the ration.

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This work was undertaken to investigate the maximum level of the cotton seed oil which can be added to rations of B. W. chicks without affecting their growth or performance.

Material and Methods

The initial number of B. W. chicks used was 318 of 3 weeks old. They were divided into 6 groups, equal in number and average body weight. The experimental rations were supplemented with cotton seed oil No. 3 (CSO) at the levels of : 0, 5, 10, 12.5, 15 and 17.5% for rations 1, 2, 3, 4, 5 and 6 respectively (Table 1). The digestible protein level was nearly constant in the 6 rations (ranged from 15.10 to 15.30%). The C/P ratios (calories of productive energy per kg. ration/crude protein %) were 106, 116, 127, 132, 138 and 143 for rations 1, 2, 3, 4, 5 and 6 respectively. Birds were individually weighed every two weeks and feed consumed was recorded. Feed and water were offered *ad libitum*.

TABLE 1.—COMPOSITION AND FEEDING VALUE OF THE EXPERIMENTAL RATIONS.

Ingredient	Ration No.					
	1	2	3	4	5	6
	%	%	%	%	%	%
Corn, ground	46.8	40.8	34.8	31.8	28.8	25.8
Decorticated cottonseed meal	20.0	21.0	22.0	22.5	23.0	23.5
Wheat bran	10.0	10.0	10.0	10.0	10.0	10.0
Rice bran	10.0	10.0	10.0	10.0	10.0	10.0
Dried skim milk	10.0	10.0	10.0	10.0	10.0	10.0
Cottonseed oil No. 3	—	5.0	10.0	12.5	15.0	17.5
Cod liver oil	1.0	1.0	1.0	1.0	1.0	1.0
$Ca\ CO_3$	1.5	1.5	1.5	1.5	1.5	1.5
Na Cl	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin (A-D_3) Mixture[1]	0.2	0.2	0.2	0.2	0.2	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
Crude protein (calculated)	18.53	18.43	18.33	18.28	18.28	18.18
Digestibel protein (calculated)	15.30	15.20	15.20	15.10	15.10	15.10
S.E.[2]	68.80	76.20	83.60	87.30	91.00	94.70
P.E. (Cal./kg.)[3]	1960	2143	2326	2418	2509	2601
C/P	106	116	127	132	138	143

1. Vitamin (A-D_3) mixture supplied each kilogram of ration by 5000 I.U. vitamin (A) and 1000 I.U. vitamn (D_3).

2. Starch equivalent (S.E.) was calculated after Ghonein, 1957.

3. Productive energy (P.E.) was calculated after Fraps, 1946.

Results and Discussion

The average body weight of chick :

Fig. 1 shows that the average body weight of chicks of the six groups was nearly equal at the start of the experiment being 53.3 ± 0.2 gm. The average body weight of group 1 (0.0% CSO) was the highest till the age of 19 weeks At the end of the experimental period, the average body weight of this group was 909 gm. The average body weight of chicks of group 2 (5.0% CSO) was lower than that of group 1 till the age of 19 weeks, then it showed a slight increase thereafter at the end of the experiment. The final average body weight of this group was 924 gm. The average body weight of chicks in group 3 (10.0% CSO) was nearly equal to that in group 2 during the period of 3—9 weeks old. Then, the average body weight of chick in group 3 was lower than that of group 2 till the end of the experiment. At the end of the experiment, the average body weight of the chick was 909, 924, 824, 659, 505 and 411 gm. for groups : 1, 2, 3, 4, 5 and 6 respectively. This shows that retardation of growth was progressively related to the percentage of oil in the ration over 10%. Assuming that the average body weight of group 6 equals 100(it would be 221.2, 224.8, 200.5, 160.3, 122.9 and 100 for the six groups respectively.

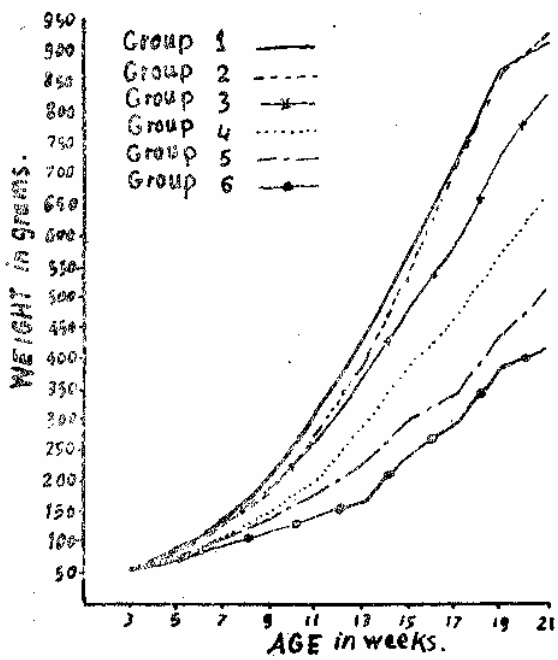

FIG. 1.—Average body weight of B W chicks fed 6 different levels of C S O.

The linear regression equations of the six groups were calculated as outlined by Snedecor (1956) as follows :

Group 1 $\hat{Y} = 52.1 \times - 198.2$

,, 2 $\hat{Y} = 52.5 \times - 218.5$

,, 3 $\hat{Y} = 44.5 \times - 166.6$

,, 4 $\hat{Y} = 34.7 \times - 121.1$

,, 5 $\hat{Y} = 24.9 \times - 63.4$

,, 6 $\hat{Y} = 20.4 \times - 48.9$

Therfore, it was possible to study the differences in the rate of growth in groups : 2, 3, 4, 5 and 6 each compared with group 1 (0.0% CSO). This was done by calculating "t" for each two regression coefficients as outlined in the following table :

Groups compared	Calculated "t"
1 vs. 2	0.03
1 ,, 3	0.78
1 ,, 4	2.14×
1 ,, 5	4.72××
1 ,, 6	5.39××

× $P < 0.05$ ×× $P < 0.01$

From the provious table it can be seen that the weekly average growth rate of chicks of groups fed 5 and 10% CSO was not significantly different from that of the control group (0.0% CSO). However, groups 4, 5 and 6 (fed 12.5, 15 and 17.5% CSO respectively) had significantly lower average weekly growth rate than the control group. Thus it may be concluded that the addition of CSO up to 10% had no effect on growth of B.W. chicks. Higher levels than 10% CSO caused significant growth retardation. It may also be concluded that 10% would be considered as the maximum level of CSO to be added to ration of B.W. chicks up to 21 weeks of age.

These results are similar to those found by Henderson and Irwin, 1940; and Fraps. 1943. Also. Kummerow *et al.*, 1949, found that ration contained 25% raw linseed oil depressed the growth. Similarly, Dam *et al.*, 1959, mentioned that using maize oil at levels over 10% did not increase the growth.

The gain in body weight :

The total body gain during the entire experimental period was : 855, 871, 771, 606, 451 and 358 gm. for groups :1,2,3,4,5 and 6 respectively (Table 2). Assuming the gain in weight of group 6 (17.5% CSO) equals 100, it would be 238.8, 243.3, 215.4, 169.3 and 126.0 for groups supplemented with 0.0, 5.0, 10.0, 12.5 and 15.0% CSO respectively. Therefore, it may be concluded that the total body gain in weight of group 1 (0.0% CSO), 2 (5.0%CSO) and 3 (10.0%CSO) was nearly equal. While that of groups 4,5 and 6 was less than that of group 1.

Feed consumption :

The average feed consumed by the chick during the entire period was: 5.172, 4.755, 4.310, 3.610, 2.987 and 2.805 kg. for groups : 1, 2, 3, 4, 5 and 6 respectively (Table 2). Assuming that the average feed consumed per chick in group 6 equals 100, it would be 184.3, 169.5, 153.7, 128.7 and 106.5 for groups : 1, 2, 3, 4 and 5 respectively. This shows that feed consumption is inversely related to the level of cotton seed oil in the ration. It seems that the chick had restricted the amount of feed consumed according to its energy content.

Starch equivalent consumed :

The average starch equivalent consumed by the chick during the entire period in the six groups :1, 2,3, 4, 5 and 6 respectively was : 3.558, 3.624, 3.603, 3.152, 2.717 and 2.656 kg. (Table 2). This indicates that inspite of the fact that groups :1,2 and 3 were fed on rations which contained different levels of starch value, chicks consumed realy equal amount of starch value. This may be due to the self control practiced by the chick to reduce the amount of feed consumed as the oil percentage increased in the ration. In group 4, the strach equivalent consumed by the chick was 3.152 kg. during the entire experimental period. It was less than that in group 1 (the control). In group 5 and 6 the chick consumed nearly equal amounts of starch equivalent (2.717 and 2.656 kg respectively). The amount of strach consumed per chick in the last two groups was less than that in the control. Starting at the level of 12.5% CSO there appeared a corresponding depression of starch equivalent consumed. This trend became more evident in the groups fed higher levels i.e., groups 5 and 6.

TABLE 2.—TOTAL BODY GAIN, FEED CONSUMED, S.E. CONSUMED AND G.M. OF B.W. CHICKS.

Item	Group					
	1 (0.0% CSO)	2 (5.0% CSO)	3 (10% CSO)	4 (12.5%CSO)	5 (15.0%CSO)	6 (17.5%CSO)
Total body gain (gm.)	855	871	771	606	541	358
Total feed consumed per chick (kg.)	5.172	4.755	4.310	3.610	2.987	2.805
Total S.E. consumed per chick (kg.)	3.558	3.624	3.603	3.152	2.717	2.656
S.E. required to produce one kg. growth (G.M.)	4.161	4.160	4.673	5.201	6.024	7.418
G.M. assuming the control = 100	100	100	112	125	145	178
Calculated C/P	106	116	127	132	138	143

The growth measure (G.M.) :

Table 2 shows that the G.M. (kgs of starch/kg. of weight gain) during the whole experimental period was : 4.161, 4.160, 4.637, 5.201, 6.024 and 7.418 for groups : 1, 2, 3, 4, 5 and 6 respectively. This indicates that it was nearly equal within groups 1 and 2. Then the G.M. began to increase as the level of CSO increased in the ration. For comparison, these figures would be : 100, 100, 112, 125, 145 and 178 units for groups : 1,2,3,4,5 and 6 respectively, showing that increasing the energy level without increasing the protein content of the ration may lead to higher G.M.

The effect of calorie — protein ratio (C/P) :

Groups 1, 2, 3, 4, 5 and 6 were fed rations of calculated C/P : 106, 116, 127, 132, 138 and 143 respectively per kg. of the ration. Group 1, 2 and 3 which were fed rations of C/P : 106, 116 and 127 respectively showed no significant difference in growth rate. When the C/P of the rations fed to groups 4, 5 and 6 was widened being 132, 138 and 143 respectively, the body gain was reduced as the C/P increased. When the average body weight of chicks within groups 4, 5 and 6 was compared with that of group 1, the difference was significant. Thus it may be concluded that increasing C/P from 106 up to 127 did not affect the growth of chicks, but rations having C/P over 127 had caused deleterious effect on growth under conditions of this experiment.

Mortality rate :

From the following Table, it can be seen that increasing the level of CSO in the ration to 10% or higher was associated with high mortality. Although the 10% CSO level is not detrimental to the growth of chick, yet it is correlated with high mortality rate. Therefore, for best performance, CSO may be used at levels lower than 10% of the ration.

Period	Group					
	1 (0.0% CSO)	2 (5.0% CSO)	3 (10.0% CSO)	4 (12.5% CSO)	5 (15.0% CSO)	6 (17.5% CSO)
3—7 weeks	11.32	7.69	18.87	22.64	5.66	11.32
8—11 weeks	1.89	0.00	5.66	7.55	9.43	33.96
12—15 weeks	0.00	0.00	7.55	0.00	13.21	11.32
16—19 weeks	0.00	1.92	0.00	1.89	0.00	[illegible]
20—21 weeks	0.00	1.92	0.00	0.00	0.00	0.00
Total . . .	13.21	11.53	32.08	32.08	28.30	56.60

REFERENCES

DAM, R., LEACH, R.M. (JR), NELSON, T.S., NARRIS, L.C. and HILL, F.W. (1959). Studies on the effect of quantity and type of fat on chick growth. *J. Nutrition*, **68** ; 615–632.

EL-ABBADY, M.R., EL-KOTOUBY, M.I., OMAR, E.M. and HAMADA, M.R. (1968). A nutritional study on the effect of supplying different levels of cotton seed oil in rations for broilers. (In Press).

FRAPS, G.S. (1943). Relation of the protein, fat and energy of the ration to the composition of chickens. *Poultry Sci.*, **22** : 421-424.

FRAPS, G.S. (1946). Composition and productive energy of poultry feeds and rations. *Texas Agricultural Experiment Station*, Bulletin No. **678**.

GHONEIM, A. (1957). "*Feeding domestic poultry*". 3rd edition, Anglo Egyptian bookshop, Cairo. (Arabic text book).

HENDERSON, E.W., and IRWIN, W.E. (1940). The tolerance of growing chicks for soybean oil in their ration. *Poultry Sci.*, **19** : 389–395.

ISAACKS, R.E., DAVIES, R.E., DEYOE, C.W. and COUCH, J.R. (1960). Growth stimulating effect of high levels of vegatable oils. *Poultry Sci.*, **39** : 1262.

KUMMEROW, F.A., WEAVER, R., and HONSTEAD, H., (1949). The choline replacement value of ethanol amine in chickens kept on high fat ration. *Poultry Sci.*, **28** : 475–478.

RUNNELS, T.D. (1955). Animal fat in combination with various other ingredients in broiler rations. *Poultry Sci.*, **34** : 140–144.

SIEDLER, A.J., SCHEID, H.E. and SCHWEIGERT, B.S. (1955). Effects of different grades of animal fats on the performance of chicks. *Poultry Sci.*, **34** : 411–414.

SNEDECOR, G.W. (1956). "*Statistical Methods*". 5th Ed. Iowa State College Press, Ames, Iowa, U.S.A.

تأثير استعمال مستويات مختلفة من زيت بذرة القطن على نمو كتاكيت البلدى الأبيض

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الملخص

تمت هـذه التجربة فى محطة ابحاث تغذية الدواجن بكلية الزراعة ـ جامعة القاهرة بغرض دراسة تأثير تغذية الكتاكيت على علائق تحتوى على مستويات متدرجة من زيت بذرة القطن رقم ٣ (من صفر الى ٥ر١٧ ٪ من العليقة) . وقد استخدم فى هـذه التجربة ٣١٨ كتكوت فى عمر ثلاثة أسابيع واستمرت التجربة لمدة ١٨ أسبوع . قسمت هذه الكتاكيت الى ٦ مجاميع متماثلة وغذيت كل مجموعة على عليقة بها نسبة معينة من زيت بذرة القطن وكانت نسـبة البروتين المهضوم فى علائق التجربة ثابتة (١ر١٥ ٪) والقيمة الغذائية للعلائق مقدرة بمعادل النشا كانت تزداد بزيادة نسبة الزيت فى العليقة وتراوحت بين ٨ر٦٨ ـ ٧ر٩٤ .

وقد أوضحت نتائج هـذه التجربة أن اضـافة زيت بذرة القطن حتى مستوى ١٠ ٪ من العليقة لم يكن له تأثير سيىء على النمو ولكن زيادة نسبة الزيت عن هذا المستوى وحتى ٥ر١٧ ٪ من العليقة تسبب انخفاض معـدل النمو كما أن كفاءة التحويل الغذائى معبرا عنها بمقياس النمو فى المجاميع التى تغذت على علائق بها زيت حتى ١٠ ٪ كانت من الوجهة العملية واحدة . وكانت كميات الغذاء التى تتناولها الكتاكيت تقل كلما زادت نسبة الزيت فى العليقة وارتفعت تبعا لذلك قيمتها النشوية . أما نسبة النفوق فانها ازدادت فى المجاميع التى تغذت على نسب زيت ١٠ ٪ أو أعلى .

ويوصى من نتائج هذه التجربة أنه عند استخدام زيت بذرة القطن رقم ٣ كمصدر للطاقة فى غذاء الكتاكيت أن تقل نسبته عن ١٠ ٪ من العليقة .

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THE EFFECT OF FEEDING DIFFERENT RATIOS OF HEATED TO UNHEATED CONCENTRATE MIXTURE ON THE VOLATILE FATTY ACIDS, pH AND AMMONIA CONTENTS OF RUMEN FLUID IN THE COW*

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A Friesian cow with fistulated rumen was used to investigate the effect of feeding a ration of long hay and varios ratios of heated to unheated concentrate mixture upon the volatile fatty acids, pH and ammonia contents of the rumen fluid.

Increasing the percentage of heated concentrate in the daily ration from 0 to 100% increased the total VFAs, on the average, from 9.88 to 11.51 mg. equiv./100 ml. rumen fluid, respectively, and the molar proportion of propionic acid from 17.9 to 19.2%. On the other hand, it decreased the molar proportion of acetic acid from 70.9 to 69.5% and resulted in a narrower acetate to propionate ratio from 3.97 : 1 to 3.62 . 1. In addition, the pH was depressed from 6.71 to 6.38 and the ammonia concentration decreased from 21.4 to 19.7 mg./100 ml.

The differences in the pH and molar proportions of the acetic, propionic and butyric acids, between the different feeding periods of various ratios of heated to unheated concentrate mixture were found to be statistically significant ($P < 0.01$) while those of ammonia were not significant. On the other hand, the variations in the concentrations of ammonia, total and individual VFAs, between the sampling hours after feeding time, were found to be statistically significant while those of pH were not significant.

The volatile fatty acids produced during fermentation in the rumen play an important role in the energy metabolism of ruminants. They have been shown to vary in their nutritive properties and to be used with a greater efficiency for fattening when they contain a high proportion of propionic and butyric acids than when they contain a high proportion of acetic acid. (Armstrong and Blaxter, 1957).

Ensor *et al.* (1959), also reported that the fat content of milk of dairy cows as well as the efficiency of gains in steers can be controlled to a remarkable extent by manipulating the ruminal production of volatile fatty acids.

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* This investigation was carried out in "Hoorn" Institute for Animal Nutrition Research, Hoorn, Netherlands.

El-Shazly (1952), made an extensive study of the VFAs in the rumen of sheep fed on a number of different rations and concluded that the amino acids of the protein fed may be the principal source of both the ammonia and the branched-chain acids.

It has been widely recognized that factors other than the chemical composition of the ration are of great importance in relation to the pattern of microbial fermentation in the rumen, as showed by the marked effect of the physical form of the ration (Balch and Rowland, 1957 ; Ensor *et al.*, 1959 ; Van Adrichem, 1962). Grinding the hay and pelleting the ration (King and Hemken, 1962 ; Jorgensen and Schultz, 1963 ; and Jorgensen *et al.*, 1965) and cooking the maize portion of the concentrate (Balch and Rowland, 1957 ; Ensor, 1959 ; Ensor *et al.*, 1959 ; Show *et al.* 1959, 1960 ; and Rook, 1961) have been reported to cause changes in the proportions of the volatile fatty acids formed in the rumen, by decreasing the proportion of acetic acid, increasing the proportion of propionic acid and narrowing the ratio of acetate to propionate as a result of the two previous changes. Accordingly, the nutritive value of the ration can be increased by such methods without changing its chemical composition due to the relatively smaller heat increments of propionic and butyric acids than that of acetic acid, as found by Armstrong and Blaxter (1957). On the other hand, it is probable that the only disadvantage of a ration which increases propionate and decreases acetate is its tendency to depress the milk fat test. (Jorgensen and Schultz, 1963 ; and Van Soest, 1963). However, such ration will be excellent for dairy cows during the dry and freshening periods since it produces more efficient gains and is more glucogenic than normal rations, and thus aids in the prevention of ketosis as believed by Ensor *et al.* (1959), Shaw *et al.* (1959) and Van Adrichem (1962).

Cardon (1963), reviewed research on grain processing and concluded that steam rolling was advantageous for corn and barley, but not for sorghum grain. He discussed the interrelationship of moisture, temperature and time in processing and attributed the benefits obtained to the gelatinization of starch.

An experiment has, therefore, been undertaken to investigate the effect of feeding different ratios of heated to unheated concentrate mixture on the total and molar proportions of the volatile fatty acids and also on the pH and ammonia contents of the rumen fluid in the cow.

Material and Methods

A Friesian cow with fistulated rumen from the herd of "Hoorn" Institute for Animal Nutrition Research was placed on experiment for 60 days. It was fed daily 7 kg. of grass hay together with 5 kg. of concentrates. The daily ration was given in two equal meals. The hay was given to the cow in the long form. The concentrate mixture contained linseed meal, 43.03%. maize meal. 29.26%. barley meal. 22.38%; dried beet pulp, 3.44% and vitamin and mineral supplement, 1.89%ro%, experimental periods of ten days each 0, 1, 2, 3, 4, and 5 kg. of the daily concentrate ration were fed after being moistened with hot water (1.5 litres/1 kg. conc.), heated in autoclave at 120.°C (under 1 kg. press/cm^2) for 30 minutes to assur complete gelatinization of strach and finally cooled to room temperature.

The scheme of feeding and the daily rations are shown in Table 1.

TABLE 1.—Scheme of feeding and Daily Rations

	p.m. a.m.	
1st period	(10—20 April) :	7 kg. Hay + 5 kg. conc. (unheated) + 0 kg. Conc. (heated).
2nd ,,	(20—30 ,,) :	7 kg. Hay + 4 kg. Conc. (unheated) + 1 kg. Conc. (heated).
3rd ,,	(30 Apr.—10 May:	7 kg. Hay + 3 kg. Conc. (unheated) + 2 kg. Conc. (heated).
4th ,,	(10—20 May) :	7 kg. Hay + 2 kg. Conc. (unheated) + 3 kg. Conc. (heated).
5th ,,	(20—30 May) :	7 kg. Hay + 1 kg. Conc. (unheated) + 4 kg. Conc. (heated).
6th ,,	(30 May—9 June):	7 kg. Hay + 0 kg. Conc. (unheated) + 5 kg. Conc. (heated).

Change of ration : on 10th days (p.m.).

After transitory periods of eight days each on the assigned ration rumen fluid samples were taken during the ninth and tenth days of each of the experimental periods at 8, 10 and 12 O'clock in the morning i.e. 0,2, and 4 hours after the feeding time, respectively. The samples were analysed for PH, ammonia and molar proportions of the volatile fatty acids.

Representative samples of the hay and the concentrate mixture were taken throughout the experiment and analysed. Their proximate composition is given in Table 2.

TABLE 2.—The Proximate Composition of the Feeds

Feed	Dry matter	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
		% of dry matter				
Hay	96.82	9.96	—	35.56	48.53	5.95
Concentrate Mixture	88.34	21.86	5.55	7.63	59.75	5.21

Analytical procedures :

1. *Feeds* : The A.O.A.C. methods (1950), were used in the analysis of the feeds.

2. *Rumen fluid :*

   (*a*) The pH was determined with a glass electrode after the samples had been cooled rapidly to room temperature.

   (*b*) Total and proportions of VFAs : The technique of Erwin, Marco and Emery (1961), was followed using a F & M. gas chromatograph.

   (*c*) Ammonia was determined by distillation.

Results and Discussion

The experimental heated concentrate ration was palatable and readily consumed by the cow without noticeable digestive or physiological disturbances. The pH and ammonia concentration of the rumen fluid samples and their mean values representing the sampling hours throughout the experimental periods are given in Table 3. The pH and NH_3 mean values are also plotted in Fig. 1 and 2, respectively.

pH : The highest pH values were obtained in the first period with the starting ration of hay and unheated concentrate while the lowest values were attained in the last period with the fiinal ration of hay and heated concentrate. The mean pH values in the first period were 6.69, 6.79 and 6.66 in the rumen fluid samples taken 0, 2, and 4 hours after feeding, respectively. The corresponding mean values in the last period were 6.45, 6.36 and 6.32. During the other periods the pH values were intermediate.

It was noticed that the pH dropped after feeding and fell to lowest levels in the rumen fluid samples taken 4 hours after feeding. Fig. 1.

However, there was an abnormal rise in the pH of the samples taken 2 and 4 hours after feeding in the first and fourth periods, respcctively which cannot be explained. The fall in the pH values after feeding appeared to be rather slower in the 2nd and 3rd periods than in the last two periods.

The analysis of variance (Table 5) showed that the differences in the pH mean values were significant ($P < 0.01$) between the periods where different proportions of heated concentrate were fed, and not significant ($P > 0.05$) betcween sampling hours after feeding time.

