

## Studies on Zinc Retention in Sheep

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A study with Zinc was undertaken in relation to its content in common Egyptian feedstuffs and the balance trials with sheep to establish the possibilities of natural deficiency under normal feeding practices. Routes of excretion and retention per kilogram live weight (LW) of per unit metabolic body size (UMBS) of this mineral were determined. Fourteen balance trials were carried out using two castrated rams nearly equal in body weight ( $\pm 2$  kg) in each trial to study fourteen common Egyptian feedstuffs. These tested feedstuffs consisted of four green forages, two dry roughages, three grains and five milling and factory by-products. Energy and protein requirements were calculated for each experimental animal and the rations were sufficient to maintain nitrogen equilibrium during the trial periods.

Among the fourteen tested feedstuffs, wheat and rice brans recorded the highest values for Zinc (76.4 and 71.9 ppm respectively). Wheat straw contained the lowest amount of Zinc (16.5 ppm). Zinc contents in the rest of the feedstuffs tested layed between these two limits. By comparing the Zinc contents of the tested feedstuffs with the reported requirements of farm animals, it was concluded that Zinc deficiency in ruminants with daily requirements of 8.6-60 ppm was unlikely to happen under normal feeding practices. Turkeys, on the other hand, with daily requirements up to 100 ppm and fed rations consisting mainly of grains and grains by-products could suffer from Zn deficiency. Zinc supplementation in poultry rations in the form of ingredients rich in Zinc should be considered.

Zinc balance was positive in all the tested feedstuffs. Faeces were shown to be the major pathway of Zinc excretion in sheep.

Modern work shows that Zinc is a dietary essential. The functions of Zinc in the body are poorly understood. It occurs in at least three enzymes: carbonic anhydrase, uricase, and kidney phosphatase; and is a part of crystalline insulin. It is widely distributed in the body and appears to be associated with proteins. Slight or moderate deficiencies of Zinc (Zn) in the ration would retard growth (Prasad *et al.*, 1963), lowered feed efficiency (Newland *et al.*, 1958, and Bieson *et al.*, 1962), caused abnormal bone formation (Supplee *et al.*, 1958, and Sullivan, 1931), and lowered fertility (Haaranen and Hyppols, 1931). Phytic acid in soybean meal apparently inactivated some of the Zn in the ration and made it unavailable (Smith *et al.*, 1961, and O'Dell and Savage, 1960). Edwards *et al.*, 1958, reported that Zn in Zinc sulfate, Zinc carbonate, Zinc oxide and Zinc metal was relatively available to young chicks.

The amount of Zn required in a ration varied with the type and level of other minerals in the different constituents of the ration. O'Dell *et al.*, 1958, and Roberson and Schaible (1960) found that increased calcium content of the ration caused a marked increase in the Zn requirement of poultry. Hofer *et al.*, (1960) claimed that para-keratosis in swine occurred at all calcium levels and it was completely by Zn addition. Supplee (1961, 1963) found that high levels of cadmium raised the Zn requirements of turkeys and chicks. Kinnamon and Bunce (1965) found that growth was retarded when molybdenum and Zn deficiencies were combined. The range of Zn requirements recorded by several workers for different animals could be summarized as follows :

Author	Year	Animal	Requirement
Beason . . . . .	1941	Cattle . . . . .	20-30 ppm
Miller and Miller . . . . .	1960	Calves . . . . .	46 ppm
Miller and miller . . . . .	1962	Calves, Sheep . . . . .	0.2 mg Zn/kg. Lw
Miller <i>et al</i> . . . . .	1963	Calves (9 months) . . . . .	8.6 ppm
Lewlor . . . . .	1962	Sheep . . . . .	11-60 ppm
Zeigler <i>et al.</i> . . . . .	1964	Chickens . . . . .	12-29 ppm
Kratzer <i>et al.</i> . . . . .	1958	Turkey . . . . .	66 ppm
Savage and O'Dell . . . . .	1959	Turkey . . . . .	100 ppm

#### Materials and Methods

Fourteen balance trials were carried out to determine Zinc content and retention from common Egyptian feedstuffs using two castrated rams nearly equal in body weight ( $\pm 2$  kg) in each trial. The inside surface of the metabolic cages was covered with polyethylene sheets to prevent contamination of urine with Zinc. Urine was collected in suitable polyethylene bottles and faeces were collected in polyethylene bags. Water was offered ad-libitum and daily water consumption was recorded. Both rations and water were offered in suitable polyethylene containers.

Energy requirements as starch value was calculated for each experimental animal according to Kiaiber (1961) using the following equation :

$$\text{Maintenance requirements in S.V.} = 70 \text{ wkg}^{0.75} \frac{133}{100} \cdot \frac{1}{3761}$$

where W = weight of the animal in kilograms.