All the pH values obtained in the present investigation were below the range of 6.83 — 7.01 reported by Monroe and Perkins (1939), with normal rations of roughages and concentrates in fair amounts. The comparatively low pH values found in the rumen fluid samples taken during the last two periods, favours rapid absorption of short chain fatty acids, as suggested by Phillipson (1952). However they were higher than the

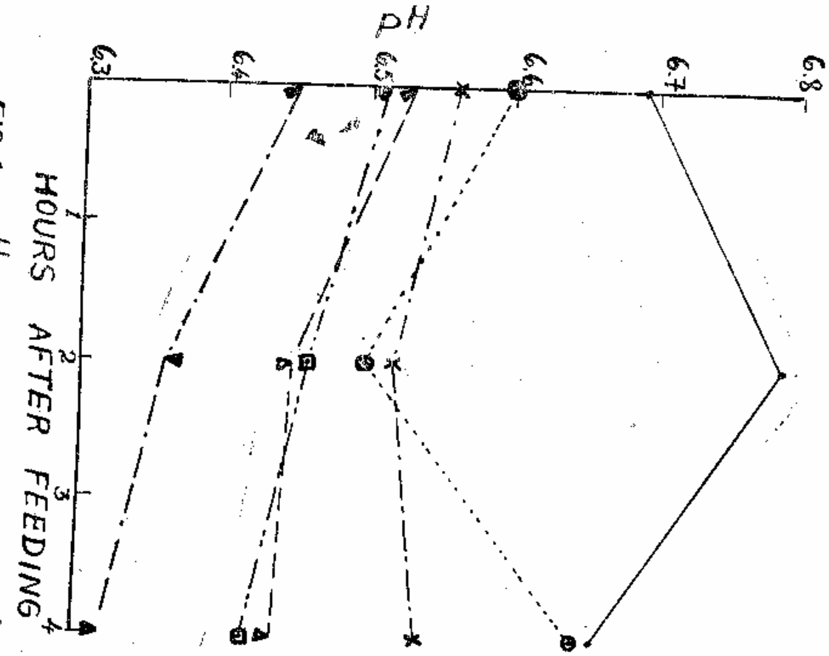

FIG.1 pH IN RUMEN FLUID

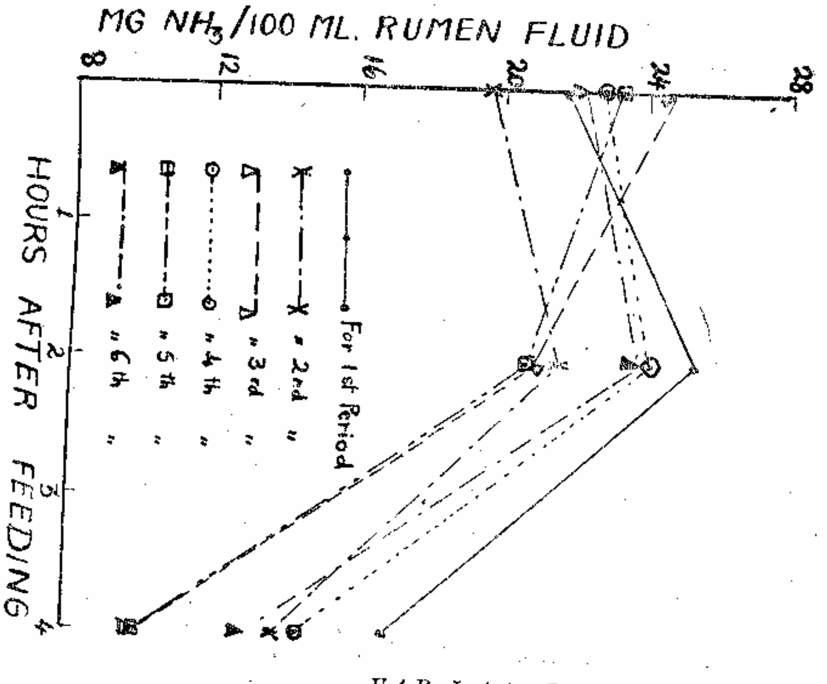

FIG.2. NH_3 IN RUMEN FLUID

TABLE 3.—THE pH AND AMMONIA CONCENTRATION IN CONSECUTIVELY DRAWN SAMPLES OF COW'S RUMEN FLUID

Period	Date of Sampling	Daily Ration (kg)			pH				NH_3 mg/100 ml.			
		Hay	Conc. (unheated)	Conc. (Heated)	Hours after feeding			Period mean	Hours after feeding			Period mean
					0	2	4		0	2	4	
1	19/4/66	7	5	0	6.62	6.75	6.50		21.7	24.8	15.1	
	20/4/66	7	5	0	6.75	6.82	6.82		21.7	26.1	18.7	
					6.69	6.79	6.66	6.71	21.7	25.5	16.9	21.4
2	29/4/66	7	4	1	6.53	6.50	6.40		16.6	22.2	15.4	
	30/4/66	7	4	1	6.58	6.54	6.67		22.6	20.9	12.4	
					6.56	6.52	6.54	6.54	19.6	21.6	13.9	18.4
3	9/5/66	7	3	2	6.53	6.48	6.38		25.5	24.6	11.2	
	10/5/66	7	3	2	6.53	6.42	6.50		23.9	17.3	8.4	
					6.53	6.45	6.44	6.47	24.7	21.0	9.8	18.5
4	19/5/66	7	2	3	6.60	6.50	6.70		22.7	21.9	12.4	
	20/5/66	7	2	3	6.60	6.50	6.60		22.7	26.5	16.6	
					6.60	6.50	6.65	6.58	22.7	24.2	14.5	20.5
5	29/5/66	7	1	4	6.55	6.48	6.43		22.9	20.5	8.8	
	30/5/66	7	1	4	6.47	6.43	6.40		23.5	21.1	10.9	
					6.51	6.46	6.42	6.46	23.2	20.8	9.9	18.0
6	8/6/66	7	0	5	6.52	6.42	6.39		26.4	27.9	15.0	
	9/6/66	7	0	5	6.37	6.30	6.25		18.0	19.9	11.2	
					6.45	6.36	6.32	6.38	22.2	23.9	13.1	19.7
	(Time of sampling) mean				6.56	6.51	6.51		22.4	22.8	13.0	

values obtained by him with diets low in hay and high in flaked maize. A rapid fall in pH was reported by Elsden and Phillipson (1948) ; and Phillipson (1952), with the addition of readily available carbohydrates to the ration. Briggs *et al.* (1957), also found that lactic acid accumulated and rumen pH was lowest when much soluble carbohydrates were fed, and reported that with other diets pH was the result of the balance between volatile fatty acids and ammonia and salivary alkali. In the present investigation, the mean pH values for all the rumen fluid samples taken 0, 2 and 4 hours after feeding were 6.56, 6.51 and 6.51, respectively. Gray (1947), demonstrated that the rumen pH has a profound effect on the rates at which the volatile fatty acids are absorbed, and showed that at a pH of 6.50 propionic acid disappeared more rapidly from the rumen than did acetic acid.

Amonia : Reference to Table 3 shows that the mean values for ammonia concentration in the first period with unheated concentrate were 21.7, 25.5 and 16.9 mg. per 100 ml. in rumen fluid samples taken 0, 2 and 4 hours after feeding, respectively. The corresponding values in the last period with heated concentrate were 22.2, 23.9, and 13.1 mg per 100 ml. It is clear that, in the last period, there was a drop in NH_3 concentration in the rumen fluid sampled 2 and 4 hours after feeding compared with those of the first period, while there was a slight increase in the first sample taken just after feeding time. There were some fluctuations in ammonia concentration during the intermediate periods, on various heated to unheated concentrate ratios. However, the analysis of variance (Table 5) indicated that the differences found in ammonia mean values between the experimental periods were not significant ($P > 0.05$).

It was noticed that the decrease in ruminal ammonia content during the successive experimental periods was associated with decrease in ruminal pH. It seems that the total output of saliva was reduced to some extent by feeding the increased proportions of heated concentrate, and as a consequence the buffering capacity of the rumen contents was reduced resulting in a lower pH. It was reported by McDonald (1952), Chalmers and Synge (1954) ; and Annison *et al.* (1954), that ammonia concentration in the rumen varies with the kind of protein in the ration, but the addition of starch rich feeds such as maize meal or flaked maize to high protein rations depressed considerably the formation of ammonia. In this connection, Phillipson *et al.* (1959), suggested that the decreased ruminal ammonia level obtained with such rations might be partly due to an increase in the numbers of bacteria that can utilize ammonia nitrogen. It is worth noting that the total ration used in the present investigaion was not high in protein content ; it had approximately 15 percent crude protein. This may partly explain the comparatively moderate decrease in ammonia concentration by increasing the percentage of the heated concentrate mixture in the daily ration.

It was noticed in the present investigation, that ammonia concentration rose after feeding and reached the maximum levels after two hours then declined (Fig. 2). This was noted in all the experimental periods except the 3rd and the 5th periods where the highest values were found in the first samples taken just after feeding time. The lowest mean values for ammonia concentration were attained in all the rumen fluid samples taken 4 hours after feeding. The differences in ammonia mean values were found to be statistically significant ($P < 0.01$) between the hours of sampling after feeding time (Table 5).

These observations are generally in accordance with the findings of Butz. *et. al.* (1958) and Van Adrichem (1962). The former workers found that ammonia concentration rose after feeding and then declined slowly over several hours. Van Adrichem (1962), reported that the easily fermentable carbohydrates decreased the ammonia content in the rumen and stimulated the synthesis of bacterial protein and that the maximum NH_3 concentration was attained two hours after feeding. A range from 4 to 41 mg.% of ammonia nitrogen was reported by Briggs *et al.* (1957), in rumen fluid of sheep fed a ration of 50% Iucerne and 50% cracked maize. In the prsent investigation a narrower range was found (from 11.2 to 27.9 mg. NH_3 per 100 ml. of rumen fluid) on approximately 58% hay and 42% heated concentrate, in the last period.

Volatile Fatty Acids

The total volatile fatty acid concentration and the molar percentages of the individual acids in the consecutively drawn samples of rumen fluid, representing the experimental periods, are given in Table 4. In addition, the variations in the mean concentrations of the aceticе, propionic, butyric and total VF As are also shown in figures 3, 4, 5 & 6, respectively.

Acetic Acid

Acetic acid was present in greatest amount in the rumen fluid and the proportion of propionic acid exceeded that of butyric. On the starting ration of hay and unheated concentrate, acetic acid on average accounted for 71.3, 70.4 and 71.1 per cent of the total volatile fatty acids on molecular basis, in the rumen fluid samples taken 0, 2 and 4 hours after feeding, respectively. The corresponding mean values on the final ration of hay and heated concentrate, in the last period, were 68.3, 69.5 and 70.7%. It was noticed that, by increasing the percentage of the heated concentrate in the daily ration during the successive periods, the acetic acid concentration decreased with some fluctuations (Table 4). The lowest mean values were obtained in the 4th and 5th periods. On the other hand, the rumen fluid samples taken 4 hours after feeding contained the highest proportions of acetic acid in all the experimental periods except the first period, where the last sample contained a slightly lower concentration of acetic acid than the first sample taken just after feeding time, in the same period (Fig. 3). It was also noted, that the mean values for acetic acid proportion in the second period were nearly the same (i.e. 70.2, 70.2 and 70.3%) at different hours of sampling. This was due to the fact that the higher value for an individual sample on a day was compensated by a relatively lower value in the corresponding sample on the other day.

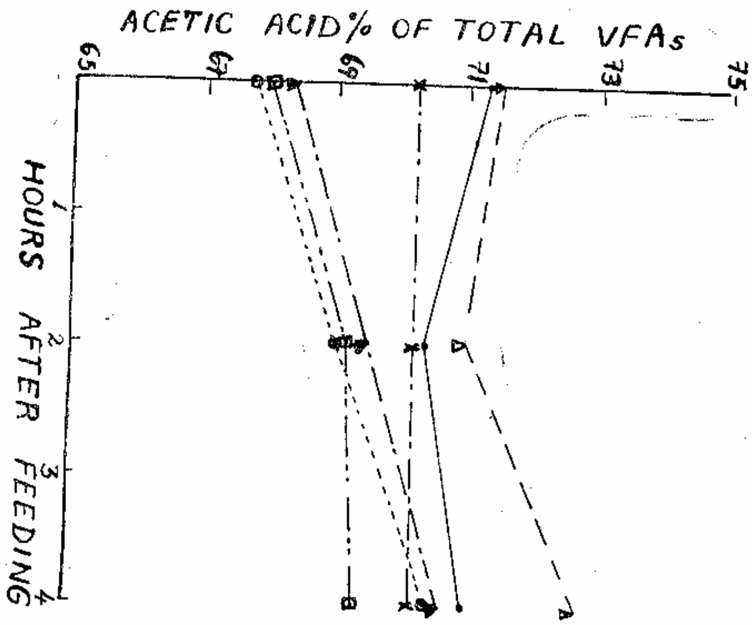

FIG.3 ACETIC ACID% IN RUMEN FLUID

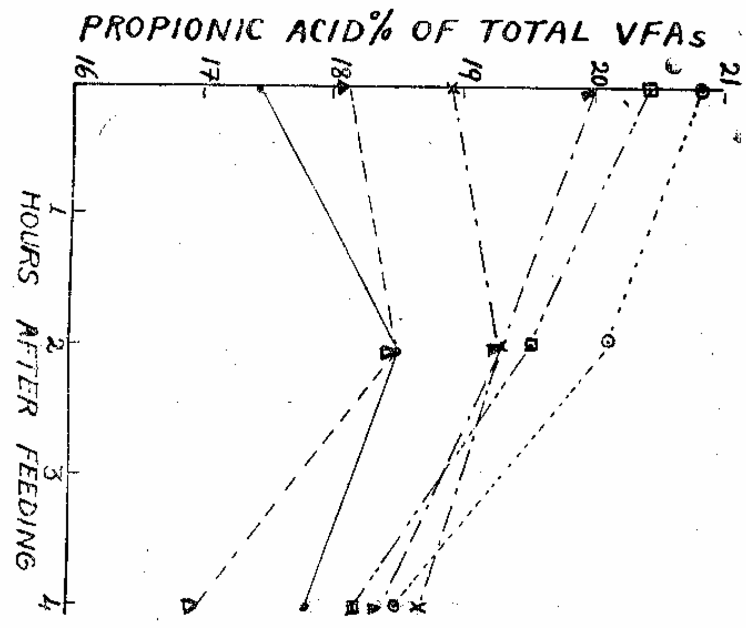

FIG.4 PROPIONIC ACID% IN RUMEN FLUID

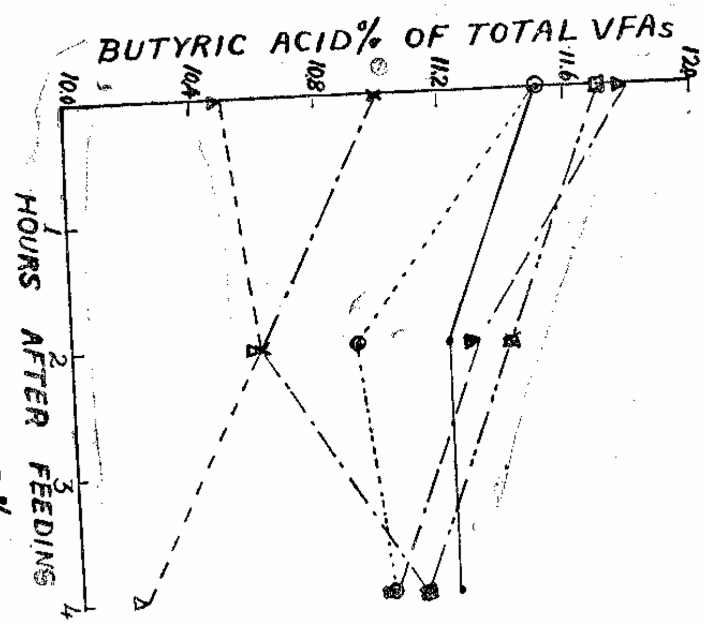

FIG.5. BUTYRIC ACID% IN RUMEN FLUID

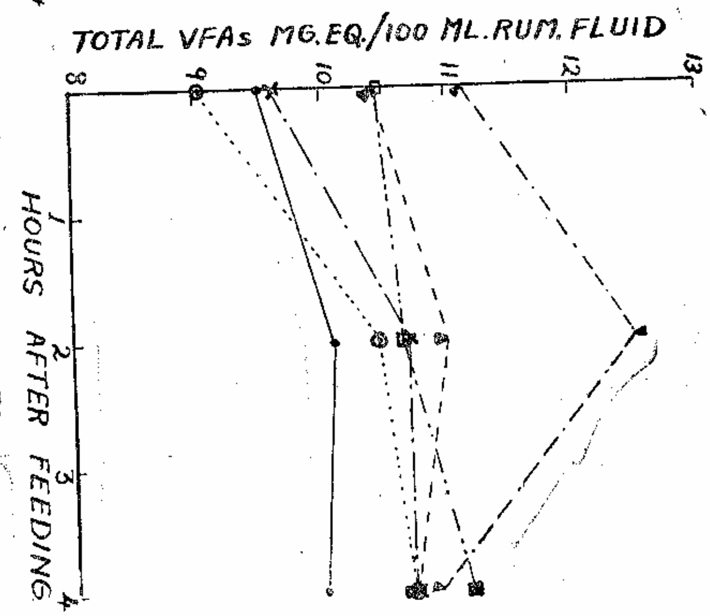

FIG.6 TOTAL VFAs IN RUMEN FLUID.

TABLE 4.—MOLAR PROPORTIONS OF VOLATILE FATTY ACIDS IN CONSECUTIVELY DRAWN SAMPLES OF COW'S RUMEN FLUID.

Period	Date of sampling	Daily ration (Kg)			Acetic Acid %				Propionic Acid %				Acetate : Propionate (: 1)			
		Hay	Conc. (unheated)	Conc. (heated)	Hours after feeding			period mean	Hours after feeding			period mean	Hours after feeding			period mean
					0	2	4		0	2	4		0	2	4	
1	19/4/66	7	5	0	70.6	71.1	71.5		18.1	18.1	17.9		3.90	3.93	3.99	
	20/4/66	7	5	0	71.9	69.7	70.6		16.6	18.8	17.7		4.33	3.71	3.99	
					71.3	70.4	71.1	70.9	17.4	18.5	17.8	17.9	4.10	3.81	3.99	3.97
2	29/4/66	7	4	1	71.2	70.0	69.6		18.5	19.9	19.3		3.85	3.52	3.61	
	30/4/66	7	4	1	69.1	70.4	70.9		19.2	18.6	18.1		3.60	3.78	3.92	
					70.2	70.2	70.3	70.2	18.9	19.3	18.7	19.0	3.71	3.64	3.76	3.70
3	9/5/66	7	3	2	70.4	70.6	73.1		18.9	18.6	16.6		3.72	3.80	4.40	
	10/5/66	7	3	2	72.5	71.3	72.4		17.3	18.3	17.4		4.19	3.90	4.16	
					71.5	71.0	72.8	71.8	18.1	18.5	17.0	17.9	3.95	3.84	4.28	4.02
4	19/5/66	7	2	3	67.7	69.9	70.9		20.8	19.7	18.2		3.25	3.55	3.90	
	20/5/66	7	2	3	67.7	68.1	70.0		20.8	20.4	18.8		3.25	3.34	3.72	
					67.7	69.0	70.5	69.1	20.8	20.1	18.5	19.8	3.25	3.43	3.81	3.50
5	29/5/66	7	1	4	67.7	69.2	69.9		20.2	19.3	18.6		3.35	3.59	3.76	
	30/5/66	7	1	4	68.0	69.2	68.8		20.6	19.6	17.7		3.30	3.53	3.89	
					67.9	69.2	69.4	68.8	20.4	19.5	18.2	19.4	3.33	3.55	3.81	3.56
6	8/6/66	7	0	5	68.1	69.8	71.5		20.2	19.1	17.4		3.37	3.65	4.11	
	9/6/66	7	0	5	68.5	69.1	69.8		19.8	19.4	19.4		3.46	3.56	3.60	
					68.3	69.5	70.7	69.5	20.0	19.3	18.4	19.2	3.42	3.60	3.84	3.62
(Time of sampling) mean					69.5	69.9	70.8		19.3	19.2	18.1		3.63	3.65	3.92	

TABLE 4. *(contd.)*—Molar proportions of volatile fatty acids in consecutively drawn samples of cow's rumen fluid.

Period	Date of sampling	Daily ration (Kg)			Butyric Acid %				Total VFAs mg. eq/100 ml. rumen fluid.			
		Hay	Conc. (unheated)	Conc. (heated)	Hours after feeding			period mean	Hours after feeding			period mean
					0	2	4		0	2	4	
1	19/4/66	7	5	0	11.3	10.9	10.6		10.16	10.15	10.51	
	20/4/66	7	5	0	11.6	11.5	11.7		8.85	10.07	9.53	
					11.5	11.2	11.2	11.3	9.51	10.11	10.02	9.88
2	29/4/66	7	4	1	10.3	10.1	11.1		10.10	10.79	11.05	
	30/4/66	7	4	1	11.7	11.0	11.0		9.04	10.58	10.27	
					11.0	10.6	11.1	10.9	9.57	10.69	10.66	10.31
3	9/5/66	7	3	2	10.8	10.8	10.2		10.34	11.02	10.49	
	10/5/66	7	3	2	10.2	10.4	10.2		10.41	11.01	10.83	
					10.5	10.6	10.2	10.4	10.38	11.02	10.66	10.69
4	19/5/66	7	2	3	11.5	10.3	11.0		9.01	10.58	10.64	
	20/5/66	7	2	3	11.5	11.5	11.0		9.01	10.29	10.79	
					11.5	10.9	11.0	11.1	9.01	10.44	10.72	10.06
5	29/5/66	7	1	4	12.0	11.5	11.5		10.81	10.46	10.30	
	30/5/66	7	1	4	11.4	11.2	10.7		10.08	10.84	12.03	
					11.7	11.4	11.1	11.4	10.45	10.65	11.17	10.76
6	8/6/66	7	0	5	11.7	11.1	11.1		11.31	12.09	10.61	
	9/6/66	7	0	5	11.8	11.5	10.9		10.96	12.86	11.21	
					11.8	11.3	11.0	11.4	11.14	12.48	10.91	11.51
(Time of sampling) mean					11.3	11.0	10.9		10.01	10.90	10.69	

The analysis of variance (Table 5) showed that the differences in the mean molar proportions of acetic acid in the rumen fluid were significant between the periods ($P < 0.01$) and also between the sampling hours ($P < 0.05$).

Propionic Acid

The data in Table 4 show that in the first period, the mean values for propionic acid molar proportions were 17.4, 18.5 and 17.8% in the rumen fluid samples taken 0·2 and 4 hours after feeding time, respectively. The corresponding values, in the last period were 20.0, 19.3 and 18.4%. It was noticed that the molar proportions of propionic acid in the rumen fluid increased gradually, with some fluctuations, by increasing the percentage of the heated concentrate in the daily ration. The highest values were attained in the fourth period, where 60% of the concentrate was given after it had been heated. However, the proportion of propionic acid in the rumen fluid sample taken 4 hours after feeding in this period, was slightly below that of the corresponding sample in the second period. A little decrease was noticed in the molar proportion of propionic acid in the rumen fluid samples taken during the last two periods in comparison with those of the fourth period.

Concerning the concentration of propionic acid throughout the feeding cycle, it was found that the highest values were obtained in the rumen fluid samples taken 2 hours after feeding in the first three periods, and just after feeding during the last three periods (Fig. 4). The minimum values for propionic acid molar proportion were obtained in the rumen fluid samples taken 4 hours after feeding time. This was noted in all the experimental periods except the first period.

The difference in the mean molar proportions of propionic acid in the rumen fluid were found to be statistically significant ($P < 0.01$) between the periods and also between the sampling hours after feeding time ($P < 0.01$) Table 5).

Acetate to Propionate Ratio

Reference to Table 4 shows that, with the unheated concentrate in the first period, the mean ratios of acetic acid to that of propionic on molecular basis were 4.10 :1, 3.81 : 1 and 3.99 : 1 in the rumen fluid samples taken 0·2 and 4 hours, after feeding, respectively. The corresponding mean ratios on the completely heated concentrate, in the last period were 3.42 : 1, 3.60 : 1 and 3.84 : 1. By increasing the percentage of heated concentrate in the daily ration throughout the intermediate experimental periods, the molar proportion of acetic acid decreased while that of propionic increased.

As a consequence, the ratio of acetate to propionate decreased and became narrower gradually with some fluctuations. However, there was an abnormal increase in the ratio of acetate to propionate in the rumen fluid

TABLE 5.—ANALYSIS OF VARIANCE

Source of Variation	Degrees of freedom	pH			Ammonia			Acetic Acid			Propionic Acid		
		Sum of squares	Mean squares	F	Sum of squares	Mean squares	F	Sum of squares	Mean squares	F	Sum of squares	Mean squares	F
Periods	5	0.20	0.04	13.33†	27.15	5.43	1.22	19.53	3.91	8.00†	9.59	1.92	5.68†
Hours after feeding	2	0.01	0.005	1.67	367.42	183.71	41.29†	5.46	2.73	5.63*	5.15	2.58	7.63†
Experimental error	10	0.03	0.003		44.49	4.449		4.85	0.485		3.38	0.338	
Total	17	0.24			439.06			29.84			18.12		

Source of Variation	Degrees of freedom	Acetate : Propionate			Butyric Acid			Total VFAS		
		Sum of squares	Mean squares	F	Sum of squares	Mean squares	F	Sum of squares	Mean squares	F
Periods	5	0.71	0.14	6.67†	2.06	0.41	9.11†	5.20	1.04	5.12*
Hours after feeding	2	0.32	0.16	7.62†	0.55	0.28	6.22*	2.59	1.30	6.40*
Experimental error	10	0.21	0.021		0.45	0.045		2.03	0.203	
Total	17	1.24			3.06			9.82		

* Significant at level of 5%.
† Significant at level of 1%.

samples representing the third period. The narrowest acetate to propionate mean ratios were found in the last three periods in the rumen fluid samples taken 0 and 2 hours after feeding where the molar proportions of acetic acid reached the minimum values and the molar proportions of propionic acid reached the maximum.

The differences noted in the ratios of acetate to propionate in the rumen fluid were found to be statisticaly significant between the periods ($P < 0.01$) and also between the sampling hours after feeding time ($P < 0.01$) Table 5.

It was interesting to find that the values for acetic and propionic acid proportions varied inversely. This agrees with the observations of Balch and Rowland (1957) ; and McCallough (1966). The latter found a negative correlation of (— 0.867) between the molar percentage of acetic acid and that of propionic in the rumen fluid. On the other hand the increase and the decrease in the molar proportions of acetic and propionic acids, respectively, showed in Figs. 3 and 4 in different sampling hours after feeding are generally in accordance with the findings of Rhodes and Woods (1962), who noted that with most rations fed to lambs, acetate increased with time to reach the peak approximately 4 hours after feeding while propionate decreased. However, the present observations differ from those reported by Reid *et al.* (1957).

It can be concluded that increasing the percentage of heated concentrate in the daily ration of the cow decreased the molar proportion of acetic acid and increased the molar proportion of propionic acid, and made narrow the acetate to propionate ratio in the rumen fluid. These results are generally in agreement with the findings of Phillipson (1952), with lambs, Eusebis *et al* (1959) with Holstein heifers and Balch and Rowland (1957) with dairy cows, all using high proportions of flaked maize.

Butyric Acid

The data in Table 4 chow that, in the first period with hay and unheated concentrate, the mean molar proportions of butyric acid were 11.5, 11.2, and 11.2% in the rumen fluid samples taken 0,2 and 4 hours after feeding. The corresponding mean values on the final ration of hay and completely heated concentrate were11.8, 11.3, and 11.0%. It is evident that the differences between the values in the two periods are rather small. It was noticed that the concentraions of butyric acid in the rumen fluid samples decreased gradually by increasing the percentage of the heated concentrate in the ration till the third period, where the lowest values were attained. Then there was an increase in butyric acid concentration during the last three periods. The analysis of variance (Table 5) indicated that the differences noted during the successive experimental periods between the mean values of butyric acid molar proportions were significient ($P < 0.01$). However, the range of variation was rather small (10.4—11.4). It has been reported by Phillipson (1952), that low values of butyric acid were found in the rumen fluid of lambs fed a diet high in flaked maize. Eusebis *et al.* (1959), also noted the same observation with Holstein heifers but when the ration of flaked corn was supplemented with linseed oil meal, the molar proportion of butyric acid increased markedly. In the light of these findings, the present results can be explained that the presence of relatively high percentage of linseed oil meal (43%) in the concentrate mixture would have hindered the depressive effect of the heated maize meal on the molar proportion of butyric acid. On the other hand, Bath and Rook (1963), found that when hafl the hay was replaced by flaked maize the molar proportions of propionic, butyric and valeric acids increased and that of acetic acid decreased.

Concerning the cocentration of butyric acid throughout the feeding cycle, it was found that the rumen fluid samples taken just after feeding contained the highest concentrations of butyric acid in all the experimental periods except the 2nd and3rd periods where they contained nearly the same proportions of those taken 4 and 2hours after feeding, respectively. On the other hand, the lowest mean concentrations of butyric acid were obtained in the rumen fluid samples taken 4 hours after feeding in the 3rd, 5th and 6th periods, and two hours earlier in the 1st, 2nd and 4th periods. The differences in the mean butyric acid molar proportions between sampling hours after feeding time were found to be statistically significant, $P < 0.05$ (Table 5). The present results differ from those reported by Rhodes and Woods (1962), that butyric acid remained fairly constant after feeding time.

Total Volatile Fatty Acids

The lowest concentrations of total VFAs were attained i nthe first period with the unheated concentrate, with the exception of the first sample which contained more total VFAs than the corresponding sample in the fourth period (Table 4). By increasing the percentage of the heated concentrate in the daily ration, the concentration of the total VFAs in the rumen fluid samples increased gradually wih some fluctuations in the successive periods to reach the maximum in the last period, where the completely heated concentrate was fed. However, the rumen fluid sample taken 4 hours after feeding in this period contained slightly lower concentration of total VFAs than the corresponding sample in the fifth period. The mean values were 9.51, 10.11 and 10.02 mg. equiv.per 100ml. in he first period, and 11.14, 12.48 and 10.91 mg. equiv./100ml in the last period, in the rumen fluid samples taken 0, 2 and 4 hrs. after feeding, resplctively. The differences found in the mean concentrations of total VFAs in the rumen fluid due to the change of the heated to unheated concentrate ratios were statistically significant ($P < 0.05$) Table 5.

The rumen fluid samples taken just after feeding contained the lowest concentrations of total VFAs in all experimental periods except in the last period where the first samples contained slightly higher content of VFAs than the third sample taken 4 hours later in the same period. It was noticed that the concentration of total VFAs increased after feeding (Fig. 6) due to increased fermentation and subsequently a decrease took place as fermentation declined. The highest concentrations of total VFAs were attained in the rumen fluid samples taken 2 hours after feeding in the experimental periods 1, 2, 3 and 6 and in the samples taken 4 hours after feeding in the periods 4 and 5. The differences noted in the mean concentrations of total VFAs in the rumen fluid between the hours of sampling after feeding were found to be statistically significant ($P < 0.05$) Table 5.

The mean concentrations of total VFAs found in the rumen fluid in the last period with 7 kg. hay and 5 kg heated concentrate (*i. e.* 11.14, 12.48 and 10.91 mg. equiv/100 ml.) were higher than han the average value of 10.73 ± 0.32 mg. equiv/100 g. reported by Van Adrichem (1962), with cows fed 4 kg. of cooked maize meal in addition to hay and concentrates. It was interesting to notice that the concentration of the total VFAs in the rumen fluid fluctuated inversely with the pH, the lowest mean VFA values found in the first period coincided with thl highest pH mean values obtained in this period, and the opposite was noticed in the last period. (Tables 3 and 4). Similar observations were reported by Balch and Rawland (1957), with dairy cows on variety of rations and by Van Adrichem (1962), who found a negative correlation of —0.94 between the pH and the total VFAs formed in the rumen.

In can be concluded that increasing the percentage of heated concentrate in the daily ration, in the successive experimental periods resulted in a decrease in the pH, ammonia and the molar proportion of acetic acid in the rumen fluid. At the same time, there was an increase in the molar proportion of propionic acid and in the total VFAs. The response of the molar proportion of butyric acid was different, it decreased during the first three periods then increased during the rest periods.

Though the differences in the pH and individual VFAs between the experimental periods were statistically significant ($P < 0.01$) yet the ranges of variation were rather small. These might have been due mainly to the following facts :

1. The hay was given in sufficient quantity, (7 kg. daily) and in the long form. Ensor *et al.* (1959), reported that the effect of heated maize on the fat content of milk and on thl ruminal VFAs was reduced greatly when long hay was fed in addition.

2. The concentrates were fed in a moderate quantity (5 kg. daily) and contained moderate percentage of starch-rich ingredients (Maize and barley, 51.6%). Moreover, the concentrates were neither pelletted nor finely ground.

The significant differences found, in the present investigation, in the total and molar proportions of volatile fatty acids in the rumen fluid, between the hours of sampling after feeding time, are generally in agreement with the findings of Bath and Rook (1963) ; Martin and Wing (1966). It is interesting that the last two workers found a significant linear change in the molar proportions of the VFAs produced in the rumen after feeding time. However, Shaw (1961), reported that the variations in the molar proportions of the individual volatile fatty aids throughout a feeding cycle are in general small and he considers that a single sample of rumen fluid drawn at any time throughout a feeding cycle is usually adequate to characterize a diet. However, Bath and Rook (1963), did not agrle with Shaw in this respect as they observed a range from 66.9 to 73.0 and from 60.9 to 67.4 for the molar proportion of acetic acid in the rumen fluid on rations of hay and of hay and concentrates, respectively, given in two feeds daily at 12 hours intervals. For this reason, they prefer the sampling of the digesta to be carried out at regular intervals throughout a feeding cycle in order to avoid gross error. In the present work, the range of variation in acetic acid molar proportion, in the rumen fluid after feeding time, was much smaller than those reported by Bath and Rook (1963). Sampling the rumen fluid at regular intervals after feeding seems to be more important for ammonia than for VFA determinations, according to the present findings.

It is recommedend to carry out more research in the U.A.R. to investigate the effects of local feed stuffs and feeding practices on the ammonia and volatile fatty acids in the rumen fluid of sheep and dairy cattle due to their great importance upon animal performance.

Acknowledgements

I wish to express my deep thanks, and gratitude to Ir. F. de Boer, Director of Instituut Voor Veevoedingsonderzoek "Hoorn", and to the members of his staff especially Dr. P. M. Van Adrichem for their cooperation and for the facilities given throughout this work.

REFERENCES

Annison, E.F., Chalmers, M.I., Marshall, S.B.M. & Synge, R.L.M. (1954). *J. Agric. Sci.*, **44**, 270.

A.O.A.C. (1950). *"Official Methods of Analysis"* 7th ed.

Armstrong, D.G. & Blaxter, K.L. (1957). *Brit. J. Nutr.* **11**, 247, 413.

Baloh, D.A. & Rowland, S.J. (1957). *Brit. J. Nutr.*, **11**, 288.

Bath I.H. & Rook, J.A.F. (1963). *J. Agric. Sci.* **61**, 341.

Briggs P.K., Hogan J.P. & Reid R.L. (1957). *Austral. J. Agric. Res.* **8**, 674.

Butz, H, Mayer H. & Schulken C. (1958). *Berl. Munch. Tierarztl. Wochemscher.* **71**, 163. (*Nutr. Abstr.& Rev.* **28** 1105 1958).

Cardon, B.P. (1963). *Proc. Am. Feed Mfrs. Assoc. Nutr., Council* Dec. 11.

Chalmers M.I. & Synge, R.L.M. (1954). *J. Agric. Sci.*, **44**, 263.

Elsden, S.R. & Phillipson A.T. (1948) *Ann. Rev. Biochem.*, **17**, 705.

El-Shazly, K. (1952). *Biochem. J.* **51**, 640, 647.

Ensor, W.L. (1959). *Doctorate thesis University of Maryland.*

Ensor, W.L. Shaw, J.C. & Tellechea H.F. (1959). *J. Dairy Sci.*, **42**, 189.

Erwin, E.S. Marco, G.J. & Emery E.M. (1961). *J. Dairy Sci.*, **44**, 1768.

Eusebis, A.N. Shaw, J.C., Leffel E.C., Lakshmanan S. & Doetsch R.N. (1959). *J. Dairy Sci.*, **42**, 692.

CRAY F.V. (1947). *J. Exp. Biol* **24,** 1, 15.

JORGENSEN, N.A. & SCHULTZ L.H. (1963). *J. Dairy Sci.,* **46,** 437.

JORGENSON N.A. SCHULTZ L.H. & BARR G.R. (1965). *J. Dairy Sci.* **48,** 1031.

KING R.L. & HEMKEN R.W. (1962). *J. Dairy Sci.* **45,** 1336.

MARTIN R.J. & WING J.M. (1966). *J. Dairy Sci.* **49.** 846.

MCCULLOUGH M.E. (1966). *J. Dairy Sci.* **49,** 896.

MCDONALD I.W. (1952). *Biochem. J.* **51,** 86.

MONROE, C.F. & PERKINS, A.E. (1939). *J. Dairy Sci.,* **22,** 983.

PHILLIPSON, A.T. (1952). *Brit. J. Nutr.* **6,** 190.

PHILLIPSON, A.T., DOBSON, M.J. & BLACKBURN T.H. (1959). *Nature,* **183,** 402.

REID, R.L., HOGAN, J.P. & BRIGGS, P.K. (1957). *Austral. J. Agric. Res.,* **8,** 691.

RHODES, R.W. & WOODS W. (1962). *J. Animal Sci.* **21,** 483.

ROOK, J.A.F. (1961). *A Review, Dairy Sci. Abstrs.* **23,** 251, 303.

SHAW, J.C. (1961). *Proc. VIII Intern. Tierzuchkongres, Hamburg.*

SHAW J.C. ROBINSON, R.R. SENGER, M.E. LAKSHMANAN, S. & LEWIS, T.R. (1959). *J. Nutr.,* **69,** 235.

SHAW, J.C., ENSOR, W.L., TELLECHEA, H.F. & LEE, S.D. (1960). *J. Nutr.* **71,** 203.

VAN ADRICHEM, P.W.M. (1962). *Doctorate thesis, University of Utrecht.*

VAN SOEST, P.J. (1963). *A Review, J. Dairy Sci.,* **46,** 204.

تأثير التغذية بنسب مختلفة من المخلوط المركز المعامل وغير المعامل بالحرارة على محتويات سائل الكرش في البقرة من الأحماض الدهنية الطيارة والأمونيا ورقم الاس الايدروجيني *

محمد السعيد صالح يوسف

الملخص

استعملت بقرة فريزيان بفتحة كرش صناعية لدراسة تأثير التغذية بعليقة من الدريس غير المقطع مع نسب مختلفة من مخلوط مركز معامل وغير معامل بالحرارة على محتويات سائل الكرش من الأحماض الدهنية الطيارة والأمونيا ورقم الاس الأيدروجيني .

وقد وجد أنه بزيادة نسبة المخلوط المركز المعامل بالحرارة من صفر الى ١٠٠٪ في العليقة اليومية قد زادت جملة الأحماض الدهنية الطيارة في المتوسط من ٩٫٨٨ الى ١١٥٫١ مللجرام مكافىء/١٠٠ سم٣ من سائل الكرش على التوالي كما ارتفعت نسبة حمض البربيونيك من ١٧٫٩ الى ١٩٫٢٪ بينما انخفضت نسبة حمض الخليك من ٧٠٫٩ الى ٦٩٫٥٪ وضاقت نسبة الخليك : البربيونيك من ٣٫٩٧ : ١ الى ٣٫٦٢ : ١ وبالاضافة الى ذلك انخفض رقم الاس الأيدروجيني من ٦٫٧١ الى ٦٫٣٨ كما انخفضت الأمونيا من ٢١٫٤ الى ١٩٫٧ مللجرام/١٠٠ سم٣ .

وقد وجدت الاختلافات في رقم الاس الأيدروجيني وفي نسب حمض الخليك والبروبيونيك والبيوتريك بين فترات التغذية على النسب المختلفة من المخلوط المركز المعامل وغير المعامل بالحرارة وجدت مؤكدة احصائيا (تحت احتمال ١٪) بينما وجدت الفروق في الأمونيا غير مؤكدة احصائيا . ومن الناحية الأخرى وجدت الاختلافات في الأمونيا وفي الأحماض الدهنية الطيارة فردية وجملة بين ساعات أخذ العينات بعد وقت التغذية وجدت مؤكدة احصائيا بينما كانت الفروق بينها بالنسبة لرقم الاس الأيدروجيني غير مؤكدة احصائيا .

(*) أجرى هذا البحث في معهد « هورن » لأبحاث تغذية الحيوان في هورن بهولنده .

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METABOLISM OF ^{45}Ca IN LAMBS

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Six growing fat tailed Aussimi lambs were experimented on to study the effect of different dietary calcium levels upon stable and radioactive calcium. These lambs were divided into three equal groups. One group received the normal ration while the other two groups received the supplemented and the deficient ration.

Three months after the beginning of the experiment, each lamb received 0.5 mc. ^{45}Ca as $^{45}Ca\ cl_2$ as a single dose intravenously. Blood samples, feces and urine were collected at different intervals. Seven days after the isotope administration, lambs were weighed and slaughtered. Some selected tissues were taken for chemical and radioactive calcium assay.

Total absorption and retention of radioactive calcium increased in deficient lambs. Calcium status of the animal affected the endogenous fecal losses. The apparent availability of calcium was 9.87, 0.376 and 14.26% while the true availability was 75.00, 5.65 and 17.20% for deficient, normal and supplemented animals respectively. About 1.77, 1.57 and 1.14 percent of the plasma calcium of deficient, normal and supplemented lambs were returning per hour from the extravascular calcium.

Calcium content in the different parts of the body was affected by the dietary calcium level; being the least for the deficient lambs and the highest for the supplemented ones. The bones, especially the shaft may be the main organ controlling the calcium storage in the animal body.

Calcium and phosphorus are required for the formation of bones and teeth. Calcium is present in body cells and in some ways necessary for their functioning.

Bone breaking strength, growth data, blood values, and apparent digestibility have been used as supporting criteria for determining the calcium status of animals in relation to dietary treatment. These methods did not indicate exactly the true availability of calcium. Advances in radioisotope procedures have permitted the quantitative differentiation between the portion of dietary calcium that passes unabsorbed through the gastrointestinal tract and the metabolized excreted calcium ; thereby making possible a simple and direct means of the quantitative separate estimation of the endogenous and exogenous calcium fractions in the feces of the normal intact animal.

This work was undertaken to study the effect of different dietary calcium levels upon stable and radio-calcium ^{45} Ca in growing lambs under controlled conditions, to determine the endogenous calcium loss, and calculate the true calcium availability.

Kirkpatric and Robertson (1953), found that low concentration of calcium in the ration produces rickets in young animals, osteomalacia, hyperirretability and tetany in mature ones, while high concentration causes depression of nerve conductivity and muscle rigor.

Hansard *et al.* (1952), concluded that ^{45}Ca was excreted in both feces and urine, and fecal calcium consisted of unabsorbed calcium together with calcium which was absorbed and reexcreted.

Gallup and Briggs (1950), proved that calcium maintenance requirements must be slightly greater than the phosphorus requiements. There have been variation in procedures used for the measurements of calcium availability for the various species. Comar *et al.* (1953), used ^{45}Ca to estimate the true digestibility.

Hansard *et al.* (1954), stated that the metabolic fecal calcium in ruminants makes up the major portion of the total calcium loss from the body. The requirement for growth, pregnancy, and lactaion may be estimated directly by product analysis. Therefore, the summation of these and the maintenance requirements should equal the net requirement.

Experimental and Methods

1. *Animals* :

Six growing fat tailed Aussimi lambs were used in this work. They were six months old with an aveage weight of 23 kg. These lambs were divided into three equal groups. One group received the normal ration, while the other two groups received the supplemented and the deficient ration respectively. The composition of lambs' rations given daily was as shown in the following table :

Ingredients	Normal group	Supplemented group	Deficient group
Clover hay (gm.)	1000	1000	——
Calcium carbonate (gm.) . . .	——	15	——
Yellow corn (gm.)	——		500
Calcium % in the ration . . .	1.225	1.771	0.0186

(*) Water was offered ad lib for each group.

2. Application of Radioisotope :

After three months from the start of the experiment, each lamb received quantitatively 0.5 mc. ^{45}Ca as ^{45}Ca cl_2 as a single dose intravenously in the jugular vein.

Concurrent 7 days, chemical and radioisotope balance studies were started at the time of dosage. Blood samples. feces and urine were collected at different intervals. Seven days after the isotope administration, lambs were weighed and slaughtered.

Some selected tissues were taken for chemical and radio-calcium assay. Since ^{45}Ca is a low energy beta emitter, and for eliminating the problem of self absorption, the standard solution samples for plasma, ash solution of soft tissues, bones and feces were prepared and counted as reported by Thomas *et al.* (1952). The radioactivity of samples was measured using a thin mica end window counter tube and scaler.

3. Calcium determination :

To get rid of phosphate ions calcium solutions of biological material samples were managed as the A.O.A.C. (1955). Calcium determination in the ash solution of biological materials, urine and in plasma was carried out using EDTA (Ethylene diamine tetra acetic acid) and ammonium purpurate indicator as described by Greenblatt and Hartman (1951).

4. Calculation :

All radioisotope values, except those for excreta, were calculated to an equivalent body weight basis and corrected to percentage of retained radioactivity, thus permitting the measurement of the comparative behaviour of the activity absorbed by lambs' body. Endogenous fecal calcium, true availability and calcium maintenance requirements were calculated as stated by Hansard *et al.* (1957).

Results and Discussion

^{45}Ca excretion and retention :

The average urinary ^{45}Ca out put for normal and supplement lambs were about 2.48 and 2.30 times as that of the deficient animals. The averages of ^{45}Ca out put in feces of the previous two groups of lambs were about 1.11 and 1.68 times as that of the deficient ones. ^{45}Ca percentage excreted in feces of lambs was more than that excreted in urine as shown in table (1). These results are in good agreement with those obtained by Hansard *et al.* (1954).

TABLE 1.—CUMULATIVE RADIOACTIVE CALCIUM PERCENTAGE EXCRETED IN FECES AND URINE OF LAMBS DURING 7 DAYS BALANCE TRIAL PERIOD.

Hours after injection	FECES			URINE		
	Deficient	Normal	Supplemented	Deficient	Normal	Supplemented
	%	%	%	%	%	%
24	4.05	5.06	10.37	0.07	0.27	0.31
48	6.82	7.92	13.66	0.13	0.45	0.45
72	8.60	9.93	15.83	0.18	0.57	0.54
96	9.73	10.94	17.45	0.23	0.66	0.61
120	10.43	11.69	18.10	0.27	0.73	0.67
144	10.97	12.19	18.59	0.31	0.78	0.72
168	11.23	12.49	18.96	0.34	0.82	0.76

The total radioactive calcium percentage excreted in both feces and urine was 11.57, 13.31 and 19.72 in case of deficient, normal and supplemented lambs respectively. This means that the radioactive calcium percentage retained at 7 days after administration was equal to 88.43, 86.69 and 80.28 in the previous group of animals respectively.

It appeared that the retention of calcium eppears to be related to the body requirement, for it increases in the depleted animals. These results are in harmony with those obtained by Henry and Kon (1953).

True availability of Calcium and maintenance requirement :

The results obtained from concurrent chemical and radioactive calcium studies for true availability of calcium and maintenance requirement are shown in table (2).

Calcium deficient animals excreted the highest percentage of calcium from the body stores, being 72.36%. The total fecal calcium excreted from metabolic sources increased in lambs maintained on the highest calcium diet being 14.698 gm. this is in agreement with the results of Mitchell and Curtzon 1939). It can be noticed that the high endogenous fecal calcium loss in the normal lambs (0.645 gm/day) tended to mas the true availability value (5.65%). These results further illustrate the ability of the growing lambs to adjust their metabolic losses according to the dietary calcium available from both endogenous and exogenous sources, either by increasing absorption or by more retention of that calcium normally absorbed and reexcreted into the gastrointestinal tract.

TABLE 2.—CALCIUM BALANCE FOR LAMBS MAINTAINED ON DIFFERENT DIETARY LEVELS OF CALCIUM.

Item	Deficient	Normal	Supplemented
Calcium content in the ration (%). . .	0.018	1.224	1.771
Daily calcium intake (gm).	0.084	12.245	17.133
Daily fecal calcium excretion (gm). . .	0.076	12.199	14.698
Daily urinary calcium excretion (gm).	0.020	0.027	0.032
Apparent availability (%).	9.87	0.376	14.26
Calcium balance (gm).	—0.012	+0.019	+2.403
Total ^{45}Ca excretion (% of dose) . . .	11.57	13.31	19.72
^{45}Ca retained at 7 days after dosing (%)	88.43	86.69	80.28
Endogenous fecal calcium (% of total).	72.36	5.3	3.47
Endogenous fecal calcium (gm/day) . .	0.055	0.645	0.511
True availability (%)	75.00	5.65	17.20
Calculated calcium requirement for-maintenance (gm/day).	0.076	11.415	2.97

True availability of calcium from clover hay plus calcium carbonate tended to be higher than that from clover hay alone.

This may be due to the presence of calcium binding-substances in hay that decreased the availability of absorption. Hansard *et al.* (1957), stated that ground limestone and calcium carbonate as sources of calcium were intermediate between bone meal and hay.

It can be concluded that the value of a feed as a source of calcium depends not only upon the calcium content, but also on the availability of calcium which can be used by the animal.

It is of interest to notice that the requirement of calcium for maintenance at the various levels of dietary calcium intake varied with the nutritional status of the animal. This requirement was closely associated with the ability of the animal to adjust its endogenos losses to its mineral intake level as shown in table (2).

Total calcium and ^{45}Ca in the plasma :

The average plasma calcium values were 10.65, 8.63 and 5.83 mg/100ml. for deficient, normal and supplemented lambs respectively. These results are in harmony with Yasseen (1958) who found that the plasma calcium value was the highest in the deficient animals and it was the least in the supplemented ones.

The ^{45}Ca uptake percentage by plasma of deficient, normal and supplemented lambs are shown in figure (1).

Data for the 24 up to 168 hours period were analysed using the procedure of Conrad and Hansard (1957).

The following exponential equations were found to represent radiocalcium disappearance from the plasma from 24 up to 168 hours after dosing :

Deficient lambs $C_{(t)} = 100\ e^{-0.0177\,t}$

Normal lambs $C_{(t)} = 100\ e^{-0.0157\,t}$

Supplemented lambs $C_{(t)} = 100\ e^{-0.0115\,t}$

Were $C_{(t)}$ is the uptake percentage of the injected dose in the plasma at time (t).

The turnover rate for radioactive calcium calculated by the formula established by Thomas *et al.* (1952), showed that the plasma radioactive calcium in the deficient lambs disappeared faster than that of both normal and supplemented lambs. It can be noticed that approximately 1.77, 1.57 and 1.15 percent of the plasma calcium (measured as ^{45}Ca) left the blood stream per hour in deficient, normal and supplemented lambs respectively.

Since the plasma calcium level remained constant, an amount of calcium equals to 1.77, 1.57 and 1.15 persen of the plasms calcium returned from the extravascular calcium per hour.

Total calcium and ^{45}Ca in different tissues :

In general the calcium content in the different parts of the body was affected by the dietary calcium level, being the least for the deficient lambs and the highest for the supplemented ones as show in table (3).

Statistical analysis showed that the differences were insignificant.

There were differences in ^{45}Ca concentration in the different tissues, but slight variations were observed among the different groups. The bones, especially the shafts contained the highest amount of calcium ; they are the main organs controlling the calcium storage in the animal body.

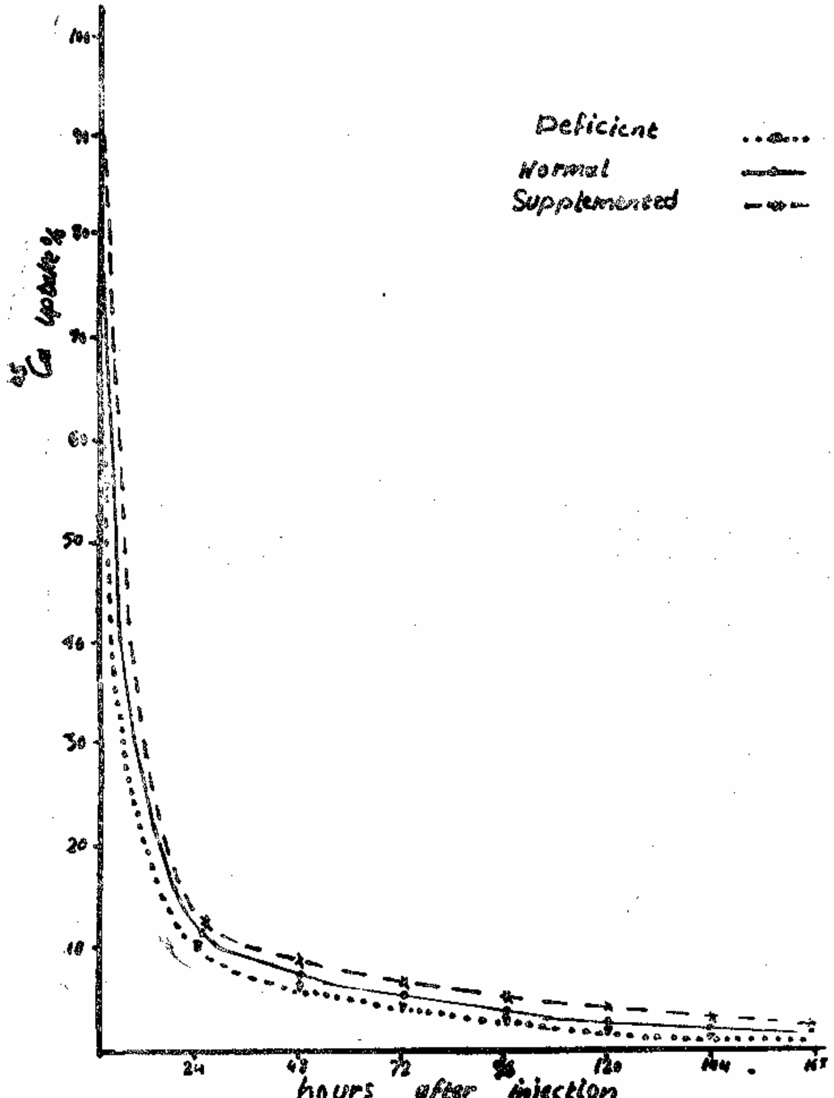

FIG. 1.—45Ca uptake % by lambs' plasma

In this connection Hansard and Plumlee (1954), found little differences between groups of rats in radioactive calcium percentage retained by the various bones and soft tissues. They added that a higher percentage of the ^{45}Ca dose was absorbed by rats on the lower calcium diet.

TABLE 3.—THE EFFECT OF DIFFERENT DIETARY CALCIUM LEVELS UPON CALCIUM CONTENT AND ^{45}Ca UPTAKE PERCENT IN SELECTED LAMBS' TISSUES.

Tissue	Deficient		Normal		Supplemented	
	Ca* Content	45 Ca Uptake%	Ca Content	45 Ca Uptake%	Ca Content	45 Ca Uptake%
Liver	0.0887	2.15	0.1078	2.06	0.1082	2.75
Kidney	0.0311	2.64	0.0560	3.10	0.0594	2.42
Brachialis muscle	0.0192	2.69	0.0196	1.23	0.0256	1.84
Gluteus muscle	0.0182	2.66	0.0220	1.24	0.0206	1.41
Tibia-bone head	11.8300	953.0	15.8930	462.0	18.2220	422.0
Tibia-bone shaft	27.6740	561.0	30.2700	227.0	35.6080	270.0

* mg Ca/gm fresh tissue.

REFERENCES

A.O.A.C. (1955).—"*Official methods of analysis of the association of official agricultural chemists*". 8th Ed. Published by the A.O.A.C. Washington.

COMAR, C.L., MONROE, R.A., VISEK, W.J. and HANSARD, S.L. (1953). Comparison of two isotope methods for determination of endogenous fecal calcium. *J. Nutr.* **50**, 459.

CONRAD, H.R. and HANSARD, S.L. (1957). Effects of massive doses of vitamin D on physiological behaviour of calcium in cattle. *J. Appl. Physiol.* **10**, 98.

GALLUP, W.D. and BRIGGS, H.M. (1950). The minimum phosphorus requirement of lambs for phosphorus equilibrium. *J. Anim. Sci.* **9**, 426.

GREENBLATT, I.J. and HARTMAN, S. (1951). Determination of calcium in biological fluids *Anal. Chem.* **23**, 1708.

HANSARD, S.L., COMAR, C.L. and PLUMLEE, M.P. (1952). Absorption and tissue distribution of radio calcium in cattle. *J. Anim. Sci.* **11**, 524.

HANSARD, S.L., COMAR, C.L. and PLUMLEE, M.P. (1954). The effect of age upon calcium utilization and maintenance requirement in the bovine. *J. Anim. Sci.* **13**, 25.

HANSARD, S.L., and PLUMLEE, M.P. (1954). Effects of dietary calcium and phosphorus levels upon the physiological behavior of Ca and P in the rats. *J. Nutr.* **54**, 17.

HANSARD, S.L., GROWDER, H.M. and LYKE, W.A. (1957). Biological availability of calcium in feeds for cattle *J. Anim. Sci.*, **16**, 437.

HENRY, K.M. and KON, S.K. (1953). The relation between calcium retention and body stores of calcium in the rat. *Brit. J. Nutr.* **7**, 147.

KIRKPATRIC, W. and ROBERTSON, J.D. (1953). Calcium and phosphorus metabolism. *Biochem. and physiol. of Nutr.* **2**, 410.

MITCHELL, H.H. and CURTZON, E.G. (1939). The dietary requirements of calcium and its significance. *Acta Scientifiques et Industrielle* : **771** (After Hansard *et al.* 1954).

THOMAS, R.O., LITOVITZ, T.A., RUBIN, M.I. and GESCHICKTER, C.F. (1952). Dynamics of calcium : Time distribution of intravenously administered radio calcium. *Am. J. Physiol.* **169**, 568.