Proteins contents of the rations were enough to cover the maintenance requirement as 1.76 g. digestible protein/unit metabolic body size (UMBS) as reported by Kleiber (1961). When wheat straw was tested, it was supplemented with 40g. casein per day to cover the maintenance requirements of protein for rams. Clover hay was used as a basal constituent of the ration when concentrates and green maize were tested to supply half of the daily maintenance requirements of starch value.

The chemical analyses of feedstuffs and faecal materials for moisture and nitrogen followed the ordinary conventional methods of A. O. A. C. (1960). In all samples of feedstuffs, faeces, urine, and water, the modified Zn determination method of Harold *et al.*, (1966) was applied. Unicam spectrophotometer at a wave length of 525 Mu was employed.

### Results and Discussion

#### 1. Zinc content in feedstuffs

In roughages, hay contained the highest amount of Zn and the lowest value was of the first cut clover when calculated on as fed basis. On dry matter basis, Zn content was the highest in hay and the lowest in wheat straw as shown in Fig. (1). Zinc content of hay obtained here was in agreement with that found by Ghoneim (1964) and Jungmann (1961), but higher than that recorded by CNRC (1964). In concentrates, rice bran and wheat bran gave the highest values of Zinc while barley and maize grains contained the lowest values. The American zinc Institute (1966) pointed out that Zn contents were 17.0, 20.0, 30.0, and 80.0 ppm in barley grains, corn grains, rice bran and wheat bran respectively. These figures are in agreement with those found in this study except with the tested rice bran which contained much more Zn than the values cited.

By comparing the results obtained in this study on Zn contents in common feedstuffs and Zn requirements for farm animals (20–30 ppm for cattle up to 100 ppm for turkeys), supplementing Zn appeared necessary in turkey rations as they usually contain high percent of maize and barley grains which contain relatively low amounts of Zn. It is unlikely that ruminants fed on variety of feeds containing roughages and other concentrates to need Zn supplementation.

#### 2. Zinc excretion

With roughages, the percent urinary Zinc excretion ranged between 12.95 and 20.04%. The high urinary excretion percent in wheat straw may be due to the presence of casein in the ration. In this connection Scotte and Ziegler (1963) found that casein improved Zn absorption. With concentrates, Zn excretion percent in urine ranged between 12.54 and 17.1% as shown in Table (1). The previous results are in harmony with those of Mc Conce and Widdowson (1942), Montgomery *et al.*, (1943), Shelton (1943), and Spence *et al.*, (1955) who reported that the gastro-intestinal tract was the major route of Zn excretion through the faeces in all species.