YASSEEN, A.M. (1958). The effect of by-product VS. grain mixture on the growth of lambs. *M.Sc. Thesis. Fac. of Agric. Alex. University.*

التمثيل الغذائي للكالسيوم في الحملان النامية

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الملخص

أجرى هذا البحث لمعرفة تأثير المستويات المختلفة من الكالسيوم فى الغذاء على توزيع الكالسيوم الموجود فى جسم الحملان النامية وذلك بالاستعانة بالكالسيوم المشع (كا٤٥) وتقدير النسبة المئوية فى الكالسيوم المفرز داخليا Endogenous والخارج فى الروث والذى يقدر فى تجارب الهضم على أنه غير مهضوم .

وكانت النسبة المئوية للكالسيوم فى العلائق الثلاث هى ١ر٢٣ ٪ فى الأولى، ١ر٧٧ ٪ فى الثانية ، ٠ر٢٠ ٪ فى الثالثة ــ وبعد ثلاثة أشهر حقن كل حيوان فى الوريد الوداجى بنصف ميللى كورى كالسيوم مشــع على صورة كلوريد كالسيوم مشع ثم أخذت عينات من الدم والروث والبول لمدة سبعة أيام من بدء الحقن ثم ذبحت الحيوانات بعـد ذلك وأخذت عينات من أجزاء مختلفة من الجسم ، وقدر الكالسيوم كيماويا واشعاعيا .

وأمكن الحصول على النتائج الآتية :

١ ــ كانت النسبة المئوية للكالسيوم المشع التى خرجت فى روث وبول الحيوانات المغذاه على عليقة فقيرة ــ عادية ــ وغنيــة فى الكالسيوم كالآتى فى الترتيب :

١١ر٢٣٪ ، ٠ر٣٤٪ ــ ١٢ر٤٩٪ ، ٠ر٨٢٪ ــ ١٨ر٩٦٪ ، ٠ر٧٦٪

٢ ــ كانت النسبة الهضمية الظاهرية والحقيقية للكالسيوم هى ٩ر٨٧٪ ، ٧٥ر٠٠٪ ــ ٠ر٧٦٪ ، ٥ر٦٧٪ ــ ١٤ر٢٦٪ ، ١٧ر٢٠٪ وذلك بالنســبة للحملان المغذاه على عليقة فقيرة وعادية وغنية فى الكالسيوم .

٣ ــ استطاعت الحملان المغـذاه على دريس + كربونات كالســيوم استخلاص الكالسيوم بكفاءة غذائية أعلى من مثيلاتها المغذاه على دريس فقط .

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٤ — يتجدد الكالسيوم الموجود فى دم الحملان بنسبة ٧٧ر١ ٪ ، ٥٧ر١ ٪ ، ١٤ر١ ٪ فى الساعة وذلك فى حالة الحملان المغذاة على علائق فقيرة وعادية وغنية بالكالسيوم .

٥ — وجد أن أعلى نسـبة مئوية مأخوذة من الكالسيوم المشع كانت فى العظم وأقل نسبة كانت فى الطحال .

٦ — أظهرت التحليلات الاحصائية أن الفروق فى محتويات أجزاء الجسم فى كل من الكالسيوم والبروتين فى حالة المجاميع المختلفة فروق غير معنوية .

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EVALUATION OF POULTRY FEEDS IN DIGESTION TRIALS WITH REFERENCE TO SOME FACTORS INVOLVED

By

A. K. Abou-Raya and A. Gh. Galal

Fifteen digestion trials with adult Fayoumi cocks were under taken to study the feeding value with common feeds using 4 cocks in 13 trials. The associative effect of feeds and the effect of trichloacetic acid versus uranyl acetate for faecal N separation were studied allong with discussing N retention and feed consumption in digestion trials.

The feeding value as starch value as fed was 77.74, 73.44, 63.41, 60.32, 64.54, 63.87, 30.24, 50.06, 37.99 with maize, wheat, barley, beans, maize gluten, decort. cake, undecort. cake ,rice bran (high ash) and wheat bran respectively being the lowest down to 23.42% with bad quality rice bran samples containing high ash and crude fibre. The feeding value of feed mixtures ranged between 51.27 and 73.14% SV. The average digestibility of protein was 76.75± 2.52 in 8 feeds and 78.60 ± 2.0 in 9 mixtures.

There are doubts about the feeding value of feeds obtained indirectly due to associative effect. The level of protein, crude fibre or the feeding value appeared to have no direct effect on feed consumption. Applying trichloro-acetic acid did not materially affect the feeding value but produced high digestible protein.

In U.A.R., there is a great shortage in the suitable concentrates for feeding poultry. Preliminary work was done to determine their feeding value Ismail, 1964 and Abou-Raya *et al.*, 1966. It was important to continue confirmatory work on their feeding value and to study the suitability of some of the currently used by-products for feeding poultry particularly those from extracting cotton seeds, polishing rice and milling wheat. Some of these products contain relatively high content of fibre, and perhaps should be used with reservation as poultry feeds. At the same time grains, high in feeding value, are used preferably for human consumption.

Figures of the feeding value obtained by ruminants were sometimes used for poultry, bing very approximate particularly with feed high in crude fibre. This study was undertaken to evaluate the feeding value in common poultry feeds in digstion trials. Some factors involved were investigated to overcome some difficulties in the procedure.

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Experimental and Methods

Adult Fayoumy cocks were taken from the Poultry Farm of the High Institute of Agriculture at Minia. For each experiment, four cocks were housed individually in metabolic cages except in cases of rice bran III, and the two mixtures of rice bran II with maize, only two cocks were used.

The preliminary period continued for 5 days, and the collection period was extended to 4 days up to 10 in some cases to collect suitable quantities of the excreta.

The metabolic cage was made from metalic wires with wooden frames (50×50×70 cm.). as described by Abou-Raya *et al.*, 1966.

Food was offered coarsely ground; the daily ration was kept in paper bags for each bird. Nine feeds were used in the study including 15 digestion trials. In nine cases of indirect feeding, the feeding value of the tested ration was determined as well as that of the feed mixture (Table 1).

Calculation of urinary organic matter, OM :

The data published by Strukie, 1954 were consulted which indicated the composition of urine. The following table was calculated from a knowledge of N% in each urinary component.

Component (A)	N in A as g/100 g urinry N	N% in A	OM of each component /gs urinary N
	g.		g.
Uric acid	62.9	33.33	1.89
Ammonia	17.3	82.35	0.21
Urea	10.4	46.66	0.23
Creatine and other compounds (assumed to be creatine)	9.4	32.06	0.29
Total	100.0	—	2.62

Therefore, each 100 g. urinary N, would equal 262 g. organic matter. The factor for deuermining organic matter would be then 2.62. The factor appeared to be lower than that recorded by Katayama, 1924.

Calculation of the feeding value :

It was calculated as total digestible nutrients TDN and as starch value, S.V. The conversion factors for starch vaule per one unit of different digesttible nutrients were according to published data by Bachmann (in Ghoneim, 1964) being 1.03, 3.11 and 1 for crude protein CP, crude fat EE and crude carbohydrates (crude fibre. CF and nitrogen free extract. NFE) respectively.

For computing the strach value, the deduction of crude fibre was considered 0.30 unit of strach value for each 1% crude fibre. Metabolizable energy, ME was calculated as 4.20 per gram TDN as suggested by Titus, 1961; the calorie : protein ratio was considered as kilocalories ME correspond to 1 gram CP in feed.

Analytical methods :

For summative analysis of food and faces the ordinary official methods of analysis are used for determining moisture, ash, protlin, crude fibre and ether extract. Faecal nitrogen was determined directly using the method of Ekman *et al.*, 1949. NFE was determined by differenec. In the dry matter of the excreta this was as follows :—

% NFE = 100 (% CP + % EE + %CF + % Crude ash + %urinary OM).

Results and Discussion

The analysis of feeds used in these experiments (Table 1a) was within the suandard specifications publishd in the U.A.R. 1967 except with rice bran samples. The lowest protein content was with rice bran I, II, and mixtures containing either of them. Rice barn samples I and II contain much higher ash and crude fibre and much less crude protein than permitted including most likely some rice hulls. Rice bran III contains high ash being contaminated during polishing when chemical drying is used by $CaSO_4$.

Crude protein was highly digested with most feeds having a coefficient ranging between 54.33 up to 88.20%. The protein of rice barn was the least digested, the coefficients being between 54 and 63%. Excluding rice bran and feed mixtures, the other 8 common feeds would have an average of ca. 76.75 $\pm$ 2.52% for CP digestion. This is probably similar to the figure recorded using 22 common concentrated feeds (79 + 4.7%); Crampton, p. 164, 1956). Protein digestion coefficient of the 9 mixtures was 78.60 $\pm$ 2.0%, being 2 percent degrees higher than with single feeds.

The coefficients of CF ranged from — 3.57 to 40%. Henning 1929 found that the digestion of fibre derived from different food meterials varies from 0 to 40%. The average digestion coefficients in all studied feeds (20 cases) was 9.03 1.76% indicating a significant digestion. It is probable that slight digestion of CF could be achieved by microorganisms in the caecum and the crop (Ibrahim, 1969).

It is equally possible that a small fraction of CF could have been subjected to partial degradation to products which are physiologically unabsorbed but chemically are dissolvable in the reagenents of CF determination. In this connection, Maynard and Loosli 1962, and Abou-Raya 1967, discussing this matter indicated that in routine digestion trials particularly with ruminants, there is an apparent overestimation of CF digestion coefficient. It might be also argued that the differences in texture and fineness of feed material and that of the droppings might apparently reduce the recovery of CF in the droppings.

The digestibility of ether extract by poultry was usually high, particularly with feeds having higher ether extract %. Except one case of negative digestion with beans, (due to associative effect) the coefficients ranged from 49 to 94%. It appears that feeds containing higher level of true fat in the ether extract had high digestion coefficients. Grains and their by-products containing relatively high proportion of non-fatty extracted material, had a low digesion coefficient for ether extract. In the majority of feeds the low coefficient was associated with low EE content.

Concering NFE with grains such as maize, wheat, barley and beans, the digestibility ws 87.93, 87.57, 80.55 and 70.18% respectively being lower with legumes. The digestion with wheat bran, rice bran samples and decorticated cotton seed cake was somewhat low ranging from 36.83 to 55.05%. The digestion with undecorticated cotton seed cake was very low (5.11%). A low figure of 17% was recorded by Halnan 1943, for NFE in sun flower seeds. Halnan 1944 explained the low digestibility of NFE of wheat brans as due to their low starch content. The nature and the proportion of ingredients in NFE and their digestibilities appeared to vary greatly. This subject is thoroughly studied by the authors, and will be prepared for publication shortly.

The digestion coefficients of organic matter in each feed was a resultant of other coefficients of separte ingredients. It is commonly known that poultry feeds should have an organic matter digestion coefficient not less than 70%. Therefore, feeds of low digestion could be only partly added to other poultry feeds of very high OM digestion.

Feeds with poultry, had a distinct lower feeding value than those recorded for ruminants. Undecorticated cotton seed cake, rice bran I and II had a very low feeding vlue being 30.24, 26.88 and 23.42 respectively. Such feeds cannot be considered suitable for poultry. The figure for the undecorticated cotton seed cake was as obtained by Ismail, 1964, being about half that obtained with sheep (30.24 against 55%). The two rice bran samples high in CF were unsuitable for poultry being adulterated samples. Such by-products from rice polishing shuold be ckecked at least for analysis before being purchased or used for poultry feeding.

Rice bran III, though high in ash proved to be more suitable as a poultry feed than wheat bran. Further studies with good quality rice bran sample low in both ash and crude fibre would decide more about the quality of such product.

TABLE 1.—THE ANALYSIS, DIGESTION COEFFICIENTS AND FEEDING VALUE OF COMMON FEEDS AND FEED MIXTURES

(a) *Analysis*

Feed	Percent as fed	D m as fed %	Analysis on dry matter basis %					
			OM	Ash	CP	CF	EE	NFE
Yellow maize	100	88.89	98.29	1.71	9.78	2.91	2.98	82.62
Wheat	100	88.74	98.00	2.00	11.05	2.92	1.97	82.06
Barley	100	89.45	95.98	4.02	9.60	6.02	1.41	78.95
Wheat bran	100	90.70	94.13	5.87	16.34	11.52	3.95	62.32
Rice bran II	100	92.72	69.78	30.22	5.63	23.98	6.49	33.68
Rice bran III	100	92.35	75.16	24.84	10.40	10.41	9.58	44.77
Rice bran I (indirect)	100	92.40	68.01	31.99	6.58	23.05	6.58	31.80
Maize gluten (indirect)	100	89.40	97.57	2.43	33.91	6.42	6.07	51.17
Beans (indirect)	100	92.24	96.76	3.24	30.43	8.98	1.02	56.33
Und.cotton seed cake (Indirect)	100	93.72	94.40	5.60	28.38	27.99	5.82	32.21
Decort. cotton seed cake (indirect)	100	93.34	92.30	7.70	45.01	12.97	7.19	27.13
Maize : maize gluten	40 : 60	89.26	97.86	2.14	24.28	5.02	4.84	63.72
Wheat : ,, ,,	40 : 60	89.70	97.72	2.28	24.72	5.01	4.42	63.59
Maize : rice bran I	40 : 60	91.46	81.00	19.00	8.15	11.20	4.37	63.34
Maize : rice bran II	70 : 30	89.88	89.21	10.79	8.79	9.14	4.09	66.90
Maize : rice bran III	55 : 45	90.47	84.34	15.66	8.30	12.19	4.64	59.20
Maize : Wheat bran	40 : 60	89.33	95.81	4.19	13.66	8.01	3.56	70.61
Maize : beans	50 : 50	92.20	97.53	2.47	20.10	5.95	2.00	69.48
Maize : und. cotton seed cake	60 : 40	92.78	96.72	3.28	17.30	13.04	4.13	62.25
Maize : decort. cotton seed cake	60 : 40	92.38	95.87	4.13	24.02	6.97	4.69	60.19

TABLE 1.—THE ANALYSIS, DIGESTION COEFFICIENTS AND FEEDING VALUE OF COMMON FEEDS AND FEED MIXTURES.
(b) *Digestion coefficients and feeding value*

Feed	Digestion coefficients					Feeding value as fed	
	OM	CP	CF	EE	NFE	SV	TDN
Yellow maize	85.00	84.59	15.26	72.92	87.93	77.74	76.66
	± 0.06	0.33	1.72	1.24	0.12		
Wheat	83.57	75.72	3.92	49.82	87.57	73.44	73.25
	0.54	0.60	5.99	3.71	0.24		
Barley	73.36	70.81	-3.57	54.54	80.19	63.41	64.26
	0.40	0.61	3.16	5.19	0.51		
Wheat bran	42.97	68.99	77.7	54.94	41.86	37.99	39.13
	0.99	0.80	0.98	3.78	1.55		
Rice bran II	31.41	63.06	-0.89	79.14	36.83	23.42	25.57
	0.68	2.76	1.00	2.09	1.93		
Rice bran III	49.29	55.56	6.48	87.49	33.05	50.06	46.14
Rice bran I (indirect)	35.42	54.33	9.53	89.58	37.92	26.88	28.82
	2.05	1.73	4.11	2.15	0.78		
Maize gluten (indirect)	67.81	87.46	7.68	49.30	65.99	64.54	63.17
	0.90	0.45	1.97	3.21	1.50		
Beans (indirect)	66.94	78.99	13.78	-11.69	70.18	60.32	61.49
	1.49	0.64	2.57	18.75	1.92		
Und. cotton seed cake (indirect)	30.29	68.50	7.70	93.70	5.11	30.24	33.28
	1.90	2.14	3.95	1.42	3.00		

TABLE 1 b (Cont.)

Feed	Digestion coefficients %					Feeding value as fed	
	OM	CP	CF	EE	NFE	SV	TDN
Decort. cotton seed cake (indirect)	62.53	78.93	33.51	90.07	41.35	63.87	61.31
	2.36	1.06	4.15	3.05	4.64		
Maize : maize gluten	75.15	87.00	9.35	55.02	77.35	69.97	68.61
	0.82	0.38	1.52	2.33	0.73		
Wheat : maize gluten	73.08	88.20	7.88	54.55	73.63	67.90	66.76
	0.24	0.50	1.87	1.22	0.41		
Maize : rice bran I	58.51	70.37	9.95	85.70	68.65	53.78	53.75
	0.97	0.69	3.61	1.75	0.30		
Maize : rice bran II, 70 : 30	70.21	80.24	5.55	83.67	76.74	60.23	59.86
Maize : rice bran II, 55 : 45	62.27	71.48	40.00	77.87	71.77	51.27	51.61
Maize : wheat bran	64.66	75.53	11.95	63.53	68.30	59 93	7.06
	0.85	0.37	2.79	4.82	0.73		
Maize : beans	75.97	80.36	14.17	50.37	80.48	68.63	69.32
	0.67	0.56	2.00	4.60	0.80		
Maize : und. cotton seed cake	63.42	73.92	8.25	84.81	70.62	60.49	60.97
	0.76	1.59	3.74	0.90	0.64		
Maize : decort. cotton seed cake	76.01	80.31	28.89	85.01	79.44	73.14	72.14
	0.93	0.80	3.80	1.84	0.84		

TDN values in studied poultry feeds were numerically as starch value because they have low fibre content.

It is usually considered that poultry mixtures should contain at least ca. 2.7 Kilocal. Me per gram. In studied feeds it was found to vary between 1.40 (undecort. cake) and 3.22 in yellow maize (excluding bad quality rice brans. The range with mixtures was 2.17—3.02 Kilocal./g. The calorie protein ratio ranged between 1:5.25 and 1:37.05.

Associative effect in digestion trials with poultry :

Effect of direct and indirect feeding

Results in Table 2 with maize (No 2) indirectly fed using wheat bran as basal show that noticeable increase occurred in all digestion coefficients and feeding value when compared with direct feeding in No. 1 (77.74% SV against 88.79). The same occurred with wheat bran which when fed alone, the feeding value was 37.69% SV becoming 42.52% when fed indirectly using maize as a basal ration (No. 5 and 6). In both cases, differences were highly significant when comparing the resultant of the effect on average digestion coefficients of OM as follows :

	direct feeding	indirect feeding
Maize.	58.00 ± 0.06	94.56 ± 1.85
Wheat bran . .	42.97 ± 0.99	94.64 ± 1.34

Whn comparing the results with maize and rice bran II (No. 1 against 3 and No. 7 aginst 8), the assiciative effect was of a decreasing nature.

Therefore, the feeding value of certain feed mixtures obtained directly in digestion trials, with poultry would differ from that calculated from the knowledge of the feeding value of the separate feeds owing to associative effcts. Calculating the feeding value from that of the separate feeds would not represent the actual feeding value of their mixtures.

Effect of the nature of the basal ration on the feeding value of the tested ration :

Results in Table 2 with maize, indicated that using wheat bran as a basal ration (No. 2) produced a net feeding value of 88.79/SV., but using rice bran (No. 3) produced a net feeding value 67.22% SV. This was due to the fact that both basal rations differed greatly in their nature producing different trends in the associative effect.

On the other hand, results with maize gluten (No. 10 and 11) indicated that using maize as a basal ration produced a similar feeding value as with wheat (64.54% SV), against (63.10%). This indicated that maize and wheat grains were nearly of the same nature affecting very similar associative effect. It was therefore preferable to stick to a standard basal ration in order to make results of the feeding values of tested feeds relatively comparable.

TABLE 2.—Associative effect in digestion trials with poultry

Serial No.	Feed	Basal				Digestion coefficients %					Feeding value as fed		
						OM	CP	CF	EE	NFE	SV	TDN	DP
	Maize :												
1	Maize.	100	—	—		85.00	84.59	15.26	72.92	87.93	77.74	76.66	7.35
2	Maize.	40	Wheat bran . .	60		94.56	91.33	36.22	85.02	98.36	88.79	87.36	8.05
3	Maize.	70	rice bran II . .	30		82.23	85.48	25.19	88.22	83.85	76.22	74.77	7.42
4	Maize.	55	rice bran II . .	45		80.50	76.32	30.28	75.45	83.26	74.05	72.90	6.62
	Wheat bran :												
5	Wheat bran	100	—	—		42.97	68.99	7.77	54.94	41.32	37.69	38.82	10.22
6	Wheat bran	60	Maize	40		49.64	71.81	11.39	58.42	50.85	42.52	43.51	10.22
	Rice bran :												
7	Rice bran II	100	—	—		31.41	63.06	-2.08	79.14	36.83	23.42	25.57	3.85
8	Rice bran II	30	Maize	70		22.42	65.83	2.78	90.61	13.12	19.35	20.89	4.01
9	Rice bran II	45	Maize	55		23.80	48.82	2.15	78.44	22.63	18.66	20.86	2.97
	Maize gluten :												
10	Gluten . . .	60	Maize.	40		67.81	87.46	7.68	49.30	65.99	64.54	63.17	26.52
11	Maize. . . .	60	Wheat	40		66.04	90.94	3.82	55.64	58.58	63.10	61.24	27.25

Effect of the proportion of the basal ration on the feeding value of the tested ration :

When determining the feeding value of rice bran II (No. 8 and 9) indirectly using two levels of maize as a basal ration (70 and 55%), the difference was negligible not exceeding 3.50%. Comparing the results with maize (No. 3 and 4) using 30% rice bran as a basal ration and 45% in the other case, revealed the fact that the difference in calculated feeding value was also negligible being 2.17%. The results appeared to indicate generally that in digestion trials there was relatively a wide range for the proportion of the basal ration in the feed mixture, producing practically the same results for the tested feeds.

It was obvious from this study of the associative effect, that there are always doubts about the feeding value of feeds obtained indirectly. In some cases, the values obtained are under-or over-estimated. With poultry feeds which are usually mixtures of several ingredients, a mean should be tried to evaluate the feeding value of single feeds when being in the mixture rather than when fed alone.

Feed consumption in digestion trials with poultry :

Feed consumption ranged between 55.69 to 98.34 gm. (51.67—89.62 DM) as in Table 3. Some samples contained high protein level (up to 20.66 CP) and had a high consumption up to 95.42gm. Similar consumption (94.48gm.) was recorded with a low protein level (1.0048 gm. N or 6.28 CP).

With rice bran II, containing up to 24% CF, consumption was on the high side. The same was found with the starch value level.

Therefore, the protein level, crude fibre level or feeding value appeared to have no direct effect on feed consumption. Multiple factors appeared to be involved. Perhaps the palatibility of the feed also might be concerned.

It was also clear that in practical feeding, the feed consumption *ad. lib.* might fail to provide the bird with the necessary requirements. With rice barn (23 SV) although feed consumption appeared satisfactory, yet the starch value consumed was 23gm. being below the basal requirements. It seems nesessary in practical voluntary feeding with poultry, that a test for the adequacy of the consumed feed for the type of production is necessary.

N-retention in digestion trials :

It appears from the N retention (results in Table 3) that in the majority of cases, the mount of digestible protein in feeds was adequate to maintain either neutral or positive N retention. It was also clear that using cereal grains alone did not result in a negative N balance with adult cock fed *ad lib.* Therefore, such grains could be used as suitable basal rations for feeds usually having higher protein content.

TABLE 3.—FEED CONSUMPTION AND NITROGEN RETENTION WITH SINGLE AND MIXED FEEDS FED *ad libitum* WITH MATURE COCKS.

Feed	Initial wt. of cocks kg.	Feed consumption		N eaten	N excreted		N retained
		feed as fed gm.	SV gm.	gm.	Faecal gm.	Urinary gm.	gm.
Single feeds :							
Yellow maize	2.133	98.34	76.45	1.3676	0.2108	0.9553	0.2015
Wheat	2.018	83.99	61.69	1.3180	0.3188	0.9958	0.0034
Barley	2.017	91.32	58.14	1.2548	0.3664	0.7140	0.1744
Wheat bran	1.870	78.06	29.41	1.8504	0.5740	1.2079	0.0685
Rice bran II	1.935	96.65	22.64	0.9432	0.3484	1.0596	-0.4648
Rice bran III	1.735	77.08	37.76	1.1592	0.5192	0.6512	-0.0112
Mixed feed :							
Maize : maize gluten	2.145	95.43	66.59	3.3056	0.4296	2.4820	0.3940
Wheat : maize gluten	2.010	87.29	59.24	3.0960	0.3644	1.9359	0.7957
Maize : rice bran I	2.165	94.48	50.81	1.0048	0.2984	0.6976	0.0088
Maize : rice bran II	1.585	75.77	45.63	0.9576	0.1896	0.7222	0.0458
Maize : rice bran III	1.493	77.00	39.48	0.9256	0.2640	0.7272	-0.0656
Maize : wheat bran	1.990	80.60	45.89	1.5568	0.3808	0.9267	0.2490
Maize : beans	1.903	70.39	48.29	2.0872	0.4092	1.5340	0.1440
Maize : und-cotton seed cake	2.038	55.69	33.68	1.4300	0.3692	0.9907	0.0701
Maize : decort cotton seed cake	1.975	60.22	44.51	2.1380	0.4248	1.4037	0.3092

Effect of replacing uranyl acetate by trichloroacetic acid in digestion trials with poultry :

Regarding digestion coefficients of CP and NFE, (Table 4), it was claer that trichloroacetic acid appeared to fail to percipitate a part of the falcal protein producing higher digestion coefficients of crude protein than with uranyl acetate. Decreasing the CP would increase accordingly the feacal organic matter. This would raise the NFE of the faeces and would accordingly, reduce their digestion coefficients.

As th eaten fraction of NFE was usually much higher than that of crude protein, the NFE coefficients were slightly reduced. Such differences would not affect materially the amount of calculated digestible NFE in the feed.

TABLE 4.—EFFECT OF USING TRICHLOROACETIC ACID ON DIGESTION COEFFICIENTS OF CRUDE PROTEIN AS WELL AS COMPARED WITH URANYL ACETATE METHOD.

Sambl6	Uranyl acetate method		Trichloroacetic acid method	
	CP	NFE	CP	NFE
Wheat :				
eaten	8.75	64.98	8.75	64.98
excreted	2.10	8.52	1.15	9.10
digested	6.65	56.46	7.60	55.88
Dig. coeffs. %	76.00	86.89	86.86	86.00
Wheat bran :				
eaten	11.76	44.86	11.76	44.86
excreted	3.64	25.75	1.92	26.80
digested	8.12	19.11	9.84	18.06
Dig. coeffs. %	69.05	42.60	83.67	40.26
Rice bran II :				
eaten	5.86	28.33	5.86	28.33
excreted	2.47	17.56	1.54	18.42
digested	3.39	10.77	4.32	9.91
Dig. coeffs. %	57.85	38.02	73.72	35.10

The digestible protein in the three feeds (Table 5), was 7.45, 10.43 and 3.53 uranyl acetate against 8.52, 12.40 and 4.50 with trichloroacetic acid in wheat bran and rice bran respectively. This was reflected on the nutritive ratio, becoming narrower with trichloroacetic acid particularly with rice bran. This may lead to errors in calculating the level of protein if "digestible protein" was taken as basis. From this point, it would be preferable to use uranyl acetate for more efficient separation of faecal crude protein.

Concerning the feeding value, slight differences were found between the two methods either as TDN, SV or ME. The increased fraction in digestible protein with trichloroacetic was compensated with approximately the same magnitude in digestible NFE. From a practical point of view, calculating the feeding value by either methods would lead practically to the same results. As the uranyl acetate costs more and is not availble as a common reagent, using trichloroacetic acid would be quite satisfactory for determining the feeding value of poultry feeds.

It is also suggestive to use an average digestion coefficient of crude protein in common feeds of 57% and to obtain faecal N by calculation without any necessity of using certain reagents for seperation. The error introduced would be even less than when using trichloroacetic acid in poultry digestion trials.

TABLE 5.—EFFECT OF USING TRICHLOROACETIC ACID ON THE FEEDING VALUE AS COMPARED WITH URANYL ACETATE METHOD.

Feed	Feeding valué (as fed)	Uranyl acetate	Trichloroacetic acid
***Wheat*:**	DP %	7.45	8.52
	SV %	72.29	72.74
	TDN %	72.26	72.68
	ME Kcal/100 g.	303.49	305.26
	Nutritive ratio	1 : 8.69	1 : 7.71
Wheat bran:	DP %	10.43	12.40
	SV %	39.78	40.69
	TDN %	40.58	41.42
	ME Kcal/100 g.	170.44	173.96
	Nutritive ratio	1 : 2.97	1 : 2.34
Rice bran II:	DP %	3.53	4.50
	SV %	22.44	22.58
	TDN %	24.89	24.99
	ME Kcal/100 g.	104.54	104.96
	Nutritive ratio	1 : 6.04	1 : 4.55

REFERENCES

ABOU-RAYA, A.K., (1967). *"Animal and Poultry Nutrition"*, 1st. Edit. Dar-el Maarif, Cairo (Arabic Textbook).

ABOU-RAYA, A.K., RAAFAT M.A., ABOUL-SEOUD, A.A. and ISMAIL, M.F., (1966). Digestibility trials with Egyptian poultry to study the feeding value of some feeding-stuffs. II. A study with barley grains, sorghum grains and a rice starch by-product. *Proceed. 2nd Animal Prod. Conf. Cairo*, Vol. **1**, pp 119–33 1963.

CRAMPTON, E.W. (1956). *"Applied animal nutrition"* W.H. Freemenn and Company, San Francisco.

EKMAN P., EMANUELSON and FRANSSON, A., (1949). Estimation of faecal protein. *K. Lanthbrukse. Ann.*, **16**, 749.

GHONEIM, A., (1964). *"Animal Nutrition, Principles and the feeding-stuffs"* Anglo Egyptian Lib., Cairo (Textbook in Arabic).

ISMAIL, M.F., (1964). "The biological value of proteins in poultry rations" *M.Sc. Thesis, Fac. Agric., Cairo University.*

HALNAN, E.T., (1943). Digestibility trials with poultry. IX-The digestibility and metabolizable energy of sun-flower seeds. *J. Agric. Sci.*, **33**, 113.

HALNAN, E.T., (1944). Digestibility trials with poultry. X-The effect of war time changes in milling practice on the composition and nutritive value of fine and coarse wheat bran. *J. Agric. Sci.*, **34**, 133.

HENNING, H.T., (1929). Digestibility of crude fibre by hens. *Landw. Vers. Sta.*, **108**, 253–86 (*Chem. Abst.* **24**, 5343, 1930).

IBRAHIM, M.A., (1963). Some nutrtional studies on the effect of crude fibre in Poultry rations with reference to their production. *M.Sc. Thesis, Fac. Agric.*, Cairo Univ.

KATAYAMA, T., (1924). The digestibility of feeding-stuffs by chickens. *Bull. Imp. Agr. Expt. Sta.* (Japan) **3**, No. **1**, 1–78. (Chem. Abst. **22**, 803, 1928).

MAYNARD, L.A., and LOOSLI, J.K., (1962). *"Animal Nutrition"* Mc. Graw-Hill Book Company, Inc., New York.

STURKIE, P.D., (1954). *"Avian Physiology"* Comstock Publishing Associates, Cornell Univ. Press, Ithaca, New York, P. 224.

TITUS, H.W., (1961). *"The scientific feeding of chickens"*. The Interstate, Danivell, Illinios.

تقييم مواد علف الطيور فى تجارب الهضم مع دراسة بعض العوامل الموجودة

احمد كمال أبو ريه (١) ــ على غريب جلال (٢)

الملخص

أجرى خمسة عشرة تجربة هضم على الديوك الفيومى البالغة ، وذلك لدراسة القيمة الغذائية لمواد العلف الشائعة وقد استخدم ٤ ديوك فى ثلاث عشرة تجربة منها كما درس التأثير الاضافى للغذاء وتأثر استخدام ثلاثى كلور وحامض الخليك مقارنا مع خلات اليورانيل لفصل ازوت الروث ــ على القيمة الغذائية لمادة العلف ونوقش أيضا ميزان الآزوت والمستوى الغذائى فى تجارب هضم الدواجن .

وقد وجد ان القيمة الغذائية كمعادل نشا هى ٧٧ر٧٤ للذرة ، ٧٣ر٤٤ للقمح ، ٦٣ر٤١ للشعير ، ٦٠ر٥٤ للفول ، ٦٤ر٥٤ لجلوتين الذرة ، ٦٣ر٨٧ لكسب القطن مقشور ، ٣٠ر٢٤ لكسب القطن غير المقشور ، ٥٠ر٠٦ فى عينة رجيع عالية الرماد ٣٧ر٩٩ لردة القمح ، وقد انخفضت القيمة كثيرا فى عينات رجيع عالية فى الألياف والبروتين الى ٢٣ر٤٢٪ وكانت القيمة الغذائية للمخاليط المستخدمة بين ٥١ر٢٧ ، ٧٣ر١٤٪ . وكان متوسط معامل هضم البروتين فى ثمانية أغذية هو ٧٦ر٧٥ ± ٢ر٥٢ وفى ٩ مخاليط هو ٧٨ر٦٠ ± ٢٠٠ .

ووجد من الدراسة أن هناك شك فى القيمة الغذائية للأغذية المقدرة بالفرق (تغذية غير مباشرة مع عليقة أساسية) وذلك لوجود التأثير الاضافى كما ظهر أن مستوى البروتين او الألياف الخام أو القيمة الغذائية لمادة علف لا تؤثر تأثيرا مباشرا على كمية الاستهلاك اليومى من الغذاء ، ووجد أن استخدام ثلاثى كلور وحامض الخليك لا تؤثر على القيمة الغذائية لمادة العلف ولكنه ينتج أرقاما عالية للبروتين المهضوم .

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19 *U.A.R. J. Anim. Prod.*, Vol. 11, No. 2, pp. 223-232 (1971).

EFFECT OF CRUDE FIBER LEVELS IN THE RATION OF LAYING HENS ON THEIR EGG PRODUCTION

By

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This experiment included 240 Baladi White (BW) and 240 Rhode Island Red (RIR) hens. Hens of each breed were divided into 4 groups containing 60 pullets each, equal in their average egg production and body weight. This experiment lasted for 52 weeks. The experimental rations fed to the BW hens had 4, 7, 12 and 17% crude fiber (CF). The levels of CF in the RIR rations were: 4,9, 12.5 and 16%. Rations given to each breed were nearly iso-nitrogenous and iso-caloric. Feed and water were offered *ad libitum*.

This experiment was undertaken to study the effect of crude fiber level on the egg production of BW and RIR layers and to determine the maximum level beyond which egg production is affected.

Results of this investigation can be summarized as follows:

The BW pullets can tolerate up to 7.0% CF in their rations without affecting egg production. Hens of the RIR were observed to tolerate up to 9.0% CF in their rations with no apparent effect on egg production. However, raising the CF level to 12-12.5% resulted in marked decrease in the number of eggs produced from BW or RIR layers.

The kilograms of SE required to produce 1.0 kg. eggs was calculated to denote the efficiency of converting feed energy into eggs. In the RIR layers it was found that up to 9% CF did not effect the efficiency of feed conversion. However, feeding BW layers a ration containing 7% CF resulted in moderate reduction in efficiency of feed conversion.

The average egg weight showed no difference due to the level of CF in the rations of layers.

Literature on the effect of crude fiber on egg production is limited. Morris *et al.* (1932), reported that the amount of fiber in a chick ration could be increased to as much as 8 to 9% of the ration without harmful effect on feed consumption, age of maturity and egg production. Heuser (1945); and Bird and Whitson (1946), reported that fibrous feed did not affect the rate of egg production. Furthermore, lillie *et al.* (1951), found that adding oat hull cellulose in a diet even at a level of as high as 64% did not reduce the rate of egg production but did actually decrease feed utilization.

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Although there may be some recommendations on the best crude fiber levels in the rations for layers in the U.A.R. (Abou-Raya, 1967), yet these were not based on actual experiments devoted to study the suitable fiber level alone. This research was undertaken to study the effect of crude fiber levels, apart from SE, on the egg production of (BW) and RIR layers.

Material and Methods

Pullets of BW and RIR breeds used in this experiment were beginning their first laying season. Pullets of each breed were divided into 4 experimental groups containing 60 birds each, equal in their average monthly egg production and body weight. This experiment lasted for 52 weeks. Eggs were collected every hour and the total weight and number was recorded every day for each group. Pullets were weighed at the beginning of the experiment and at monthly intervals. Feed and water were offered *ad libitum.*

Table 1 shows the composition of the experimental rations. Rations 1-4 fed to BW hens had 14.58 — 15.08% crude protein and 63.45 — 64.90 S.E. The CF level in these rations was : 4.24, 7.12, 11.96 and 16.84% for rations fed to group 1, 2, 3 and 4 respectively. These levels will be referred to in the text as 4, 7, 12 and 17% respectively. Rations 5—8 fed to RIR hens had 17.80 — 18.30% crude protein and 66.90 to 68.37 SE The CF level in these rations was : 4.34, 8.87, 12.55 and 16.29% for rations fed to group 5, 6, 7 and 8 respectively. These fiber levels will be referred to in the text as 4, 9, 12.5 and 16% respectively. Sawdust was used to raise the level of crude fiber while cotton seed oil was added to keep the rations iso-caloric as possible (Table 1). Thus it can be seen that the rations offered to each breed although contained graded levels of CF but were nearly iso-nitrogenous and iso-caloric.

Results and Discussion

Average Body Weight of Pullet :

It can be seen from Table 2 that BW pullets maintained their average body weight during the experimental period as evidenced by comparing their initial and final average body weight. However, RIR pullets of groups 5 and 6 gained 310 and 382 g. respectively. The other two groups of the RIR showed no significant body weight change during the experimental duration.

TABLE 1.—COMPOSITION OF THE EXPERIMENTAL RATIONS

Breed / Ration No.	Baladi White				Rhode Island Red			
	1	2	3	4	5	6	7	8
	%	%	%	%	%	%	%	%
Corn	47.8	49.8	44.8	34.8	46.8	47.8	42.3	30.8
Wheat bran	30.0	27.0	20.0	13.0	15.0	5.0	—	—
Horse beans	—	—	—	—	10.0	13.0	14.0	15.0
Decorticated cotton seed meal	15.0	12.0	15.0	19.0	19.0	19.0	20.0	21.0
Dried skimmilk	5.0	5.0	5.0	5.0	7.0	7.0	7.0	7.0
Cotton seed oil	—	—	2.5	6.0	—	—	2.5	6.0
Sawdust	—	4.0	10.5	20.0	—	6.0	12.0	18.0
$CaCO_3$	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Na Cl	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin A D_3 mixture[1]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Chemical Composition:								
Crude protein	14.58	14.81	15.08	14.91	17.80	18.02	18.30	17.81
Crude fiber	4.24	7.12	11.96	16.84	4.34	8.87	12.55	16.29
Starch equivalent[2]	64.90	63.64	63.90	63.45	68.37	66.90	67.25	67.23

TABLE 2.—Average Body Weight, SE Consumed and Feed efficiency of BW and RIR layers.

Breed / Ration No.	Baladi White				Rhode Island Red			
	1	2	3	4	5	6	7	8
Initial number of hens	60	60	60	60	60	60	60	60
Initial average body weight, kg. .	1.152	1.132	1.144	1.135	1.575	1.551	1.551	1.543
Final average body weight, kg. . .	1.218	1.167	1.074	1.006	1.885	1.933	1.544	1.557
Feed consumed/hen/year, kg. . . .	36.537	34.580	34.027	32.190	45.813	44.852	42.008	38.397
S.E. consumed/hen/year, kg. . . .	23.566	21.938	21.743	20.424	31.322	30.006	28.250	25.814
S.E. required to produce 1.0 kg. eggs, kg.	5.493	6.444	7.087	6.638	8.044	8.138	9.089	9.705

Average Number of Eggs Produced Monthly Per Pullet :

A. *Baladi White :*

As can be seen from Table 3 and Figure 1, the number of eggs produced monthly per pullet was higher during the first 6 month (from October to April) in all groups and then began to decrease therafter. The total number of eggs per pullet during the season (52 weeks) was 103.27, 81.92, 74.06 and 74.31 egg for group 1, 2, 3 and 4 respectively. The corresponding monthly average was 8.60, 6.83, 6.17 and 6.19 eggs. Assuming the lowest production (group 3) equals 100, it would be 139.4, 110.6 and 100.3 for group 1,2 and 4 respectively, showing that group 1 (4% CF and 2 (7% CF) surpassed group 3 (12% CF) and 4 (17% CF) to the extent of 10 to 39%. This indicates that raising the CF to the level of 12% or higher has depressing effect on egg production of BW layers.

B. *Rhode Island Red :*

Table 3 and Figure 1 show that the number of eggs produced per pullet assumed a similar trend as in theBW pullets, being high until March and decreased thereafter. The total number of eggs per pullet during the whole season was : 76.56 (gp. 5 : 4% CF), 73.18 (gp. 6 : 9% CF), 61.34 (gp. 7 : 12.5% CF) and 52.62 (gp. 8 : 16% CF). The corresponding monthly average was : 6.38, 6.10, 5.11 and 4.33 eggs. Assuming the lowest equals 100 (gp. 8), it would be 145.5, 139.1 and 116.6 for group 5, 6 and 7 respectively. This shows that raising the level of CF to 12.5% or higher resulted in reducing the number of eggs produced.

Therefore, it may be concluded that up to 7% and 9% CF can be tolerated in rations fed to BW and RIR hens respectively without effecting the egg production. This is in accordance with the findings of Morris *et al.* (1932), who reported that as much as 8.9% CF can be added to rations of hens without affecting egg production.

Average Egg Weight :

A. *Baladi White :*

The average monthly egg weight during the first six months (October — April) was higher than that of the last six ones (Table 3). The average egg weight during the whole year was : 41.53 (gp. 1 : 4% CF), 41.17 (gp. 2 : 7% CF), 41.23 (gp. 3 : 12% CF) and 41.37 g. (gp. 4 : 17% CF) as shown in Table 3. This shows that the egg weight was not affected to an appreciable extent by increasing the CF level of the ration.

B. *Rhode Island Red :*

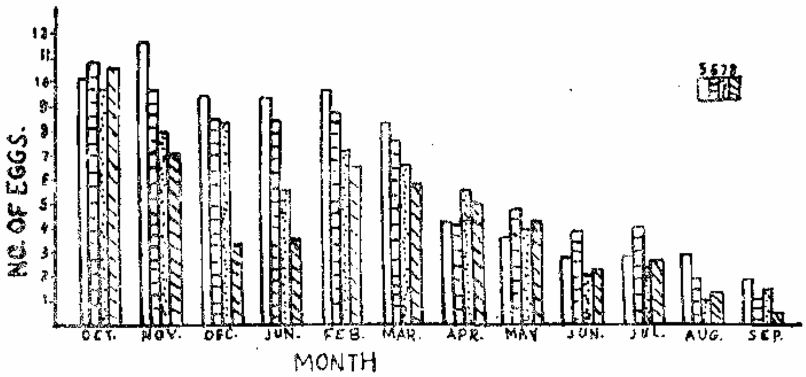
The average monthly egg weight was higher during the first half of the season (October — April) than during the last half as was noted with the BW layers (Table 3). The average egg weight during the whole year was 50.02 g. (gp. 5 : 4% CF), 49.69 g. (gp. 6 : 9% CF), 49.92 g. (gp. 7 : 12.5% CF) and 49.68 g. (gp. 8 : 16% CF) showing, as noted with the BW, that the average egg weight is not affected by increasing the level of crude fiber in the ration (Table 3).

TABLE 3.—AVERAGE NUMBER OF EGGS AND AVERAGE EGG WEIGHT OF BW AND RIR LAYERS

	Ration 1		Ration 2		Ration 3		Ration 4	
	No. of Eggs	Av. Egg wt. g.	No. of Eggs	Av. Egg wt. g.	No. of Eggs	Av. Egg wt. g.	No. of Eggs	Av. Egg wt. g.
October	7.95	42.01	8.42	42.01	8.97	42.22	8.62	41.97
November	9.87	42.12	7.73	41.95	8.02	42.23	6.60	42.47
December	10.06	42.50	6.04	41.64	5.06	42.54	3.84	43.04
January	12.43	43.22	9.91	42.13	4.98	42.53	3.97	42.89
February	12.29	42.84	10.40	43.12	10.92	41.60	8.39	43.00
March	12.11	41.72	9.83	41.84	8.65	40.31	10.22	40.73
April	8.82	41.21	8.40	41.52	6.28	41.40	6.31	41.61
May	6.79	42.81	5.45	41.10	4.96	40.18	4.46	40.42
June	7.13	40.53	5.47	39.85	5.29	41.21	7.57	41.41
July	7.12	40.24	5.65	39.73	5.10	40.37	7.35	40.24
August	5.23	39.73	3.75	39.68	3.01	39.60	4.77	39.73
September	3.47	39.48	0.87	39.49	2.82	40.60	2.21	39.00
Total	103.27	—	81.92	—	74.06	—	74.31	—
Average	8.60	41.53	6.83	41.17	6.17	41.23	6.19	41.37

TABLE 3 (Cont.)

	Ration 5		Ration 6		Ration 7		Ration 8	
	No. of Eggs	Av. Egg wt. g.	No. of Eggs	Av. Egg wt. g.	No. of Eggs	Av. Egg wt. g.	No. of Eggs	Av. Egg wt. g.
October	10.15	51.03	10.81	50.51	9.69	51.18	10.62	51.13
November	11.59	52.37	9.63	51.09	7.97	50.31	7.08	51.55
December	9.47	51.64	8.46	51.18	8.31	51.14	3.31	51.06
January	9.21	50.81	8.37	50.90	5.53	50.99	3.50	52.00
February	9.71	51.39	8.77	51.31	7.16	51.12	6.52	50.92
March	8.30	51.81	7.53	51.00	6.57	52.66	5.76	51.21
April	4.16	50.72	4.09	51.59	5.52	50.72	5.03	50.50
May	3.55	49.57	4.73	49 68	3.89	49.87	4.15	50.12
June	2.79	48.39	3.84	47.91	2.07	48.31	2.24	48.66
July	2.86	47.20	4.00	48.00	2.31	48.05	2.68	47.01
August	2.90	49 31	1.90	47.37	0.98	46.94	1.29	46.51
September	1.87	45.98	1.05	45.71	1.34	47.76	0.44	45.45
Total	76.56	—	73.18	—	61.34	—	52.62	—
Average	6.38	50.02	6.10	49.69	5.11	49.92	4.38	49.68



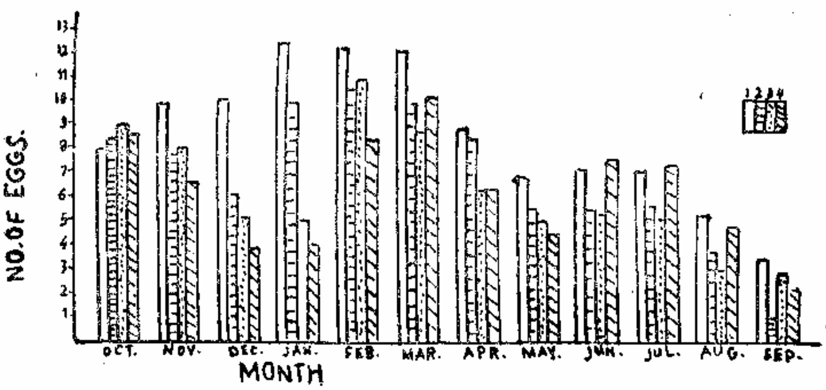


FIG. 1.—EGG PRODUCTION OF B W AND R I R LAYERS FED 4 DIFFERENT LEVELS OF CF.

تقييم مواد علف الطيور فى تجارب الهضم مع دراسة بعض العوامل الموجودة

احمد كمال ابو ريه (١) ــ على غريب جلال (٢)

الملخص

اجرى خمسة عشرة تجربة هضم على الديوك الفيومى البالغة ، وذلك لدراسة القيمة الغذائية لمواد العلف الشائعة وقد استخدم ٤ ديوك فى ثلاث عشرة تجربة منها كما درس التأثير الاضافى للغذاء وتأثر استخدام ثلاثى كلور وحامض الخليك مقارنا مع خلات اليورانيل لفعل أزوت الروث ــ على القيمة الغذائية لمادة العلف ونوقش أيضا ميزان الآزوت والمستوى الغذائى فى تجارب هضم الدواجن .

وقد وجد أن القيمة الغذائية كمعادل نشا هى ٧٧ر٧٤ للذرة ، ٧٣ر٤٤ القمح ، ٦٣ر٤١ للشعير ، ٦٠ر٥٤ للفول ، ٦٤ر٥٤ لجلوتين الذرة ، ٦٣ر٨٧ لكسب القطن مقشور ، ٣٠ر٢٤ لكسب القطن غير المقشور ، ٥٠ر٠٦ فى عينة رجيع عالية الرماد ٣٧ر٩٩ لردة القمح ، وقد انخفضت القيمة كثيرا فى عينات رجيع عالية فى الألياف والبروتين الى ٢٣ر٤٢٪ وكانت القيمة الغذائية للمخاليط المستخدمة بين ٥١ر٢٧ ، ٧٣ر١٤٪ . وكان متوسط معامل هضم البروتين فى ثمانية أغذية هو ٧٦ر٧٥ ± ٢ر٥٢ وفى ٩ مخاليط هو ٧٨ر٦٠ ± ٢.٠ .

ووجد من الدراسة أن هناك شك فى القيمة الغذائية للأغذية المقدرة بالفرق (تغذية غير مباشرة مع عليقة أساسية) وذلك لوجود التأثير الاضافى كما ظهر أن مستوى البروتين أو الألياف الخام أو القيمة الغذائية لمادة علف لا تؤثر تأثيرا مباشرا على كمية الاستهلاك اليومى من الغذاء ، ووجد أن استخدام ثلاثى كلور وحامض الخليك لا تؤثر على القيمة الغذائية لمادة العلف ولكنه ينتج أرقاما عالية للبروتين المهضوم .

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دراســة تغذية الدجاج البياض على مستويات مختلفة من الألياف الخام وتأثير ذلك على انتاج البيض

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الملخص

شملت هـذه الدراسة ٢٤٠ دجاجة بلدى أبيض ، ٢٤٠ دجاجة رود ايلاندرد . عند بدء التجربة قسم الدجاج داخل كل نوع الى أربع مجاميع متساوية فى العدد (٦٠) وكذلك متوسط انتاج البيض . استمرت التجربة لمدة سنة (٥٢ اسبوع) وكانت العلائق المعطاة للدجاج تحتوى على النسب الآتية من الألياف الخام :

الدجاج البـلدى الأبيض : ٤٪ ، ٧٪ ، ١٢٪ ، ١٧٪ ، وفى الرود ايلاند رد : ٤٪ ، ٩٪ ، ٥ر١٢٪ ، ١٦٪ . وكانت العلائق المعطاة لـكل نوع متساوية تقريبا فى البروتين المهضوم وكذلك معادل النشا .

يمكن تلخيص نتائج البحث كالآتى :

يمكن للدجاج البلدى الأبيض أن تحتوى علائقه على ٧٪ ألياف خام بدون أن يؤثر ذلك على عدد البيض المنتج أما بالنســبة للدجاج الرود ايلاند رد فيمكنه أن يتحمل حتى ٩٪ ألياف خام . كما وجد أن رفع نسبة الألياف الخام الى ١٢ ـ ٥ر١٢٪ بالنسبة للنوعين أن ذلك سبب انخفاض ملحوظ فى عدد البيض المنتج .

أما عن كفاءة تحويل الغذاء الى بيض (يعبر عنها بعدد كيلوجرامات نشا العليقة اللازمة لانتاج كيلو جرام واحد بيض) فقد لوحظ أن الدجاج الرود ايلاند رد يمكن أن تحتوى عليقته على ٩٪ ألياف خام بدون أن يؤثر ذلك على كفاءة تحويل الغذاء الى بيض أما فى الدجاج البلدى الأبيض فقد لوحظ أن العليقة التى بها ٧٪ ألياف خام كانت كفاءة تحويل الغـذاء منخفضة نوعا ما .

أما عن متوسط وزن البيضة فلم يلاحظ هنـاك علاقة بين نســبة الألياف الخام بالعليقة ووزن البيضة .

(*) قسم الانتاج الحيوانى « فرع تغذية الحيوان » ـ بكلية الزراعة ـ جامعة القاهرة ـ بالجيزة .

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THE NUTRITIVE VALUE OF FODDER BEET UNDER THE U.A.R. CONDITIONS.

By

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Fodder beet cultivated in newly reclaimed area in U.A.R. directed the attention to this study. Some seed pre-sowing using G.A. and C.C.C. treatments were performed to increase its yield by raising its stand percent. It was found that there was no significant differences among the tratments, which might be due to the hetrogimity of the soil or to the lack of experience in this crop production.

The chemical composition and the digestibility trials were carried out on both dried tops sad dried roots to determine their feeding values. The ratio between tops and roots was 1 : 9. The yield was 2.283 tons of tops containing 18.13% D.M. and 20.0 tons of roots containing 14.99% D.M. considering the stand % of plant 46.3.

The roots contained a considerable amounts of C.P. from (16.18-18.56%) and N.F.E. ranging from (45.4-50.42%) on D.M. basis respectively.

The feeding value of the fodder beet tops as fed was 45.52% S.V. and 57.22% T.D.N., and the feeding value of the roots as fed was 50.27% S.V. and 55.11% TDN. The roots contained a narrow nutritive ratio being 1 : 4 which could be recommended for feeding the lactating and growing animals.

This scope of study directs the attention to more investigations to be carried out on fodder beet tops and roots which might help in introducing such forage crop to be cultivated in the UAR and could help in solving the problem of feed shortage during the summer period.

In U.A.R. there is a shortage of green fodder for livestock during summer months. Therefore, any crop which might help in solving this problem, ought to be sought for investigation.

The relatively quicker rate of land reform in the U.A.R. and the establishment of the High Dam would provide new areas of land to be cultivated. In fact, fodder beet could play an important role for feeding livestock under these conditions. It can be cultivated in newly reclaimed areas and relatively poor soils.

Lot of questions at least in U.A.R. regarding this crop, are still to be answered. This might throw light on the utlization of fodder beet roots and tops (Foliage) as a recommended source of feed-stuff for feeding animals.

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Regarding its nutritive analysis, digestion coeficients and feeding value for both roots and tops Ghoneim, 1967, reported the following data after (Kellner and Backer, 1962) :

Item	Dry matter DM	Crude protein GP	Ether extract E.E.	Crude fibre C.F	NFE	Ash	Feeding value	
							Sv	DCP
Analysis of roots %	80.00	8.30	5.00	6.9	52.00	7.00	54	5.4
Digestibilies %	—	65	68	68	95	—	—	—
Analysis of tops %	16.00	2.2	0.8	2.5	6.0	4.5	6.5	1.6
Digestibilities %	—	71	60	80	80	—	—	—

Therefore, the calculated feeding values for both roots and tops were 67.5% SV and 6.75 DCP and 40.6% SV and 10% DCP on moisture free basis respectively.

Evans, 1960 reported that the summative analysis of both roots and tops ware as follows :

Item	DM	CP	EE	CF	NFE	Ash
Analysis of roots %	22.20	1.00	0.1	1.10	18.80	1.20
Analysis of roots %	16.80	1.80	0.3	1.40	7.50	5.8

In this work, the following criteria was investigated : — Some Seed pre-sowing treatments were performed in an attempt to increase its yield by raising its stand percent. Additionally the relationship between these treatments and the chemical analysis of roots were presented. For completion, digestibility trials with sheep were carried out using either dried roots or dried tops to determine their feeding values. The yield from each roots and tops were estimated in tonnage. Moreover, the ratio between the yield of roots to that of tops was obtained.