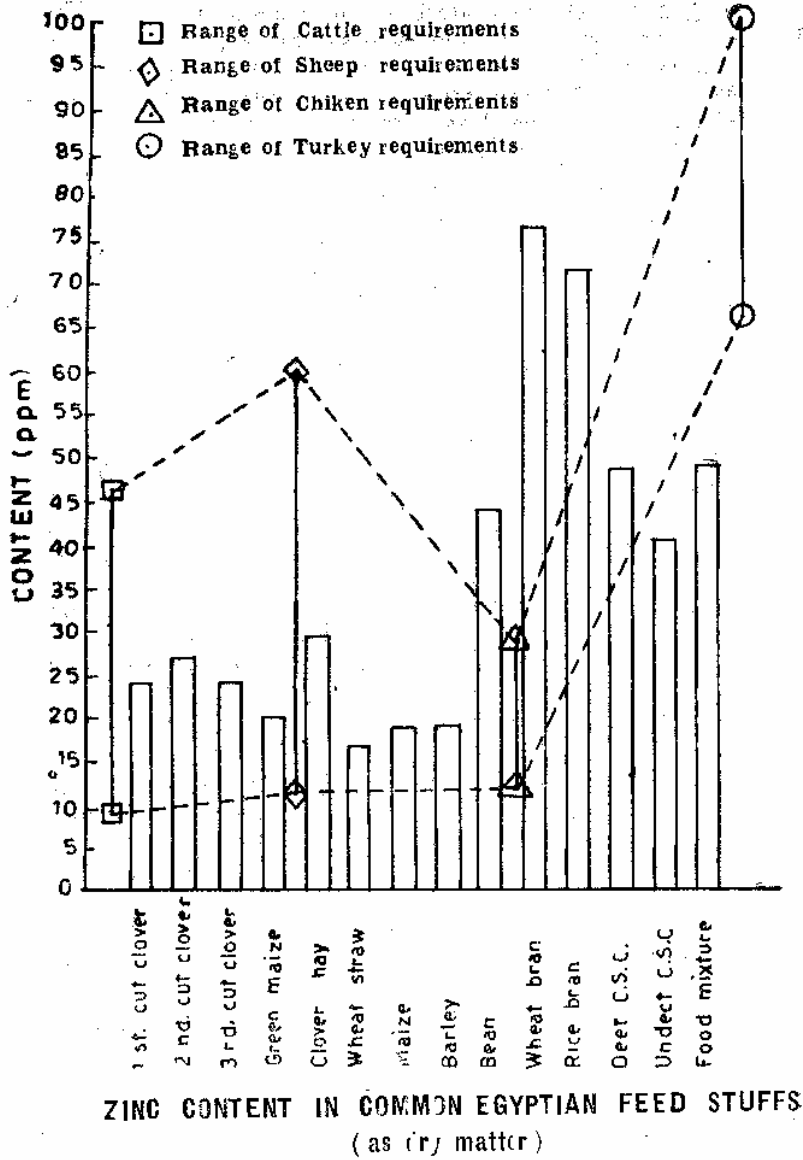


TABLE 1. — AVERAGE DAILY ZINC EXCRETION

Feedstuffs	Total excreted	Zn excretion		Excretion percent	
		in urine	in faeces	in urine	in faeces
	Mg	Mg	Mg	%	%
<i>Roughages</i>					
1st cut clover . . . . .	8.640	1.676	6.364	20.04	79.96
2nd cut clover . . . . .	13.220	1.940	11.280	14.68	85.32
3rd cut Clover . . . . .	16.4.6	2.128	14.298	12.95	87.05
Green maize . . . . .	20.446	3.414	17.032	16.70	83.30
Clover hay . . . . .	17.882	2.680	15.202	15.06	84.94
Wheat straw . . . . .	6.331	1.090	5.241	17.20	82.80
<i>Concentrates</i>					
Maize grains . . . . .	18.150	2.981	15.169	16.42	83.58
Barley grains . . . . .	17.729	2.982	14.747	16.81	83.19
Bean grains . . . . .	18.480	3.035	15.445	16.44	83.56
Wheat bran . . . . .	33.774	4.255	29.519	12.54	87.46
Rice bran . . . . .	22.475	3.848	18.627	17.10	82.90
Dec. Cotton. S.C. . . . .	24.898	4.208	20.690	16.90	83.10
Undect. Cotton. S.C. . . . .	21.008	3.056	17.952	14.54	85.46
Feed mixture. . . . .	28.126	3.892	24.234	13.84	86.16

### 3. Zinc retention

#### 3.1. Roughages

Zinc balance was positive in the three cuts of clover as shown in Table (2). Concerning Zn retention per kilogram liveweight (LW) or per unit metabolic body size (UMBS) the results indicated that the highest retention value was in the 2nd cut clover. Abd-Elmotagalli (1966) found that the 2nd cut clover was the lowest in calcium compared with that of the 1st and 3rd cuts. In this connection, Lewis *et al.* (1956) found that increased dietary calcium decreased Zn absorption. The results obtained here in agreement with their findings. With green maize, Zn balance was positive. The retention percent was lower than that of the 1st and 2nd cut clover, but higher than that of the 3rd cut. The results indicated that the amount retained per kg LW or per UMBS was higher than that of the different cuts of clover.

Zinc balance was positive in both clover hay and wheat straw. Zn retention percent in hay was lower than that in wheat straw. The results indicated that both Zn retained per kg LW and per UMBS were higher in hay than that in wheat straw plus casein. These results are in agreement with the results of Moeller (1958), Morrison and Sarett (1958), and Pensack *et al.*, (1958).

#### 3.2. Concentrates

Positive Zn balance was obtained with all grains and by-products. Zinc retention values were the same when the animals fed grains (Table 2). The retention per kg LW and per UMBS was the highest in broad beans followed by barley and maize grains. Within the by-products, wheat bran gave the highest values of Zn retention per kg LW or per UMBS while decorticated cottonseed cake gave the lowest values.

From the previous data it can be concluded that the level of Zinc in the tested common Egyptian feed stuffs could provide sufficient amounts of Zinc for ruminants. When zinc contents of normal constituents of poultry ration, especially turkeys' ration, was compared with their requirements, the possibility of Zinc deficiency could be a problem. Supplementation of turkeys' ration with Zinc was suggested. The addition of casein to a ration of plant sources increased Zinc availability and absorption as clarified by the increased urinary excretion of Zinc under such feeding practices. The gastric-intestinal tract was the major excretion pathway of Zinc in sheep.