Experimental and Methods

A variety of fooder beet was imported from D.D.R.[3] and planted in the Plant Research of the Faculity of Agriculture, Cairo University, on december the 5th 1966. The soil was silt loam.

The experiment was contained of 9 treatments. Each treatment contained two rows of 25 plants each. The rows were 1 meter a part and the plants 50 cm. The treatment were arranged in the field in three replicates using complete randomize black design.

These treatments were :

1. Control checks (seeds were planteld dry).
2. Seeds were soaked in tap water for 24 hours before planting.
3. Seeds were stratified in humidified peat moss at 45° F for 30 days before planting.
4. Seeds were soaked for 24 hours in gibbrellic acid (G.A.) solution of 1000 ppm.
5. Seeds were soaked for 24 hours in gibbrellic acid solution of 500 ppm.
6. Seeds were soaked for 24 hours in gibbrellic acid solution of 250 ppm.
7. Seeds were soaked for 24 hours in C.C.C.[4] solution of 2500 ppm.
8. Seeds were soaked for 24 hours in C.C.C. solution of 1000 ppm.
9. Seeds were soaked for 24 hours C.C.C. solution of 500 ppm.

On march the 7th 1967 each plant received equal amounts of fertiliysation. The fertilisers consisted of 50 Kgs. of ammonium sulphate 100 Kgs. of Super Phosphate and 50 Kgs. of Potasium Sulphate per feddan.

Plants reached the proper stage of maturity on July the 30th 1967. They were picked and transfered to the Animal Production Department where nutritional and chemical studies were conducted. The yield was expressed as roots and tops weights.

Data were analysed statistically and the signeificant differences were recorded according to Senedecor, 1956.

Sampling roots for Chemical analysis :

A representative sample was taken from each replicate to form a composite sample for the treatment in question. The roots were cut into longitudinal sections which were grated and well mixed for sampling.

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3. Deutch Democratic Republic.
4. (2-Chloroethyl)-Trimethlyammonium Chloride.

For moisture determination 30 grams were taken. For preparing a dry sample of the roots to be kept for summative analysis, 200 grams of the fresh material were dried at 70°C. Tt was milled to a fine material which was kept in glass-stoppered jars.

Digestion trials :

Three digestion trials were performed to determine the feeding value of each dried roots and dried tops. Clover hay was applied as a basal ration using duplicate sheep.

Sampling the feed and the faeces :

The roots were harvested and immediately sliced, mixed and spread in a thin layer of ca. 20 cm. to be dried in open air. The roots were turned over every two days. After being dried, they were heaped in suitable place. The necessary amount for digestion trial was taken. The same procedure was followed with the tops, except the necessary amount for the digestion trial was chopped into ca. 2 inchs and thoroughly mixed. A representive sample from each of the feed and faeces was laken daily for drying to be user for chemical analysis.

Feeding :

When clover hay was used alone 1300 g. from it was consumed daily by each ram. The air dried roots and tops (400 g.) from each was consumed daily by each ram along with 500 g. air dried clover hay as a basal ration. Animals were fed twice daily and water was affered *ad lib.* Each of the preliminary period and the collection period lasted for 10 days.

Analytical methods :

The ordinary conventional method of the (A.O.A.C., 1955) were used for the chemical analyses of feed and faeces with slight modifications (Abou-Hussein, 1958).

For calculating the starch value, deduction of crude fibre was according to Kellner, 1926, being 0.29 and 0.58 kg. SV for each 1% crude fibre with the roots and tops respectively.

Results and Discussion

Effect of different treatments on stand percentage and the yield of the different parts of the plant :

Data indicated in Table 1 revealed that the highest stand percent was obtained by soaking pre-treatments, whereas, the lowest percentage was noticed by the G.A. solution at 500 ppm.

Regarding the weight of the whole plant, it is postulated that the G.A. at 500 ppm. produced the heaviest plants, while the lowest concenteration (250 ppm.) of this regulator produced least weight.

TABLE 1.—EFFECT OF DIFFERENT TREATMENTS ON THE STAND PERCENTAGE AND THE YIELD OF THE DIFFERENT PARTS OF THE PLANT

Treatments (Tr.)	Stand Percentgge	Tops		Roots		Whole plant		Tops to Roots Ratio
		W/g	%	W/g	%	W/g	%	
1	42.31	478	8.1	5448	91.9	5926	100.0	1 : 11.4
2	58.33	697	11.7	5272	88.3	5969	100.0	1 : 7.7
3	42.95	633	10.1	5658	89.9	6291	100.0	1 : 8.9
4	45.51	610	10.2	5439	89.8	6049	100.0	1 : 8.9
5	25.69	575	7.5	7649	92.5	7624	100.0	1 : 12.3
6	48.90	536	11.1	4288	88.9	4824	100.0	1 : 8.0
7	47.11	611	9.8	5648	90.2	6259	100.0	1 : 9.3
8	44.80	642	10.4	5508	89.6	6150	100.0	1 : 8.6
9	42.30	566	8.9	5808	91.1	6374	100.0	1 : 10.3
Average	46.43	594	9.6	5569	90.4	6163	100.0	1 : 9.4

Moreover, it is evident that C.C.C. treatments at concentration of 1000 ppm. resulted in the heaviest tops whereas, the control checks had the lowest weight of tops.

Considering the top/root ratio, the G.A. at 500 ppm. produced the widest ratio being 1 : 12.3 while, the narrowest ratio acheived by the water soaking pre-treatment was 1 : 7.7.

Despite the noticeable variation between the different values of tops and roots, the analysis of variance indicated no significance.

The insignificance of the results might be referred to the hetroginity of the soil or to the lack of experience in this crop production.

It is worth to indicate that the average value of the different treatments were 46.43% for the stand percent, 594 g., 5569 g. for the tops and roots respectivety. The average ratio between tops and roots was 1 : 9.

The yield of tops and roots per feddan :

Considering that the plants were planted 50 cm. a part on rows 1 metre a part, the total plants per feddan was about 8000 plants. The yield in tons per feddan could be calculated as follows :

$$\frac{6163}{1000} \times 8000 \times \frac{463}{10 \times 100} \times \frac{1}{1000} = 22.83 \text{ tons.}$$

Since the ratio between tops and roots was 1 : 9, the yied of the tops according to the above estimation would be 2.283 tons containing an average of 18.13% dry matter (Table 2). For the roots, the yield would be 20.0 tons containing an average of 14.99% dry matter (Table I).

It is worthy mentioned in this connection that this plant did not flower under U.A.R. conditions, despite the different treatments used.

Therefore, further investigations are required for forcing this plant to flower and more information on cultivated practices and plant beheavior.

Effect of the different treatments on the moisture content of the fresh roots :

Results in Table 2 indicated that a slight difference in the moisture content was obtained among the different treatments in both roots and tops. The roots contained a higher percentage of dry matter (18.13%) and the tops contained 14.99%. This result agrees with those found in the literature (Evans, 1962 and Ghoneim, 1967).

Effect of the different treatments on the nutrients content of the dried roots :

As the roots are the main part of the plant to be used for feeding animals, a special attention was directed to its chemical composition. Results in (Table 3) showed that the roots in general had a considerable amounts of CP ranging from 16.18-18.56% on D.M. basis. The lower value was found in treatment 9, while the highest figure was obtained with treatment 2. (Table 3). In this connection Ghoneim, 1967, reported a lower figure being 10.4%. This difference might be due to the variety of the fodder or the kind of treatment. The higher CP content of this fodder would rank it as an additional source rich in protein for feeding animals. Concerning the other constituents, it was also observed that this fodder contained a higher percentage of N.F.E. and ash. Their ranges were successively (45.40-50.42%) in tr. 9 and, Tr. 5 and (17.59-21.61%) in Tr. 3 and Tr. 9. These results are not in accordance with those recorded by Ghoneim. 1967 and Evans, 1960.

TABLE 2.—EFFECT OF THE DIFFERENT TREATMENT ON THE MOISTURE CONTENT OF THE FRESH ROOTS

No. of treatment	Fresh tops		Fresh roots	
	Moisture %	Dry mattar %	Moisture %	Dry mattar %
1	81.80	18.20	85.50	14.50
2	82.10	17.90	85.30	14.62
3	81.66	18.34	86.22	13.78
4	82.07	17.93	84.60	15.40
5	81.95	18.05	86.09	13.91
6	82.66	17.34	83.85	16.15
7	81.35	18.65	84.16	15.84
8	82.40	17.60	85.35	14.65
9	81.81	19.19	83.94	16.06
Total	736.80	163.20	765.09	134.91
Average	81.87	18.13	85.01	14.99

Regarding the C.F. content of the roots, it was found that their values were within the ranges recorded by the different authors in the literature on rice bran or wheat bran as a carbohydrated concentrates (Hàssàn, 1968).

The same findings were noticed with the E.E. content. Nevertheless, among the different treatments there was no pronounced effect on the chemical composition of the roots. This result is expected because the difference between treatment was based on botonical procedures not on nutritional methods.

TABLE 3.—EFFECT OF THE DIFFERENT TREATMENT ON THE NUTRIENTS CONTENT OF THE DRIED ROOTS

No. of Tr.	DM %	Chemical analysis on dry matter basis				
		CP %	EE %	CF %	NFE %	Ash %
1	90.72	16.28	1.07	13.28	50.23	19.14
2	87.27	18.56	1.01	12.14	48.08	20.21
3	90.38	17.36	1.41	14.31	50.33	17.59
4	88.34	16.22	1.47	13.10	48.03	21.18
5	86.02	16.79	1.52	11.29	50.42	20.08
6	86.08	17.53	1.14	12.11	49.59	19.63
7	92.83	18.04	0.96	14.15	45.70	21.15
8	89.42	17.45	1.14	13.41	49.15	18.85
9	90.15	16.18	1.11	15.69	45.51	21.61
Average	89.02	17.51	1.12	13.27	48.55	20.05

Digestion coefficints and feeding value of dried tops and dried roots :

Regarding the digestion coefficients and feeding value (using sheep) with either the tops or the roots of the fodder beet the results are presented in table 4. Clover hay of the *Trifolium alexandrinum* was used as the basal ration in both cases. Composite samples from the tops of the different treatments and also the roots of the plant material were used to find out the feeding value of each component.

The digestion coefficients of the nutrients of the tops were 59.39, 98. 79, 89.74 and 75.45% for CP, EE, CF and NFE respectively. These results are comparable with those found in peanut hay especially with the digestion coefficints of CP and NFE which were 55.24 and 74.28% respectively (Abou-Raya *et al.* 1969). The results reported by Ghoneim, 1967 concerning both nutrients are higher than those found in this work. They were 71 and 80% for the CP and the NFE respectively. The digestion coefficients of the EE (98.79%) and the CF (89.74%) in this work were higher than those reported by Ghoneim, 1967, which where 60 and 80% respectively.

TABLE 4.—THE ANALYSIS, DIGESTION COFFICIENTS AND FEEDING VALUÉ OF DRIED TOPS AND DRIÉD ROOTS

Item	DM	Analysis, degestion coefficients on DM basis					Feeding value as fed	
		CP	EE	CF	NFE	Ash	SV	TDN
Dry roots								
Analysis	91.50	17.71	1.00	14.71	45.65	21.93	50.27	55.11
Digestion Coeff. .		65.22	100.0	61.22	83.82			
Digestible nut. .		11.44	1.00	9.00	38.26			
Dry tops :								
Analysis	89.80	15.57	3.82	20.82	37.40	22.39	45.52	57.22
Digestion Coeff. .		59.39	98.79	89.74	75.45			
Digestible. nut. .		9.44	3.77	18.68	28.82			

The digestion coefficients of the nutrents in the roots were 65.22, 100. 00. 61.22 and 83.82% for CP EE, CF and NFE respectively. Regarding the digestion coefficients of CP and NFE the results in this work were within the ranges recorded by Hassan, 1968 for rice and wheat brans, while there was some differences with the other nutirents.

The digestible nutrients in the tops were 9.44, 3.77, 18.68 and 28.8% for CP, EE, CF and NFE repectively. The feeding value of the tops as fed was 45.52% SV and 57.22% TDN. To obtain the SV figures the crude fibre deduction was used afterKellner, 1926 being 0.58 and 0.29 Kgs. SV per 1 % CF in tops and roots respectively.

When comparing these results with those recorded with cover hay (by Ghoneim 1967), and the air dried sweet potatoe foliage (El Moghazy, 1965), it can be siad that the SV of the fodder beet tops had a higher feeding value than the both mentioned roughages. This conclusion could recommend the application of the fodder beet tops for feeding animals.

The roots had higher digestible values in CP and NFE than the tops being 11.44% and 38.26% while they contain lower EE and CF values than the tops being successively 1% and 9.00%. The feeding value of the roots as fed was 50.27% SV and 55.11% TDN.

The feeding value of fodder beed roots expressed as SV approaches those of the undecorticcated cotton seed cake and rice bran (Ghonein, 1967.) The same findings are quite simelar to those reported by Ghonein, 1967 with same findings are quite simelar to those reported by Ghonein 1976 with fodder beet roots. He advised applications as dried material than can be added to the rations of the lactating and fattening animals.

Moreover, the roots contain a narrow nutritive ratio being 1 : 4 which could be suitable for feeding the lactating and growing animals.

This scope of research directs the attention to more investigations to be carried out on fodder beet tops and roots and the requirements of the different animals from each ingredient.

The introduction of such feed-stuff to be cultivated in the UAR will help in solving problem of feed-stuff shortage in this country specially during the summer period.

REFERENCES

A.O.A.C. (1955). *"Official Methods of Analysis"* 7th Edit. Washington 4 D.C.

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

Abou-Raya, A.K., Abou-El-Hassan, A. and F.A. Al-Rebah (1969). *"The Feeding value of peanut hay and its response to alkali treatment and addition of urea"*. (Under publication).

El-Moghazi, M.E.A., (1965). Chemical studies on different varities of sweet potatoes, as affected by different treatments with reference to their nutritive value. *M.Sc. Thesis, Fac. Agric., Cairo Univ.*

Evans, R.E., (1960). "Rations for livestock" *Ministry of Agric., Fisheries and Food Bull.* No. 48, London, Her Majestry's Stationery Office.

Ghoneim, A. (1967). *"Animal Nutrition"* Feed requirements and Economical rations Pub. Anglo-Egyptian Lib., Cairo.

Hassan, M.E. (1968) "Chemical composition of rice bran and wheat bran with reference to their nutritive value to some farm animals ". *M.Sc. Ihesis, Fac. Agric., Cairo Univ*

Kellner, O., (1926). *"The Scientific feeding of Animals"* 2nd Edit. Authorised translation by William Goodwin, Dukworth, London.

Senedecor, G.W., (1956). *"Statistical Methods"*. The Iowa State. College Press Ames., Iowa, U.S.A.

FIGURE 1.—Showing a complete plant which could reach a height of 80 cm.

القيمة الغذائية لبنجر العلف تحت ظروف الجمهورية العربية المتحدة

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الملخص

أجريت هذه الدراسة على بنجر العلف الذى يمكن ادخال زراعته فى الأراضى المستصلحة بالجمهورية العربية المتحدة . وقد عوملت البذرة بمعاملات مختلفة باستخدام كل من GA, CCC بتركيزات مختلفة لزيادة المحصول وذلك برفع نسبة الانبات واتضح من الدراسة أنه لا يوجد فرق معنوى بين المعاملات المختلفة من حيث تأثيرها على نسبة الانبات ومحصول العرش والدرنات والتركيب الكيماوى لمحصول الدرنات وقد يرجع الاختلاف الطفيف الذى ظهر فى المعاملات المختلفة الى التربة أو نقص الخبرة بالنسبة لانتاج هذا المحصول الجديد .

وكانت نسبة العرش الي الدرنات ١ : ٩ وكمية المحصول الناتج ٢٫٢٨٣ طن من العرش به مادة جافة ١٤٫٩٩٪ و٢٠ طن من الدرنات بها ١٣٫١٨٪ مادة جافة باعتبار أن متوسط نسبة الانبات للبذور كانت ٤٦٫٣٪ وقد ظهر من التحليل الكيماوى للدرنات أنها تحتوى على نسبة عالية من البروتين الخام التى تتراوح بين ١٦٫١٨ و ١٨٫٥٦٪) والكربوايدرات الذائبة تتراوح بين ٤٥٫٤ : ٥٠٫٤٢٪ فى المادة الجافة تماما .

وبتقدير القيمة الغذائية لكل من العرش والدرنات أجريت تجارب هضم على كباش تامة النمو باستعمال الدريس كعليقة أساسية وجد أن القيمة الغذائية للعرش ٤٥٫٥٢٪ معادل نشا و ٥٧٫٢٢٪ مركبات مهضومة كلية وأن القيمة الغذائية للدرنات تساوى ٥٠٫٢٧٪ معادل نشا و ٥٥٫١١٪ مركبات مهضومة كلية وذلك فى المادة الجافة هوائيا كما وجد أن النسبة الغذائية للدرنات ١ : ٤ مما يكن معه استخدام هذا المحصول فى علائق الحيوانات النامية ومواشى اللبن .

وهذه الدراسة تسترعى الانتباه لاجراء مزيد من الدراسة على هذا المحصول فى المستقبل حيث يمكن استخدامه بنجاح كمحصول علف مما يساهم فى حل النقص الحاصل فى مواد العلف اللازمة لتغذية الحيوان .

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THE MAINTENANCE REQUIREMENT OF ENERGY (SV or TDN) FOR MATURE SHEEP IN PROLONGED FEEDING TRIALS

By

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Four experiments with 5 mature Ossimi rams and 5 Rahmani ones fed individually on different levels of clover hay A (4 treatments), clover hay B (3 treatments), clover hay B + wheat straw (3 treatments) and clover hay C (3 treatments) were undertaken to find out the suitable level which would maintain body weight for a prolonged period of 12 weeks. The feeding value (SV, TDN and DP) of the feeds was determined in four digestion trials including N-balance with duplicate mature sheep, N-balance insured that rations included more than required for experimental sheep from digestible protein for maintenance.

Results indicated that 0.90 kg. hay A (276.3 g. SV, 451.3 TDN), 0.90 kg. hay B (267.0 g. SV, 445.8 g. TDN) and 0.75 kg. hay B + 0.25 kg. wheat straw (279.5 g SV, 465.2 g. TDN) are mininum energy level for mature sheep of ca. 18 months old of 37.0 to 41.2 kg. At more advanced age (2.5 years), a level of 1.00 kg. hay C (317.9g. SV, 500.6 g. TDN) was necessary for maintaining the same sheep when having heavier weights of 53 to 56 kg. The average requirements per unit metabolic body size ($Wkg^{0.75}$) were 17.8 g. SV or 29.2 g. TDN at younger ages of lower weights, being lower (15.8 g. SV or 24.8 g. TDN) with old sheep having higher weights. Kellner's crude fibre deduction (0.58 SV/unit crude fibre in roughages) was criticized, suggesting reducing it to one third (0.20 SV/unit crude fibre) when calculating SV for maintenance with roughages and not for fat production.

For maintaining mature sheep a range of 310 to 582 g. starch value (SV) per day was recorded (310 g., Ghoneim *et al.* 1960 ; Breirem, 1947 ; 485.2 Watson, 1949 ; 550 g., Ghoneim, 1967 ; 567 g. Woodman *et al.* 1937 ; 571 g., Wood and Capstic, 1926 ; and 582 g., Evans, 1960). As total digestible nutrient (TDN), Brody *et al.*, 1934, recommended 320 g. Garret *et al.*, 1959, 520 g. and the N.R.C. (National Research Council, U.S.A.). by Pope *et al.*, 1957 being 590. A range of digestible organic matter (DOM) of 320 to 516.4 g. was recommended (Longland *et al.* 1963) ; Lamborne and Readon, 1963 ; g. was recommended (Longland *et al.*, 1963; Lamborne and Readom, 1963 ; and Butterworth, 1966.)

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Regarding the basal metabolism (BM), Kleiber's figure, 1961 of 70 Kilocal per unit Wkg. $^{0.75}$ has wide acceptance. Allowing for activity ca. 33% more are recomended for ruminants by Maynard and Loosli, 1956, being 93 Kilocal. Such recommendation transferred to starch value would be 25 grams (assuming 3761 kilocal. metabolizable energy per 1 kg. SV) as deduced by Abou-Raya, 1967, being 387.5 g. for a standard sheep. Blaxter, 1962, indicated that the daily fasting energy metabolism of mature sheep is 58 Kilocal/Wkg. $^{0.73}$ considering that for maintenance 35% more are required, *i.e.* 77 Kilocal being lower than postullated by Maynard and Loosli.

Experimental and Methods

Five adult Ossimi sheep and five Rahmani ones were fed for suitable successive periods on rations starting with *ad libitum* level. Feed restriction was adjusted to the energy level as starch value which would keep constant body weight, in order to find out the minimum level suitable for maintenance. In all feeding trials, it was intended to keep the digestible protein level not less than necessary for maintenance as judged by certain high standards.

Each sheep was kept alone tied by the neck with a loose rope and fixed to the ground in a small fenced area. After each feeding, the sheep was set free in the small fenced area for a certain time. Each sheep had its seperate food compartment and water vessel.

Each sheep was weighed at morning before offering food at bi-weekly intervals in two successive days. The two weights were averaged to the nearest 0.5 kg. The average gain in each treatment was determined; its significance from zero gain was tested statistically (nul hypothesis).

The feeding-stuffs offered, from those more economically used for maintenance, included clover hay alone or along with wheat straw. The hay was cut into small pieces to be more easily used. Table 1 illustrates the design of the four experiments using four rations and different levels. The same sheep were used in all experiments. Expt. 1, 2 and then 3 in 1965 and 4 in 1966.

In each experiment the feeding value SV, TDN and DP of the ration and N-balance were determined seperately with two sheep in the metabolic cages using the level of the last suitable treatment in each experiment (treatment 4, 7, 10 and 13). The feeding value of wheat straw was determined indirectly using hay B as a basal ration (treatmen 7).

TABLE 1.– THE SUITABLE ENERGY LEVEL FROM THE FOUR RATIONS AND THE DIFFERENT LEVELS WITH MATURE SHEEP.

Treatment No.	Amount of feed	Average initial weight		Energy level		DP	Experimental period week
		Ossimi	Rahmani	SV	TDN		
	kg.	kg.	kg.	g.	g.	g.	
Expt. 1.– Hay A (30.70% SV, 50.14% TDN and 8.80% DP)							
1	1.25	37.6	39.4	383.75	626.75	110.00	2
2	1.00	38.3	40.2	307.00	501.40	88.00	2
3	0.75	39.5	41.8	230.25	376.05	66.00	2
4	0.90	37.6	39.1	276.30	451.26	79.26	12
Expt. 2.– Hay B (29.67% SV, 49.53% TDN and 10.43% DP)							
5	1.00	37.5	39.0	296.70	495.30	104.30	2
6	0.80	37.9	39.0	236.76	396.24	83.44	2
7	0.90	37.1	38.9	267.03	445.77	93.01	12
Expt. 3.– Hay B + wheat straw (22.81% SV, 37.49% TDN and 2,53 DP)							
	Hay : Straw						
8	0.75 0.30	37.0	39.0	290.96	513.95	85.81	2
9	0.75 0.15	37.9	40.5	256.76	442.71	82.01	2
10	0.75 0.25	34.4	41.0	279.54	465.20	84.57	12
Ext. 4.– Hay C. (31.79% SV, 50.06% TDN and 10.05% DP)							
11	0.90	54.0	56.0	286.11	450.54	90.45	2
12	1.10	52.0	55.0	349.69	550.66	110.55	2
13	1.00	53.0	56.0	317.90	500.60	100.50	12

Results and Discussion

The feeding value of used rations :

The feeding value of the three hays (table 2) was approaching the average feeding value of clover hay in Egypt as recorded by Khafagi, 1967. The three hays could be considered of midium quality, having a feeding value of 30.70, 29.67 and 31.79% SV in hay A, B and C respectively. The feeding value of the straw (23.81% SV) was the same as published in Egypt (Abou-Raya, 1967). The N retention was positive being 5.71, 9.00, 9.31 and 8.01 gN per day in hay A, B, C and hay B : wheat straw mixture respectively indicating the adequancy of N in rations.

TABLE 2.—ANALYSIS (a%), DIGESTION COFFICIENT (b%), N-BLANCE AND FEEDING VALUE OF THE FOUR USED RATIONS, EXPT. 1–4.

Item	Hay A		Hay B*		Hay C		Wheat straw	
	a	b	a	b	a	b	a	b
Analysis and digestion coefficients %:								
Moisture	9.38	—	9.53	—	10.42	—	7.06	—
CP	12.77	68.95	14.58	71.54	15.43	65.10	5.58	45.37
EE	4.57	72.32	3.50	58.03	2.16	39.53	2.04	71.85
CF	30.67	53.01	31.96	54.59	30.10	60.64	24.21	52.50
NFE	26.30	67.17	26.00	65.69	30.96	64.41	47.13	40.25
Ash	16.21	—	14.43	—	10.93	—	13.98	—
Feeding value as fed %:								
DP	8.80		10.43		10 05		2.53	
SV	30.70		29.67		31.79		22.81	
TDN	50.14		49.53		50.06		37.81	
Aver. Wt. of 2 sheep kg.	59.50		55.50		60.00		60.00	
Level of feed g.	900.		900.		1000.		750 hay B + 250 straw	
Level of CP g.	114.95		131.25		154.35		123.32	
Level of DP g.	79.26		93.90		100.50		84.57	
Aver. of N † retained g	5.71		9.00		9.31		8.01	

* Obtained by the difference method using hay B as basal ration.

† N. retention for the mixture.

The gains during the 6 bi-weekly intervals of this final treatment showed no significant gain as follows :

Interval	1st	2nd	3rd	4th	5th	6th
Ossimi, gain, kg.	-0.3	-0.1	-0.1	0.5	0.0	0.1
$\pm S_{\bar{x}}$	0.41	0.37	0.37	0.64	0.16	0.66
Rahmani, gain, k.g.	0.2	0.3	0.0	-0.1	-0.5	-0.8
$\pm S_{\bar{x}}$	0.76	0.5	0.0	0.19	0.5	0.64

Suitable feed level for maintaining mature sheep :

Results in Expt. 1 (Table3) using hay A started with a preliminary treatment No. 1 feeding an *ad libitum* level of 1.25 kg. hay, indicated an average slight increase in both groups of Ossimi and Rahmani. Reducing

TABLE 3.—AVERAGE GAIN IN WEIGHTS OF SHEEP IN DIFFERNT EXPERIMENTS AND TREATMENTS WITH DIFFERENT FEED LEVELS

	Ossimi			Rahmani		
	Av. Final W	Av. $\bar{X}$	gain $S_{\bar{x}}$	Av Final W	Av. $\bar{X}$	gain $S_{\bar{x}}$
Expt. 1.—Hay A Initial W. in Tr. 1,37.6 kg. for Oss. and 39.4 for Rah.						
Tr. 1, 1.25 kg.	38.3	0.7	+0.30	40.2	0.80	0.58
Tr. 2, 1.00 kg.	39.5	1.2	+0.33	41.8	1.60	0.91
Tr. 3 (0.75) kg.	36.8	-2.7	+0.20	38.0	3.80	0.79
Tr. 4,a 0.90 kg.	37.3	-0.3	+0.41	39.3	0.20	0.76
Tr. 4 b, 0.90 kg.	37.5	-0.1	+0.39	39.2	0.10	0.30
Expt. 2.—Hay B Initial W. Tr. 5,37.5 kg. for Oss. and 39.0 for Rah.						
Tr. 5, 1.00 kg.	37.9	0.4	0.18	39.0	0.5	0.27
Tr. 6, 0.80 kg.	37.2	-0.7	0.25	38.0	-1.0	0.50
Tr. 7 *a*, 0.90 kg.	37.0	-0.1	0.29	39.2	-0.3	0.46
Tr. 7 *b*, 0.90 kg.	37.0	-0.1	0.40	38.9	0.1	0.24
Expt. 3.—(0.75 kg. Hay B + Sraw) Initial W. on Tr 8,37.0 kg. for Oss. and 39.0 for Rah.						
Tr. 8, Hay + 0.3 kg.straw	37.9	0.9	0.29	40.0	1.0	+34
Tr. 9, Hay + 0.15 Straw	37.7–	0.2	0.37	40.0	-0.5	0.16
Tr. 10 *a* Hay + 0.25 Straw	37.8	0.4	0.19	40.8	-0.2	0.20
Tr. 10 *b* Hay + 0.25 Straw	37.4	0.0	0.11	41.0	0.0	0.22
Expt. 4.—Hay C Initial W. on Tr 11 54.0 kg. for Ossi and 56.0 for Rah.						
Tr. 11, 0.900 kg.	52.5	-1.5	0.31	55.0	-1.0	0.16
Tr. 12, 1.10 kg.	53.0	0.5	0.22	55.8	0.8	0.34
Tr. 13 *a*, 1.00 kg.	53.1	0.1	0.46	55.9	0.1	0.19
Tr. 13 *b*, 1.00 kg.	53.0	0.0	0.25	56.1	0.1	0.25

(*a*) After 2 Weeks, (*b*) after 12 weeks,

($\bar{X}$, $S_{\bar{x}}$) mean and its error, the hay level to 1 kg. in the 2nd treatment indicated a significant increase with Ossimi and insignifcant with Rahmani (t=3.64 and 4.47 in the respective groups). But following further reduction in treatment 3 to 0.75 kg. hay resulted in highly significant reduction in weight. Raising the hay level to 0.90 kg. in (Tr 4) did not result in any significant gain either after 2 weeks feeding (Tr. 4*a*) or after prolonged feeding for 12 weeks (Tr. 4*a*). It was therefore concluded that under the condition of the experiment, 900 g. hay A (276.3 g. SV or 451.3 g. TDN) would maintain the live weight of mature sheep having an average of 37.5 and 39.1 kg. weight in Ossimi and Rahmani sheep respectively.

Results in Expt. 2 with hay B with the same two groups of sheep confirmed those in Expt. 1. One kg. hay in (Tr. 5) showed an increase in 6 animals and no gain in 4. Reducing the level to 0.80 kg. hay (Tr. 6) showed almost significant decrease with Ossimi (0.7 + 0.25 kg., t = 2.8). Restoring the level to 0.9 kg. kept the weight constant in both groups after 2 weeks or a prolonged period of 12 weeks (Tr. 7 *a* and *b*). The intermediade gains during the bi-weekly intervals of this final treatment were not significant. Here 0.90 kg. hay B (267.0 g. S.V. or 445.8 g. TDN) could be considered a minimun feed level which maintain constant live weight of 37.0 and 40.0 kg. of Ossimi and Rahmani sheep respectively.

In Expt. 3, (Tr. 8 *a*) constant level of 0.75 kg. hay B was offered along with 0.30 kg. wheat straw (Tr. 8) intending to replace straw with some of the clover to reduce feeding cost. A significant increase in weight of both groups was noticed. Reducing the straw to 0.15 kg. in (Tr. 9) a decrease in weight occured in both groups being significant with Rahmani. Raising the straw to 0.20 kg. in Tr. 10, did not show any significant gain after 2 weeks (Tr. 10 *a*) or during the whole 12 weeks (Tr. 10 *b*) as well as at any intermediate bi-weekly intervals of Tr. 10. Therefore, a level of 0.75 kg. hay B + 0.25 kg. wheat straw (279.5 g. S. V. or 465.2 g. TDN) could be considered as a minimun level to restore the weight of adult sheep having an average weight of 37.4 kg. in Ossimi and 41.0 kg. in Rahmani. Results being similar to those in Expt. 1 and 2.

In Expt. 4 which was undertaken with the same groups of sheep in the next year, but when having a higher live weight (53 56 kg.), the level 0.9 kg. hay C was tested in Tr. 11 for comparison with the same level of hay A and B in Expt. 1 and 2 given with lower live weight. In both groups, a significant decrease in weight occured (1.5 $\pm$ 0.31 kg., t = 4.83 with Ossimi and 1.0 $\pm$ 5.16 kg., t = 6.25 with Rahmani). Increasing the level to 1.10 kg. in (Tr. 12) showed a slight increase in weight in both groups approcahing the level of significance. But when reducing the level to 1.0 kg. (Tr. 13) restored the weight of both groups after 2 weeks (Tr. 13 *a*) or after 12 weeks (Tr. 13 b). During the intermediate bi-weekly intervals of Tr. 13, no significant change in weight was achieved. Therefore, heavier weights of sheep (53 kg. from Ossimi and 56 kg. from Rahmani) needs higher level of feed intake for maintenance, the lower limit being 1.00 kg. hay C equivalent to 318.9 g. S.V. or 500.6 g. TDN.

Summarizing the results of the four final prolonged treatments in the 4 experiments, the calculated energy level per unit Wkg. $^{0.75}$ and the standard sheep (45.3g., having metabolic body size of 17.5) would be :

Expt.	Average	Weight	Food Level per unit 0.75 Wkg.		Food level per standard sheep	
			S.V.	T.D.N.	S.V.	T.D.N.
1	Oss. . . .	37.0	18.24	29.80	319.2	521.5
	Rah. . . .	39.1	17.71	28.20	309.9	493.5
2	Oss. . . .	37.0	17.80	29.72	311.5	520.1
	Rah. . . .	40.0	16.79	28.00	293.8	490.0
3	Oss. . . .	37.4	18.48	30.77	323.4	538.5
	Rah. . . .	41.0	17.25	28.71	301.8	302.4
4	Oss. . . .	53.0	16.22	25.54	283.8	447.0
	Rah. . . .	56.0	15.50	24.42	271.2	427.4

It was clear that results in Expts. 1, 2 and 3 were similar in magnitude tending to be slightly higher with Ossimi which have a slightly lower live weight. Such differences could be neglected. Therefore, it could be concluded that with an average weight of 37 to 41 kg. sheep of ca. 18 months old) an average of 17.8 g. SV or 29.2 g. TDN are minimum maintenance requirements for each unit Wkg. $^{0.75}$ the corresponding figures for a standard sheep being 311.5 g. SV and 511.0 g. T.D.N. The S.V. figure was below the range published abroad, the lower figure being that of Bereirem, 1947 (359.0 g.) and the highest of Evans, 1960 (582 g.). The figure obtained here is similar to that of Ghoneim *et al.*, 1960 (310 g. S.V. for 1 year old Egyptian sheep.

With the same sheep at more advanced age (ca. 2.5 years) having average weights of 53 kg. with Aussimi and 56 kg. with Rahmani, it was obvious that the energy level needed for maintenance per unit Wkg. $^{0.75}$ appeared to decrease with advancing age. It could be concluded that for an average live weight of ca. 55 kg., and average of 15.80 SV or 24.80 TDN per unit Wkg. $^{0.75}$ is necessary for maintenance, the corresponding figure for a standard sheep being 275.0 g. SV or 435.0 g. TDN.

In this connection Blaxter, 1965, page 432, discussing the choice of one metabolic body size with Kleiber, 1961, indicated that with advancing age in sheep metabolism per kg. metablic size decreases. This was in accordance with the results here. Sheep at younger age (37—41 kg.) was maintained relatively on a higher energy level per unit metabolic body size than when they were at an advanced age (ca. 55 kg. W).

It is also to be noted that the figure 29.5 g. TDN for maintaining one unit of $Wkg.^{0.75}$ deduced from the equation of Garret *et al.*, 1959, was very the same as that obtained here (29.2 g. TDN) in the first three experiments with sheep having an average weight from 37.0 — 41.0 kg.

It was found in this Department by Khafagi, 1967, studying the digestible energy DE of 16 clover hays in Egypt, (using direct determination in the bomb calorimeter), that the average DE/g. TDN was equal to 4.33 kcal. Therefore, the DE suitable for maintaining one unit $Wkg.^{0.75}$ in this study would be 126.4 kcal. This figure was slightly lower (8.4% less) than that stated before by Garret *et al.*, 1959 (138 kcal).

Moreover, it was noticable that the SV figure obtained here with standard sheep was relatively much lower than the highest one recorded in the literature being 311 against 582, ca. 53% of it. But the TDN figure (515 g. against 590 g.) was 87% of the highest figure of the range.

The reason for this appeared to be due to the fact that Kellner's starch value (usually calculated for fat production) underestimates the feeding value of roughages when used for maintaining animals. This subject was discussed by Evans, 1960, stating that Kellner's SE for hays and straws should be increased by one fifth as already suggested by Wood. He mentioned that Armsby's net energy figures of coarse fodder were distinstly higher than Kellner's ones which underevaluate the productive values of such feeds.

In this connection, Brouwer *et al.*, 1965, mentioned that Kellner deduction of crude fibre (2.2 Kcal per gram crude fibre) in metabolisable energy for fat production appeared to be ca. three times greater than what they found for maintenance using respiration chambers. Their deduction figure was 0.72 kcal per gram crude fibre. In other words, those authors indicate that the crude fibre deducations in starch value unit used by Kellner (0 58 unit SV unit crude fibre) should be reduced to one third, *i.e.* ca. 0.20 unit SV, to calculated starch value of hays for maintenance. This appeared to be physiologically logical because the heat produced from that called "work of digestion" in fat production, would be wasterful. For maintenance it could be fully utilized raising the relative feeding value for maintenance. The same idea was indicated by Abou-Raya, 1967, suggesting 0.20 unit SV deduction per unit crude fibre in hays when calculating the feeding value for maintenance. For example, the feeding value of hay A calculated by Kellner's method as 30.7% SV, should be 42.3% SV when used for maintenance. The increase in feeding value would be 37%. Therefore in expt.

1 for Ossimi sheep, the starch value figure for a standard sheep (317.4 g.) would be 438.0 g., a figure which would be ca. 75% of the maximum figure for standard sheep (582 g.) given by Evans, 1960.

From the previous studies, it was clear that under similar conditions with Egyptian sheep, the minimum energy requirements for maintenance from clover hay (having a feeding value of ca. 30% SV or ca. 50% TDN, the DP being 8% or more) could be covered by 900 g. hay at the age of ca. 18 months (having weights of ca. 40 kg.) and by 1000 g. hay at advanced age (ca. 2.5 years weighing ca. 55 kg). This level would keep the weight of the animal practically constant provided the animals were fed indoors and somewhat confined in narrow pens. The 900 g. of the clover hay could be replaced by 750 g. clover hay and 250 g. wheat straw reducing feeding cost.

Further experiments under other conditions using feed mixtures including concentrates are needed to gain more informations about the sutiable levels for maintaining sheep.

REFERENCES

ABOU-RAYA, A.K., (1967). "*Animal and Poultry Nutrition*". Dar-El-Maaref Lib. (Arabic text book).

BLAXTER, K.L., (1962). "*The energy metabolism of ruminants*". London Hutchinson.

BLAXTER, K.L., (1965). "Energy metabolism" European Assoc. Animal Prod. No. **11** : 432. Proceedings of the 3rd symposium, Troon, Scotland., May (1964). *Academic Press.* London - N.Y.

BREIREM, K., (1947). Calculation of the consumption of feed units by sheep on pasture. Nord, Jordbrugsforsk, **28** : (159) (*Nutr. Abst.* **18** : 900, (1948).

BRODY, S. PROCTER, R.C. and ASHWORTH, U.S., (1943). Growth and development. **34** Basal metabolism, endogenous nitrogen, creatinine and neutral sulphur excretions as functions of bodyweight, *Univ. Missouri, Coll. Agric. Expt. Station.* Research Bull **220**.

BROUWER, E., VAN ES, A.J.H. and NIJKAMP, H.J., (1964). Further investigations on early and late cut hay with some remarks on the design of difference trials. *European Assoc. Animal Prod.* No. **11** : 205. *Proceedings of the* 3rd *symposium*, Troon, Scotland, May (1964). Academic press. London-N.Y.

BUTTERWORTH, M.H., (1966). A note on the maintenance requirement of adult sheep under tropical condition. *Animal Prod.*, **8** : 155 (*Nutr. Abst.* **36** : (1151).

EVANS, R.M., (1960). Rations for livestock. *Bull. No.* **48**, Her Majesty's Stationary Office, London.

GARRET, W.N., MAYER, J.H. and Lofgreen, G.P., (1959). The comparative energy requirements of sheep and cattle for maintenance and gain. *J. Animal Sci.*, **18** : 528.

GHONEIM, A., (1967). "*Animal Nutrition*". Anglo Egyptian Library, Cairo (Arabic text book).

KHAFAGI, E.A.E., MISS., (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.

LAMBOURNE, L.J. and READON, T.F., (1963). Effect of environment on the maintenance requirements of Merino wethers. *Austral J. Agric. Res.* **14** : 272.

LANGLAND, J.P., CORBETT, J.L., MCDONALD, I. and PULLAR J.D., (1963). Estimates of energy required for maintenance by adult sheep. *Animal Prod.*, **5** : 1. *Agric. Expt. Station Bull.* **295.**

MAYNARD, L.A. and LOOSLI, J.K., (1956). "Animal nutrition". 4th. Edit. McGraw-Hill, Book Company, Inc., New York.

POPE, A.L., COOK, G.W., DINUSSON, W.E., GARRIGUS, U.S., and WEIR, W.C., (1957). "Nutrient requirements of domestic animals. V-Nutrient requirements of sheep. *Bull.* 504 *of N.R.C., Washington, D.C.,*

WATSON, S.L., (1949). *"Feeding of the livestock"*. Thomas Nelson and Sons Ltd.

WOOD and CAPSTICK, (1926). Sheep nutrition. *J. Agric. Sci.* **16** : 325.

WOODMAN, H.W., EVANS, R.E. and EDEN, A., (1937). Sheep nutrition. 1. Measurements of the appetites of sheep on typical winter rations together with critical study of the sheep feeding standards. *Agric. Sci.* **27** : 191.

احتياجات الطاقة (معادل نشــا أو مركبات مهضومة كلية) من الغذاء الحافظ للأغنام التامة النمو من تجارب التغذية لفترة ممتدة

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الملخص

اجريت اربع تجارب على خمسة كباش أوسيمى وخمسة رحمانى تامة النمو غــذيت فرديا على مســتويات مختلفة من دريس البرسيم أ (٤ معاملات) ودريس البرسيم ب (٣ معاملات) ودريس البرسيم ب مع تبن القمح (٣ معاملات) ودريس البرسيم جـ (٣ معاملات) وذلك لمعرفة أنسب مستوى غذائى يحفظ وزن الحيوان ثابتا لمدة ممتدة الى ١٢ أسبوعا. وقد قدرت القيمة الغذائية (معادل نشا م . ن ومركبات مهضومة كلية م.م.ك وبروتين مهضوم) لهذه الأغذية المستعملة فى ٤ تجارب هضـــم مع زوج من الكباش التامة النمو مع تقدير لميزان الآزوت الذى أكد أن الأغذية تحتوى على مســـتوى أعلى من احتياج حيوانات التجارب من البروتين المهضوم الحافظ .

وبينت الدراســـة أن ٩٠ر٠ و. كجم دريس أ (٢٧٦ر٣ جم م . ، ٤٥١ر٣ م.م.ك) أو ٩٠ر٠ كجم من دريس ب (٢٦٧ر٠ جم م . أو ٤٤٥ر٨ جم م.م.ك) أو ٧٥ر٠ كجم دريس جـ مع ٢٥ر٠ كجم تبن قمح (٢٧٩ر٥ جم م . ن أو ٤٦٥ر٢ م.م.ك) تعتبر أقل مستوى طاقة مناسب لكباش تامة النمو عمرها نحو ١٨ شهرا أو متوسط وزنها من ٣٧ الى ٤١ كجم ، بينما عند الأعمار المتقدمة (٢ر٥ سنة) يلزم مستوى ١٫٠٠ كجم من دريس جـ (٣١٧ر٩ جم م.ن أو ٥٠٠ر٦ جم م.م.ك) كحد أدنى يناسب العليقة الحافظة لكباش أعلى فى الوزن من ٥٣ الى ٥٦ كجم . وقد وجد أن متوسط هـــذه الاحتياجات منســـوبا لكل وحدة حيز جسم تمثيلى (٧٥ر٠ كجم) يبلغ ١٧ر٨ جم م.ن أو ٢٩ر٢ جم م.م.ك عند السن الأصغر ذى الوزن الأقل بينما عند السن الأكبر والأعلى فى الوزن نقص هــذا المقدار الى ١٥ر٨ جم م.ن أو ٢٤ر٨ جم م.م.ك .

كما انتقد مقدار خصم الألياف لكليبر (٥٨ر٠ م.ن لكل وحدة ألياف خام فى الأغذية الخشنة الجافة) ، واقترح تخفيضه للثلث (٢٠ر٠ وحدة م.ن لكل وحدة ألياف خام) عند ما يحسب القيمة الغذائية للمواد الخشنة لتغذية العليقة الحافظة وليس لانتاج الدهن .

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THE EFFECT OF SOME DIETARY FLAVOUR AGENTS ON GROWTH AND FOOD UTILIZATION FOR GROWING CHICKS

By

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Two feeding trials were conducted on 360 Dokky 4 young chicks (180 chicks for each trial) for studying the effect of some dietary flavour agents on growth and feed efficiency In the first experiment five flavour agents were investigated using a commercial diet. Three flavours of unknown character and two commercial flvours of anise and mint extractives were experimented. All the flavour agents were added ranging from 30 to 50g. per ton diet. Some chicks were taken at the end of the experiment for the flavour detection in the fresh meat. In the second experiment a flavoured high energy diet (excluding mint oil) was tested.

The results showed that :

1. No significant difference ($P = 0.05$) was found either for growth or for feed efficiency, though a trend of slight imprcvement was noted for the flavoured high enery diet.

2. All dietary flavoured agents were not detected in chick fresh meat.

3 Effect of flavoured diets on the live-weight increase and feed efficiency was not of significant importance such as that of the high energy diet.

Numerous references are available on the sences of the fowl (Ewing, 1951; Kare *et al.*, 1957 ; Kare and Pick, 1960) ; and Engleman, 1934, observed that the fowl would discriminate in choice between acids, salts, sweatness and bitterness. Kare *et al.*, 1957, with chicks, used for evaluating 32 flavours in water, concluded that they have a sense of taste. The same authors claimed that the drinking water was considered to be the best medium to permit a greater degree of flavour discrimination. They also, reported that the response to a variety of sweet and bitter flavours suggests that the broad classifications of taste recognized by man are not applicable to the fowl. In this respect, Dukes, 1955, claimed that the fowl keeps food in its mouth a short time and secretes substantially less salive per Kilogram of food consumed than man. Morley and Herbert, 1960, repoted that age was of marginal or no significance in discrimination of flavours.

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Sizemore and Lillie, 1956, with baby chicks. used sythetic poulatry feed flavours contained extractives of anise, rose, cinnamon, lemon and orris with soyameal and corn sugar as carriers, did not find any significant improvement in the body weight. Romesor *et al.*, 1958, found that the addition of imitation strawberry, anise or grape flavours to the diet of growing chicks was without apparent effect on rate of gain in body weight or food conversion. Deyoe *et al.*, 1964, used a commercial flavouring agent containing esters, organic acids and volatile oil, 0.1% of a diet based on maize and soyabean meal. Those workers, however, claimed that the flavours did not improve the body weight, though it significantly improved food conversion. It is worth noting that feeding young calves flavoured diets (Youssef *et al.*, 1969) did not show significant effect on growth and feed utilization.

The present study was carried out to investigate some flavour agents in poultry diets which are suggested for improving growth and feed efficiency.

Experimental

Experiment 1.

Chicks : 180 Dokky 4 young chicks (males and females) were used. The chicks were fed a commercial diet (shown in table 1), for the first week of age. The one-week old chicks were distributed in descending order according to their live-weight in six treatments of three replicates each. The average liveweight was similarly obtained for every ten chicks in each replicate. The chicks were allocated at random up to 8-week old in a commercial battery of five tiers ; each tier was divided into two compartments. The battery was electrically heated for, only, the first 10 days of age ; the room was naturally ventilated and provided with a 200 watt bulb to provide light source at night-time during the experimental period (23.5. 1966-18.7. 1966). The chiks were reared upto 8-week old.

Diet and feeding : The percentage composition and the proximate analysis of the experimental diet is shown in table 1.

Three synthetic flavour agents were partly provided by Firmench Swiss company Geneva. The two other commercial flavours, namely, anise seed and mint extractives were locally produced. The feeding treatments were as follows :

(A) Flavour	51.813 T	30 g. per ton diet
(B) Flavour	52.818 T	50 g. per ton diet
(C) Flavour	52.819 T	50 g. per ton diet
(D) Anise oil		50 g. per ton diet
(E) Mint oil		50 g. per ton diet
(F) Control unflavoured diet		

TABLE 1.—THE PERCENTAGE COMPOSITION AND PROXIMATE ANALYSIS OF THE EXPERIMENTAL DIET, EXP. 1.

Ingredients	Percent	Ingredients	Percent
Ground yellow maize	25	N. Free extract	45.65
Dec. cotton seed meal	25	Crude Fibre	6.12
Sesame-meal	6	Ash	11.06
Rice starch residue	10	Calculated Met. Energ (Kcal/g. diet)	2.41
Wheat bran (fine)	10	Fish-meal	3
Rice bran	10	Bone-meal	1
Maize gluten feed	5	Oyster shell(Pulverized)	1
Meat-meal	2	Lime stone (Pulverized)	1
Proximate Analysis :		Table Salt	0.5
Moisture	9.52	Mineral mixture*	0.5
Crude protein	22.20	Vitamin mixture†	++
Ether-extract	4.52	Other additives‡	+

* Each Kg. mineral mixture contains (in grams) : — Limestone phosphate 560, Calcium hydroxide 305, Sodium chloride 100, Ferric oxide 21, Sulphur 6, magenesium sulphate 11, manganese sulphate 5.6, Cobalt oxide 0.18, potassium iodide 0.4, copper sulphate 0.82.

† To each Kg. diet was added a commercial vit. mix. to provide : vitamin A 10,000 I.U., vitamin D_3 1000 I.U., riboflavin 8.8mg., Calcium pantothenate 8.8 mg., niacinamide 52.8 mg., chloine bitartarate 228.8 mg.

‡ Megasol 1 Kg. per ton diet. Megasol is M, m dinitro diphenyl disulfide (nitrophenide).

To facilitate adding the flavour agents with the basal diet, the compounds were primary mixed with absolute ethyl alcohol (95%). The same amont of ethyl alcohol (350 ml. per feeding lot) was mixed with the control diet. The experimental diets were weighed and freshly mixed wih the flavour agents in polyethylene buckets. The residue and scattered food were weighed every three days to get the food intake.

A ckick of each replicate, that recorded the highest live-weight was slaughtered and dressed for the detection of dietary flavours in the fresh meat.

Newcastle vaccin of eye-drops was used when the chicks were 8-day old. At three weeks old (2 weeks on the experimental diet) symptoms of vitamin E deficiency was observed in various groups. A number of 25 tablets of gelatenized DL-Alpha-tochophyrol acetate (vit. E) (containing 50 mg) were ued in the drinking water for 2 to 3 days until the case was over and chicks became normal.

The proximate analysis of the experimental diets were carried out using the conventional methods (A.O.A.C, 1960). The metabolizable energy for each diet was calculated, using the data recorded by Titus, 1955.

The analysis of variance for the final live-weight for each treatment was made according to Snedecor, 1960.

Experiment 2.

All experimental details were as previously described for exp. 1 other than in the following respect :—

Chicks : 180-day old Dokky 4 female chicks were reared up to 6-week old (from 30.4.1967 to 11.6.1967).

Diet : The percentage and proximate analysis of a high energy diet is shown in table 2. The same previous flavour agents were used excluding the mint oil. A reference group was fed on the commercial diet (table3.) additives free; while only ethyl alcohol was added to the high energy control diet. The experimental flavoured diets were stored in thick poly-then bags and ready for use.

Results and Discussion

Table 4. shows the average live-weights of the experimental chicks for both experiments. It could be seen that the high energy diet gave a similar average live-weight at 6-week old to that recorded at the eighth week for experimet 1. The average live-weight for the unflavoured control diet, treatment F, in experiment 1. was higher (468 g) than for some other flavoured diets. Mint flavoured diet gave the lowest average live-weight (424 g.). Anise oil flavoured diet, treatment D, experiment 1., gave higher value for the final average live-weight of 426g. than for treatment E.

TABLE 2.—THE PERCENTAGE COMPOSITION AND PROXIMATE ANALYSIS OF THE EXPERIMENTAL DIET, EXP. 2

Ingredients	Percent	Ingredients	Percent
Ground white maize	60	N. Free extract	49.41
Soybean meal	25	Crude fibre	5.02
Maize oil	5	Ash	6.14
Fish-meal	5	Calculated M. Energy Kcal/g. diet	3.3
		Bone-meal	2.5
Proximate Analysis:		Lime-stone (pulverized)	1.5
Moisture	10.52	Table Salt	0.5
Crude protein	23.42	Mineral mixture*	0.5
Ether-extract	5.49	Vitamin mixture†	++

* *See footnote table* I.

† To each kg. diet was added a commercial vit. mix. to provide : vitamin A 7500 I.U., vitamin D_3 1500 I.U., Vit. B_1 0.75 mg., vit. B_2 6.41 mg., Calcium pantothemate 9.91 mg., nicotenic acid 42.96 mg., Choline 178.91 mg., Vit. B_6 0.375 mg., vit. B_{12} 0.003 mg., vit. E. 1.875 I.U., vit. K_3 1.5 mg., Proc. penicillin 6.0 mg.

TABLE 3.—THE PERCENTAGE COMPOSITION AND PROXIMATE ANALYSIS OF THE COMMERCIAL DIET, EXP. 2

Ingredients	Per-cent	Ingredients	Per-cent
Ground white maize	25	Ether extract	4.05
Doc. Cotton seed meal	25	N. free extract	51.12
Sesame meal	6	Crude fibre	6.07
Rice starch residue	10	Ash	7.24
Wheat bran (fine)	10	Calculated M. energy Kcal/g. diet	2.41
Rice bran	10	Fish meal	3
Maize gluten feed	5	Bone-meal	1
Meat-meal	2	Oyster-shell (pulverized)	1
		Lime-stone	1
Proximate Analysis :		Table salt	0.5
Moisture	9.75	Mineral mixture*	0.5
Crude protein	21.77	Vitamin mixture†	++

* *See footnote table* 1.

† To each kg. diet was added a commercial vit. mix. to provide : vitamin A 8752 I.U., vitamin D_3 1000 I.U., vit. B_1 0.13 mg., riboflavin 2.4 mg., Calcium pantothenate 13.6 mg., nicotenic acid 14.8 mg., Choline 51 mg., vit. B_6 0.06 mg., vit. B_{12} 0.012 mg., vit. E. 0.51 I.U., vit. K_3 0.75 mg., Proc. penicillin 1.0 mg., Oxytetra cycline 7.0 mg.