TABLE 2. — DAILY RETENTION OF ZINC PER KG LM OR PER UMBS

Feedstuffs	Intake	Retention	Retention	Retention	Retention
	Mg	Mg	%	kg. LW	UMBS
<i>Green roughages</i>				µg	µg
1st cut clover . . . . .	17.150	9.110	53.12	153	425
2nd cut clover . . . . .	19.943	6.723	33.71	179	444
3rd cut clover . . . . .	22.876	6.426	28.30	164	411
Green maize <sup>2</sup> . . . . .	30.444	9.998	32.86	192	516
<i>Dry roughages</i>					
Clover hay . . . . .	25.910	8.129	31.65	208	518
Wheat straw <sup>1</sup> . . . . .	11.198	4.866	43.44	149	356
<i>Grains</i>					
Maize . . . . .	26.404	8.254	31.32	159	428
Barley . . . . .	26.240	8.510	32.43	167	447
Beans . . . . .	27.132	8.653	31.97	227	576
<i>By-products<sup>2</sup></i>					
Wheat bran . . . . .	47.422	13.648	28.82	359	893
Rice bran . . . . .	33.670	11.196	33.24	332	801
Decort. Cottonseed Cake . . . . .	35.856	10.958	30.56	211	567
Undecort. Cottonseed cake . . . . .	31.061	9.926	32.46	249	627
Feed mixture . . . . .	42.094	13.968	33.17	260	685

1. Supplemented with 40 grams casein/animal/day.

2. Half of the energy requirement was covered from clover hay.

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## دراسات عن احتجاز الزنك في تغذية الأغنام

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كان الغرض الاساسى من هذه الدراسة هو معرفة محتويات مواد العلف،  
المهضية من الزنك مع اجراء تجارب هضم وميزان لهذا العنصر المعدنى  
لتوضيح احتمال وجود نقص غذائى تحت ظروف التغذية المادية باستخدام  
كباشين مخصيين متقاربين فى الوزن (  $\pm 2$  كجم ) وقد اجريت اربعة عشر  
تجربة هضم لدراسة اربعة عشر مادة علف واشتملت مواد العلف هذه على  
البرسيم بحشائه الثلاث والندراوة والذرة والدريس والشعير والفول والردة  
والرجيع وكسب بذرة القطن المقشور وغير المقشور والعلف المخلوط .  
تغطى احتياجاته اليومية خلال فترة تجربة الهضم . ولقد جمعت عينات ممثلة  
لكل من العليقة والروث والبول لتقدير النتروجين والمادة الجافة باستعمال  
طرق التحليل المادية . وقدر الزنك فى كل العينات بالطرق اللونية .  
وحسب المختون من كل عنصر باستعمال النتائج المتحصل عليها من تجارب  
الهضم والميزان .

ويمكن تلخيص النتائج المتحصل عليها فى الآتى :

١ - اظهرت نتائج ميزان الازوت ان الحيوانات حافظت على وزنها  
وكان ميزان الازوت بها موجبا خلال تجارب الهضم الاربعة عشر .

٢ - اتضح من نتائج التجارب على الاربعة عشر مادة غذائية المختبرة  
ان الردة ورجيع النكون يحتويان على اقل نسبة من الزنك فكانت ٧٦٤ و  
٧١٩ جزء فى المليون لكل منهم بالترتيب . اما تبين القمح فقد احتوى على  
اقل نسبة من الزنك وكانت ١٦٦ جزء فى المليون . وتراوحت محتويات  
المواد الغذائية المختبرة الاخرى بين هذين الحدين .

٣ - عندما قورنت محتويات هذه المواد الغذائية المختبرة من الزنك  
مع احتياجات حيوانات المزرعة التى حصل عليها من المراجع المنشورة  
سابقا كان من الممكن استنتاج بعد احتمال حدوث نقص غذائى من الزنك  
فى الحيوانات المجيرة والتى تتراوح احتياجاتها من الزنك ما بين ٨٦ الى  
٦٠ جزء فى المليون فى اليوم خاصة وان مكونات علائق الحيوانات المجترة  
غنية بطبيعتها فى الزنك ما عدا تبين القمح .

٤ - اختلف الوضع بالنسبة للطيور وخاصة الدجاج الرومي حيث أن احتياجاتها اليومية تصل الى 100 جزء في المليون وتكون علاقتها من مركبات فقيرة بطبيعتها في الزنك مثل الحبوب ومخلفاتها .

وعلى ذلك يمكن القول أن نقص الزنك في الدجاج الرومي بالذات وفي الدواجن عموما احتمالاته قوية ، ويلزم أن يضاف الى علاقتها مصدر غنى من الزنك .

٥ - وجد أن الروث هو الطريق الرئيسي لاجراج الزنك في الاغنام .

٦ - اتضح من الدراسة أن اضافة الكازين ( بروتين اللبن ) الى عليقة أساسية مكونة من تبن القمح قد رفع من مقدرة الحيوان على امتصاص الزنك الموجود بالمليقة وكان الدليل على ذلك هو زيادة اجراج الزنك في البول مع بقاء ميزان الزنك موجبا .