TABLE 4.—EFFECT OF FLAVOUR AGENTS ON LIVE-WEIGHT OF CHICKS

Age in weeks		Live weight in grams							
		1	2	3	4	5	6	7	8
Treatment :									
A. Flavour 52.813 T									
	Exp. 1	46	68	111	154	228	295	372	466
	Exp. 2	55	109	189	281	357	452	—	—
B. Flavour 52.818 T									
	Exp. 1	46	66	97	152	207	266	346	440
	Exp. 2	55	106	187	289	366	461	—	—
C. Flavour 52.819 T									
	Exp. 1	45	66	101	145	216	273	370	478
	Exp. 2	54	106	183	276	347	440	—	—
D. Anise oil :									
	Exp. 1	46	70	104	149	213	287	363	462
	Exp. 2	53	103	180	277	349	438	—	—
E. Mint oil :									
	Exp. 1	45	62	96	136	195	259	340	424
	Exp. 2	53	103	178	268	377	425	—	—
Control (H. energy) F. Control (comm. diet)									
	Exp. 1	46	68	100	149	229	294	387	468
	Exp. 2	53	90	136	197	232	306	—	—

Ewing, 1951, suggested that anise oil has been the main flavouring agent in calf meals and in mineral feeds for both livestock and poultry. The synthetic flavour, treatment C, experiment 1 recorded the highest final average live-weight of 478 g. corresponding to an increase of about 2 percent than the control. However, statistical data for the analyses of variance for the final average live-weights, experiment 1, showed no significant difference ($P = 0.05$) between all treatments.

The flavoured high-energy diet, experiment 2, showed higher final average live-weight than for unflavoured control diet. The maximum value was for treatment B, of 461 g. while the minimum value was for the control, treatment E, of 425 g. with an increase of 36 g. corresponding to about 8.5 percent. When a commercial diet, treatment F, experiment 2 was fed, an average final live-weight of 306 g. was obtaiend. The difference between the average final live-weight in treatment F, of 306 g. and the control of high-energy diet, treatment E, of 425 g. was 119 g. corresponding to about 39 percent. It means that the effect of the unflavoured high-energy diet when compared with the unflavoured commercial diet was nearly three times (119/36) that produced by flavouring the high-energy diet. Statistical data for the analysis of variance of the final live-weight, experiment 2, showed no signifcant difference (P=0.05) between flavoured high energy diet and their control. While a highly significant difference (P=0.01) was noted between the commercial diet, treatment F, and those for the high energy diet.

Obviously, a slight increase in food intake of the high-energy diet may have a marked influence in growth than for the lower energy diet (commercial diet).

The detection of flavour agents in fresh meat, experiment 1 was negative. However, Lewis *et al*, 1956, claimed that purified diets consistently and significantly improved the flavour and aroma of light and dark meat, broth and juice of broiler. Newman *et al.*, 1958, with large amounts of various spices in poultry food, claimed that garlic (lb per 5lb food) during 4-day feeding impiared the flavour of the cooked flesh. The other spices (celery seed, allspice, sage and clover) or monosodium glutamate did not significanttly affect flavour. Similarly, Yosida *et al.*, 1964, found no diflerences attributable to diet in flavour of cooked meat.

Table 5 shows the food cnoversion data for both experiments. It could be noticed that in general, feed efficiency values (units food/unit gain) tended to increase with the increase of age.

Expermient 1 gave the highest values at 8-week old reaching 2.91 in anise oil, treatment D, and the lowest value of 2.8 in the control diet. These data indicated that flavour agents did not improve food conversion in the practical diet.

Experiment 2 gave feed efficiency values ranging from 1.96, in treatment C, to 2.01 in the control diet, treatment E. These data may suggest a slight improvement in the feed efficiency by flavouring the high energy diet.

The present data may suggest that adding flavour agents, in general, to chick diet has to be investigated preferably, with high quality diets.

TABLE 5.—EFFECT OF FLAVOUR AGENTS ON FEED EFFICIENCY

Age in weeks	Feed Efficiency (food/unit gain)						
	2	3	4	5	6	7	8
Treatment :							
A. Flavour 52.813 T							
Exp. 1	1.48	1.92	2.19	2.49	2.73	2.82	2.83
Exp. 2	0.92	1.30	1.58	1.87	1.99	—	—
B. Flavour 52.818 T							
Exp. 1	1.46	2.00	2.10	2.53	2.81	2.86	2.90
Exp. 2	0.89	1.29	1.54	1.87	2.00	—	—
C. Flavour 52.819 T							
Exp. 1	1.41	2.02	2.28	2.52	2.76	2.82	2.87
Exp. 2	0.89	1.31	1.57	1.82	1.96	—	—
D. Anise oil :							
Exp. 1	1.54	1.85	2.24	2.55	2.68	2.88	2.91
Exp. 2	0.89	1.29	1.57	1.86	2.00	—	—
E. Mint oil :							
Exp. 1	1.45	1.96	2.18	2.52	2.65	2.72	2.80
Exp. 2	0.92	1.32	1.59	1.83	2.01	—	—
Control (H. energy)							
F. Control (comm. diet)							
Exp. 1	1.42	1.90	2.19	2.43	2.66	2.82	2.85
Exp. 2	1.03	1.68	2.14	2.59	2.68	—	—

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REFERENCES

A.O.A.C. (1960). 9th edition, Published by the Association of Official Agricultural Chemists, Benjamin Franklin Station, Washington 4, D.C.

DEYOE, C.W., M.A.Z. MADERO, R.E. DAVIES and J.R. COUCH (1964). The effect of flavour on the growth and feed utilization of broiler chicks. *Brit. Poult. Sci.*, **5** : 245–247.

DUKES, H.H. (1955). *"The physiology of Domestic Animals"*. Comstack, Ithaca, N.Y.

ENGLEMANN, C. (1934). Versuche uber den Gesch mack von Taube, *Ente und Hunz. Z. verg. Physiol.* **20** : 626–645. Cited by *Kare, M.R., R. Black and E.G. Allison* (1957) Poult. Sci., **36** : 129–138.

EWING, W.R. (1951). *"Poultry Nutrition"*, 4th edition, W. Ray Ewing Publisher, South, Pasadena, California.

FISHER, R.H. and H.M. SCOTT (1962). Flavours in Poultry Rations *Poult. Sci.*, **41** : 1978–79.

KARE, M.R., R. BLACK and E.G. ALLISON (1957). The sense of taste in the fowl *Poult. Sci.*, **36** : 129–138.

KARE, M.R. and H.L. PICK (1960). The influence of the sense of taste on feed and fluid composition. *Poul. Sci.*, **39** : 697–706.

LEWIS, R.W., P.E. SANDFORD, A.T. ERICSON, D.L. HARRISON and R.E. CLEGG (1956). Flavour and aroma of birds fed purified and standard diets. *Poul. Sci.*, **35** : 251–253.

NEWMAN, S., P.J. SCHAIBLE and L.E. DAWSON (1958). Effect of spices in feed on Poultry meat flavour. *Quart. Bull., Agric., Expt. Stat., Michigan,* **40** : 747–753. Nutr. Abst. and Rev., (1959) 29 : 357.

ROMOSER, G.L., E.H. BASSARD and G.F. COMBS. (1958). Studies on the use of certain flavours in the diet of chiks. *Poult. Sci.*, **37** : 631–633.

SIZEMORE, J.R. and R.J. LILLIE (1956). Lack of effect of a synthetic poultry feed flavour on chick growth and feed efficiency. *Poult. Sci.*, **35** : 360–361.

SNEDECOR, G.W. (1956). *"Statistical Methods"* 5th edition. Iowa, State College Press, Ames. Iowa, U.S.A.

TITUS, H.W. (1955). *"The Scientific feeding of Chickens"* 2nd edition, The Interstate, Danville, Illinois.

YOUSSEF, M.S. SALEH, A.M. MAKKY, W.H. ABDEL-MALIK, E.I. SHEHATA and A.A. BAKEER (1969). The effect of some artificial flavours on the growth and feed utilitzation of buffalo and friesian calves. *Agric. Res. Rev., Minis. of Agric.*, U.A.R. (In Press).

YOSHIDA, M., H. HOSHII and H. MORIMTO (1964). Note on the flavour of broiler chickens. *Nutr. Abs. and Rev.* **34** : 284.

تأثير بعض مصادر مكسبات الطعم والرائحة على النمو والاستفادة الغذائية في الكتاكيت

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الملخص

أجريت تجربتان استعمل فيهما خمسة أنواع من مصادر مكسبات الطعم والرائحة حيث استوردت ثلاثة منها غير معروف تركيبها والباقي من مصادر محلية تجارية وهي زيت الينسون والنعناع .

أخذ ٣٦٠ كتكوت دقي ٤ حديثة الفقس (١٨٠ كتكوت لكل تجربة) . في التجربة الأولى أضيفت مصادر الطعم والرائحة الى عليقة المزرعة العادية بنسب تتراوح بين ٣٠ ، ٥٠ جرام لكل طن عليقة . في نهاية التجربة فحصت بعض الكتاكيت المذبوحة لمعرفة تأثير رائحة تلك المواد على اللحم الطازج . وفي التجربة الثانية استعملت نفس المواد السابقة — بعد استبعاد زيت النعناع — وبنفس النسب حيث تم خلطها بعليقة ذات طاقة حرارية عالية .

وقد دلت النتائج على ما يلي :

١ — ليس هناك تأثير معنوي احصائيا (على مستوى ٥٠ر٠) لاضافة هذه المواد المكسبة للطعم والرائحة الى علائق الكتاكيت النامية على النمو والكفاءة التحويلية للغذاء ، غير أنه تبين اتجاه لتحسين طفيف في الكفاءة التحويلية عند استعمال العليقة ذات الطاقة الحرارية العالية .

٢ — لم ينتج عند اضافة تلك المواد أي آثار أمكن التعرف عليها في لحم الكتاكيت المذبوحة .

٣ — كان التأثير الناتج من اضافة مكسبات الطعم والرائحة على الوزن الحي والكفاءة التحويلية أقل بكثير جدا بالنسبة للعليقتين على عكس التأثير الواضح الناتج من استعمال العليقة ذات الطاقة الحرارية العالية حيث وصل الوزن الحي للكتاكيت عند عمر ٦ أسابيع ما وصلت اليه الكتاكيت عند عمر ٨ أسابيع في حالة عليقة المزرعة العادية .

(*) قسم بحوث تغذية الدواجن — الادارة العامة للانتاج الحيواني بوزارة الزراعة الدقي — ج ٠ ع ٠ م ٠

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REPLACING SOME OF CLOVER WITH WHEAT STRAW TO INCREASE THE BALLAST IN FRIESIAN COW'S RATION

By

E.A., GIHAD, I.M. EL-GINDI, and S.M. ABD EL-BAKI,

Comparative feeding trials with Friesian cows were undertaken to study the effect of increasing ballast content(total indigestible organic matter) of berseem by adding wheat straw on milk yield and its constituents using swing-over method.

The control ration was composed of food mixture and wheat straw. The 1st tested ration was berseem fed *ad libitum*. The 2nd tested ration contained berseem to cover the nutritional requirements of cows and wheat straw to raise ballast content up to 4.3 kgs. per 500 kgs. body weight. Four friesian cows were used for a period of 100 days

The 1st tested ration significantly increased the milk and fat yield more than the control ration with $16.89 \pm 2.93\%$ and $12.5 \pm 3.57\%$ respectively. The 2nd tested ration followed the same trend but the increase of milk and fat yields were statistically insignificant. The corresponding increase were $9.22 \pm 2.28\%$ and $7.31 \pm 3.02\%$ respectively.

Feeding the 2nd tested ration saved 55% of the total intake of berseem in the 1st tested one. The average daily intake of berseem fed ad-libitum was 132.8 kgs. with the 1st tested ration while feed intake with the 2nd ration was 58.8 kgs. of berseem and 3.8 kgs. of wheat straw. The average ballast contents in terms of kgs. non-digestible organic matter per 500 kgs. body weight of lactating cows were 4.01, 6.23 and 4.29 kg. with the control, 1st and 2nd tested rations respectively.

The 1st tested ration caused an increase in protein and calcium content of milk, while the 2nd tested ration caused the highest increase in ash content. The yield of nutrients followed the same trend of milk yield.

It was concluded that wheat straw can economically be used as ballast in winter feeding to save the losses in berseem nutrients. Surplus of berseem may be preserved as hay or silage for summer feeding.

احلال تبن القمح محــل جزء من البرسيم لزيادة البــالاست
(المــادة العضوية الغير مهضومة) فى علائق أبقار الفريزيان

* السيد أحمد جهاد ــ ابراهيم محمد الجندى ــ سليمان محمد عبد الباقى

الملخص

أجريت تجارب تغذية مقارنة على أبقار الفريزيان لدراسة تأثير زيادة البالاست فى علائق البرسيم وذلك باضافة تبن القمح ــ ودراسة تأثير ذلك على انتاج اللبن والدهن وعلى مكونات اللبن وذلك باستعمال طريقة «العودة الى بدء » .

وكانت مكونات العليقة المقارنة علف مخلوط وتبن القمح . ومكونات العليقة المختبرة الأولى عبارة عن برسيم للشبع . وكانت العليقة المختبرة الثانية عبارة عن برسيم لتغطية الاحتياجات الغذائية وتبن قمح لزيادة كمية البالست الى ٣ر٤ كجم لكل ٥٠٠ كجم وزن حى .

واستخدمت ٤ أبقار فريزيان فى هذه التجربة لمدة ١٠٠ يوم .

عند استعمال العليقة المختبرة الأولى سببت زيادة معنوية فى محصول اللبن والدهن وكانت هذه الزيادة هى على التوالى ٨٩ر١٦ ± ٩٣ر٢٪ ، ١٥ر١٢ ± ٥٧ر٣٪ عن العليقة المقارنة .

وكذلك زاد انتاج اللبن والدهن عند استعمال العليقة المختبرة الثانية ولــكن كانت الزيادة غير معنوية وهى على التوالى ٢٢ر٩ ± ٨٢ر٢٪ ، ٣١ر٧ ± ٠٢ر٣٪ .

وكان لاستعمال العليقة المختبرة الثانية أثر فى توفير ٥٥٪ من كمية البرسيم المــأخوذة فى العليقة المختبرة الأولى .

كان متوسط كميــة البرسيم المــأخوذ يوميــا للشبع لــكل حيوان فى العليقة المختبرة الأولى ٨ر١٣٢ كجم بينما كان متوسط كمية البرســيم المــأخوذ يوميا لكل حيوان فى العليقة المختبرة الثانية ٨ر٥٨ كجم ، ٨ر٣ كجم من تبين القمح .

كان متوسط كمية البالست المحسوبة لكل ٥٠٠ كجم وزن حى لأبقار الفريزيان فى العليقة المقارنة والعليقة المختبرة الأولى والعليقة المختبرة الثانية هى ٤٠٫١ ، ٢٣٫٦ ، ٢٩٫٤ على التوالى . وادى استعمال العليقة المختبرة الأولى الى زيادة فى كمية بروتين وكالسيوم اللبن بينما أدى استعمال العليقة المختبرة الثانية الى زيادة كبيرة فى كمية رماد اللبن وكذا فى بقية مكونات اللبن الأخرى .

يمكن استنتاج أن تبن القمح يمكن استخدامه اقتصاديا كمصدر للبالاست فى علائق ماشية اللبن فى موسم الشتاء وذلك لتوفير الزيادة المفقودة عن الاحتياجات الغذائية عند التغذية على البرسيم — وذلك لاستعمال الفائض من البرسيم كدريس وسيلاج لاستخدامه فى تغذية الحيوانات فى موسم الصيف .

(*) قسم الانتاج الحيوانى — « فرع تغذية الحيوان » — بكلية الزراعة — جامعة القاهرة — بالجيزة .

24 *U.A.R. J. Amin. Prod.* Vol. **11** No. 2, pp. 273–274 (1971).

NUTRITION AND CHEMICAL STUDIES ON SUGAR-CANE PITH, COTTON SEED HULLS AND DRIED TOMATO PULP.

By

A. Abou-El-Hassan and E. M. Omar

Digestibility trials with sheep, using clocer hay as a basal ration were undertaken to find out the feeding value of the sugar cane pith, cotton seed hulls and the dried tomato pulp. Their chemical composition, digestion coeffcients and feeding value were estimated.

They have feeding value of 22.27, 20.62 and 55.76% as S.V. respectively as fed. The corresponding figure were 49 ; 25, 45.14 and 60.79% as T.D.N. In case of the pith and the hulls, they can be used as common roughages in feeding animals, whereas, the dried tomato pulp can be used as common concentrates. It has a relatively high level of starch value and digestible protein (15.85%) similar to medium those of the undecorticated cotton seed cake.

القيمة الغذائية لنخاع القصب ، قشور بذرة القطن ومخلفات عصير الطماطم (بعد تجفيفها)

الدكتور عبد الرؤوف أبو الحسن محمد ــ الدكتور عصمت محمد عمر

الملخص

لقد أجريت عدة تجارب هضم على كباش تامة النمو مع استخدام الدريس كعليقة أساسية وذلك لتقدير القيمة الغذائية لمواد نخاع القصب وقشور بذرة القطن ومخلفات عصير الطماطم (بعد تجفيفها طبيعيا فى الجو العادى) .

ولقد وجد ان القيمة الغذائية لهذه المخلفات هى ٢٧ر٢٢ ، ٦٢ر٢٠ ، ٧٦ر٥٥٪ معادل نشا (لكل ١٠٠ كيلوجرام مادة غذائية جافة هوائيا) لنخاع القصب وقشور بذرة القطن ومخلفات عصير الطماطم الجافة على التوالى • ووجد أن قيمتها الغذائية على أساس مواد كلية مهضومة هى ٢٥ر٤٩ ، ١٤ر٤٥ ، ٧٩ر٦٠ على التوالى •

من هذه النتائج يمكن استعمال مادتى نخاع القصب وقشور بذرة القطن كالمخلفات الخشنة الشائعة الاستعمال (كتبن القمح مثلا) فى تغذية حيوانات المزرعة ، بينما يمكن استعمال مخلفات عصير الطماطم الجافة بالطريقة الطبيعية كالمواد المركزة الشائعة الاستعمال فى تغذية الحيوان وذلك لأنها تمتاز بقيمتها الغذائية العالية من ناحية القيمة النشوية والبروتين المهضوم وهى بذلك تماثل كسب القطن الغير مقشور تقريبا .

25 *U.A.R. J. Anim. Prod.*, Vol. 11 No. 2, pp. 275-276 (1971).

METHODS OF EVALUATING CLOVER HAY (TRIFOLIUM ALEXANDRINUM) FROM DIFFERENT LOCALITIES

III.- Laboratory Methods for Predicting the Feeding Value and Protein Digestibility

By

A. K. ABOU-RAYA, M. A. RAAFAT,

M. K. HATHOUT and E. M. KHAFAGI

The prediction of the feeding value as total digestible nutrients (TDN) and starch value (SV) in 16 hays by using certain chemical laboratory method to determine digestible laboratory nutrients (DLN) or organic digestible laboratory nutrients (ODLN), was investigated. Prediction of CP digestibility via pepsin HCl digestion was also investigated, using in both cases the already available digestibility trial data with sheep. The following useful prediction equations were found :

$$TDN = 1.24\ DLN - 23.84,\ r = 0.9844$$

$$SV = 1.16\ DLN - 36.99,\ r = 0.8696$$

$$\text{Dig. Coeff. } \textit{in vivo}\ Y = 31.66 + 0.429 \times \text{Dig. Coeff. } \textit{in vitro}\ X,\quad r = 0.8515$$

The equation with DLN appeared to be applicable with negligible deviation. The deviation with SV and Y was more than in case of TDN, but still allowable in practice.

The ODLN figures were similar in magnitude with TDN, predicting the feeding value of the hay directly without any need of prediction equations, but DLN figures gave persistantly high figures than TDN necessitating applying the prediction equation. Pepsin-HCI digestion produced also higher digestibility figures than with sheep, needing to apply the regession for satisfactory prediction.

طرق تقييم دريس البرسيم المصرى (T. Alexandrinum) من مناطق مختلفة
ثالثا ــ طرق معملية لتقدير القيمة الغذائية والبروتين المهضوم

للســادة

أحمد كمال أبو ريه(١) ــ محمد على رافت(١) ــ مصطفى كامل حنحوت(٢)

انشراح عبد الرازق خفاجى(٢)

الملخص

درست القيمة الغذائية على صورة مركبات مهضومة كلية (م.م.ك) ومعادل نشا (م . ن) فى ستة عشر عينة دريس وذلك باستعمال طرق كيماوية معملية معينة لتقدير المركبات المهضومة المعملية (م . م . م .) أو المركبات المهضومة العضوية المعملية (م . م . ع . م) كما درس تقدير هضم البروتين بالبيسين وحامض الايدروكلوريك . ثم قورنت النتــائج فى كلتا الطريقتين بنتائج تجارب الهضم على الأغنام ، ووجدت معــادلات تصلح للتنبؤ بهذه التقديرات وهى :

م.م.ك = ١٫٢٤ م.م.م ــ ٢٣٫٨٤ ، معامل الارتباط = ٩٨٤٤ر

م.ن = ١٫١٦ م.م.م ــ ٣٦٫٩٩ ، معامل الارتباط = ٨٦٩٦ر

معامل الهضم على الحيوان (س) = ٣١٫٦٦ + ٤٢٩ر × معامل الهضم معمليا (ص) ، معامل الارتباط = ٨٥١٥ر

وقد وجــد أنه يمكن تطبيق معادلة م.م.م. لمعرفة م.م.ك ، بفروق قليلة عما فى تجارب الهضم . وكانت الانحرافات لتقدير م . ن أعلى قليلا عنها فى حالة م.م.ك ولكنها فروق مسموح بها من الناحية العملية .

وكانت أرقام م.م.ع.م تتساوى تقريبا لأرقام م.م.ك لكل عينــة دريس ولذلك يمكن التنبؤ بالقيمة الغذائية للدريس مباشرة بدون الحاجة الى معادلات للتنبؤ ، ولكن أرقام م.م.م قد أعطت نتائج أعلى عن م.م.ك بحيث يلزم استخدام معادلة التنبؤ الســابقة لحساب م.م.ك كما أعطت طريقة الهضم بالبيسين نتائج تزيد عن معامل هضم البروتين على الأغنام ، ولذلك فانها تحتاج أيضا الى معادلة التبنؤ السابقة للحصول حسابيا على نتائج يعتمد عليها .

(١) فرع تغذية الحيوان ــ قسم الانتاج الحيوانى ــ كلية الزراعة ــ جامعة القاهرة .

(٢) قسم تغذية الحيوان ــ الادارة العــامة للانتــاج الحيوانى ــ وزارة الزراعة الدقى ــ ج . ع . م .

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DETERMINATION OF PROTEIN MAINTENANCE REQUIREMENTS IN CLOVER HAY FOR MATURE SHEEP USING N-BALANCE TRIALS

By

A. K. Abou-Raya, S. El-Samman, M. A. Raafat and I. M. Soliman

A study was undertaken in 8 N-balance trials each with duplicate nature sheep fed a constant amount of 400 g. maize starch along with variable amounts of clover hay from 600 g. down to 150, to give a decreasing level of N intake in successive trials from 15.09 to 3.91 g. N daily. Linear relations was found between apparent digestible N up to 7.27 g. and retained N (N balance). Minimum intake of digestible N for equilibrium balance and for maintenance was 4.15 g. (26, digestible protein) for an average live weight of 56 kg. being 1.27 g. digestible protein per unit metabolic body size (Wkg. 0.75) corresponding to 22.21 g. digestible protein for a standard sheep of 45.3 kg. To allow for the adult growth it was suggested to take requirements at 1 g. N-balance level corresponding to 32 g. digestible protein. From the linear relation between N intake or hay dry matter intake and faecal N, it was extrapolated that metabolic faecal N=0.58 g. per 100 g. dry matter intake with sheep. The procedure applied for determining metabolic faecal N has its merit to be recommended to avoid non-physiological conditions of the animal. Endogenous urinary N was determined with duplicate mature sheep fed on 200 g. wheat straw and 400 g.maize starch. An average of 0.093 g. endogenous N per 1 W kg. 0.75 was obtined being equivalent to 1.627 g .N/standard sheep. Results with N-balance round neutrality appeared to be more reliable than those relying on endogerous N for deducing the minimum digestible protein requiremtnets. It was realized that recording N requirements as truly digestible N is more recommended than apparently digestible. Decreasing N level in hay : maize starch mixture was associated with a slight increase in apparent digestibility of N and crude fibre at first up to the level of 12.64 g. N then followed by a noticeable decrease in the coefficients as N level decreased there after.

تقدير البروتين الحافظ من دريس البرسيم للاغنام تامة النمو باستخدام تجارب ميزان الأزوت

احمد كمال أبو ريه ــ سعد السمان ــ محمد على رأفت ــ اسماعيل سليمان

الملخص

درس ميزان الأزوت فى ثمانى تجارب كل منها مع خروفين تامى النمو غذيتا على مستوى ثابت من نشا الذرة يبلغ ٤٠٠ جرام مع مستوى مختلف من دريس البرسيم يبلغ ٦٠٠ جرام منخفضا حتى ١٥٠ جراما لتعطى مستوى ازوت يومى منخفض متتابعا فى تجارب ميزان الأزوت من ١٥ جم الى ٣٫٩١ جم .

ووجدت علاقة خطيه بين الأزوت المهضوم ظاهريا وكمية الأزوت المحتجز (ميزان الأزوت) ، وكان أقل مستوى أزوت مهضوم ظاهريا من الدريس الذى يعطى ميزانا محايدا ويكون الأزوت الحافظ هو ٤٫١٥ جم (٢٦ جم بروتين مهضوم) لمتوسط وزن ٥٦ كجم للحيوان ، وهذا يبلغ ١٫٣٧ جم بروتين مهضوم لكل وحدة من حيز الجسم التمثيلى (وحدة وزن الجسم كجم منسوبا للقوة ٠٫٧٥ = و ٠٫٧٥ كجم) . وهذا يبلغ ٢٢٫٢٠جم بروتين مهضوم للخروف القياسى وزن ٤٥٫٣ كجم ، واذا أدخل فى الحساب النمو البالغ فى الحيوان اقترح حساب العليقة الحافظة من البروتين عندما يكون ميزان الأزوت ١ جم الذى يحتاج ٣٢ جم بروتين مهضوم من الدريس .

ومن العلاقة الخطية بين دخل الغذاء من الأزوت أو كمية الدريس مع كمية أزوت الروث ، أمكن استنباط كمية أزوت الروث التمثيلى وهى ٠٫٥٨ جم أزوت لكل ١٠٠ جرام مادة جافة يأكلها الخروف ، وقد اقترح استخدام الطريقة المتبعة فى البحث لأنها تتميز بابتعادها عن الظروف الغير مناسبة فسيولوجيا للحيوان ، وأمكن تقدير أزوت البول التمثيلى مع زوج من الخراف التامة النمو بتغذيتها يوميا على ٢٠٠ جم تبن قمح مع ٤٠٠ جم نشا أذرة ، وقد وجد أنه فى المتوسط يبلغ ٠٫٠٩٣ جم أزوت بول تمثيلى لكل وحدة (و ٠٫٧٥ كجم) وهذا يعادل ١٫٦٢٧ جم ازوت للخروف القياسى .

ويبدو أن نتائج دراسة مستوى الأزوت الحافظ من تجارب ميزان الأزوت القريب من المتعادل يمكن الاعتماد عليها عن تلك المستنتجة من تقدير كمية أزوت البول التمثيلى ، كما تبين أن تسجيل كميـة الأزوت اللازم للحيوان على صورة مهضوم حقيقى أفضل منه على صورة مهضوم ظاهرى، كما وجد ان انخفاض مستوى الأزوت فى مخلوط الدريس ونشا الذرة يكون مصحوبا فى البداية بارتفاع قليل فى معامل الهضم الظاهرى للأزوت والألياف الخام وذلك حتى مستوى ١٢٫٦٤ جم وبعد ذلك يسبب انخفاض مستوى الأزوت انخفاضا ملموسا فى معامل الهضم الظاهرى لكل من الأزوت والألياف الخام متدرجا مع خفض مستوى الأزوت فى الغذاء .

(١) فرع تغذية الحيوان ـ قسم الانتاج الحيوانى ـ كلية الزراعة ـ جامعة القاهرة .
(٢) قسم تغذية الحيوان ـ الادارة العامة للانتاج الحيوانى ـ وزارة الزراعة ج٠ع٠م .