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دراسة تأثير التسمم الصناعى الكبريتى فى الأغنام والماعز فى مصر

ثابت ابراهيم ، فوزى عيد شعبان ، سيد العمروسى

تم خلال هذه الدراسة بحث تأثير التلوث بغازى ثانى أكسيد الكبريت المتصاعدين من مصنع السوبر فوسفات بمنطقة منقباد بأسيوط على الأغنام والماعز وتحليل مصل وبول هذه الحيوانات لمعرفة معدل الكبريت والنحاس والموليبيدنم . وقد اتضح نتيجة لهذه الدراسه وجود ارتفاع معنوى فى معدل الكبريت فى المصل مع انخفاض معنوى فى كل من عنصرى النحاس والموليبيدنم . وكذلك تم تعين معدل الكبريت فى صوف هذه الحيوانات وقد اثبت وجود ارتفاع معنوى فى هذا العنصر مما قد يعطى أهمية كبرى فى تشخيص حالات التسمم بهذه الغازات عن طريق تحليل الصوف .

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INDUSTRIAL SULPHUR TOXICITY IN SHEEP AND GOATS IN EGYPT.

(With One Table and 6 Figures)

By

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SUMMARY

Some studies have been carried out to investigate the effect of environmental pollution by SO_2 and SO_3 which are being currently emitted from super-phosphate factory, at Manquabad, Assiut province. During this investigation 162 sheep and goats were chosen from different areas at variable distances far from the plant.

Analysis of sheep and goats sera and urine were carried out to determine sulphur, molybdenum and copper. Concentrations of sulphur and copper were estimated in the wool of respective animals. Our results revealed highly significant sulphur content in wool, serum and urine, besides lowering in copper and molybdenum sera. The study revealed the importance of prevention of environmental pollution by sulphur compounds as a safe-guard measure to animal health and production.

INTRODUCTION

It has been reported that sulphide is a normal metabolic product of both inorganic (ANDERSON, 1956) and organic (SUTTLE, 1975) sulphur compounds as a result of their reduction by rumen microflora. Subsequent formation of insoluble copper sulphide lowers the availability of dietary copper (DICK,1954 a; SPAIS, 1959). Sulphate decreases retention of molybdenum in sheep by decreasing its reabsorption by tubular epithelium (DICK, 1956 a) and inhibits its absorption in the lower ilium (MASON, and CARDIN, 1977). The two ions having a common membrane transport system, may be the cause of such behaviour.

DICK (1956 ab) reported the induction of dystrophic wool without hypocupraemia with sheep receiving very large supplements of molybdate and sulphate. On the other hand, WYNNE and McCLYMONT (1956), found that when only sulphate supplement was added to the basal diet, liver copper concentrations falls to a level associated with hypocupraemia and hypochromatrichia present before hupocupraemia when the diet contain high level of both molybenum and sulphate.

The super-phosphate production factory at Manquabad (Assiut province, Egypt) has two units; the first for the production of sulphuric acid, while the second for transformation of raw insoluble tri-calcium phosphate through its reaction with $H_2 SO_4$ into soluble monocalcium phosphate (Super-phosphate) and calcium sulphate. The production of $H_2 SO_4$ is carried out through the oxidation of elemental sulphur to sulphur dioxide which passes through sulphuric acid to increase its concentration. During the previous process, excess of SO_2 and SO_3 gasses through further oxidation of SO_3 in the factory were emitted in concentration of 96.120 - 9.99 Kg./hour, respectively. These gasses contaminated the atmosphere outside the factory. In addition, some elemental sulphur stored uncovered inside the plant is emitted outside adding pollution of air.

The effect of environmental sulphur pollution on sheep was the aim of this study with special reference to wool analysis as a means of sulphur intake.

MATERIALS AND METHODS

A total number of 162 Balady sheep and goats, 1½-3 years old,were chosen from different areas in the vicinity of superphosphate factory at Manquabad (Fig. 1). Out of these, 66 animals showed clinical signs of intoxication, mainly anaemia, emaciation, tuffed wool and hypochromatrichia. The rest (96 animals) were apparently healthy. Blood samples were collected from the jugular vein, serum was separated and kept frozen till used. Wool samples picked from different animals were washed thoroughly with bidistilled water and dried in electric oven at 105 °C for 3 hours. Defatting was carried out by petrolium ether for 24 hours till dried again and kept in dry Petri-dishes. Voided urine samples were collected in dry McCkartney bottles from only seven animals from El-Gazira and ten animals from Ilwan and were preserved in ice bags till used.

All glassware, needles and syringes were soaked in 6 N nitric acid plus 25% HCl for 24 hours, rinsed thoroughly with tap water, then washed finally several times with distilled water.

Concentration of copper in serum, urine and wool were estimated by the method described by GUBLER et al. (1952) and sulphur by STOCKHOLM and KOCH's method (1923). Serum and urine molybdenum were determined by Sandele's method (1944). The data obtained were subjected to analysis of variance according to KALTON (1967).

RESULTS

Analysis of serum copper, molybdenum and sulphur collected from the areas, El-Gazira and El-Tawabiya localites around the vicinity of super-phosphate factory, revealed a highly significant lowering in both copper and molybdenum ($P/\_0.01$) and highly significant ($P/\_0.01$) elevation of serum sulphur. The previous localities lie at a distance less than 2 kilometers from the factory.

In all animals of Ilwan, showing no clinical signs, the analysis of serum copper and sulphur were within normal levels. Only those nine animals which were located at El-Gazira and were grazing at Ilwan demonstrated lower serum copper and molybdenum levels ($P/\_0.01$).

Serum sulphur and molybenum from Manquabad sheep were within normal range, while copper serum was significantly lowered.

Concentration of copper, molybdenum and sulphur are illustrated in (Fig. : 2, 3 and 4).

The mean wool copper levels (Fig. 5) of animals from El-Gazira, El-Tawabiya, Ilwan and Manguabad were significantly lowered.

The mean wool sulphur content of animals from El-Gazira, El-Tawabiya and Ilwan were significantly higher than control. However, in the same localities, the animals showing no clinical signs within normal range, while wool sulphur at Manquabad was significantly high (Fig. 6).

Analysis of urine samples of animals form El-Tawabiya showed significant elevation in the concentration of copper, sulphur and molybdenum (Fig. 7). While in Ilwan-animals, these elements were within normal levels. As exception it was found that at El-Gazira investigated animals, copper levels were in the normal range, while elevation of both sulphur and molybdenum were noted.

DISCUSSION

The emission of SO_2 and SO_3 to the surrounding environment from super-phosphate factory may represent nowadys the main source of environmental pollution by these products. H_2S, SO_2 and SO_3 are converted to sulphate in the atmosphere (KELLOGG et al., 1973). Sulphates contaminate vegitation, water and air with subsequent intoxication to human and animals in this area subjected for investigation.

In this investigation, the serum sulphur level recorded highly significant ($P/\_0.01$) increase in animals which showed clinical signs up to a distance of 1.75 Km. far from the factory. However, the same level was determined in other animals without obvious clinical signs in other locatlities up to 1.5 Km. far from the factory. Excretion of sulphur via urine was greater in affected animals.

In the exposed areas close to the factory, wool sulphur content was significantly higher ($P/\_0.01$) in animals showing clinical symotoms than control. In this respect UNDERWOOD (1962) described wool achromaterichia, and DICK (1954 b) found dystrophic wool in case of sulphate intake in sheep but both authors did not estimate serum or wool sulphur. WYNNE and McCLYMONT (1956) reported hypochromatrichia before hypocupraemia was evident. Our results emphasized such an observation where elevation of serum sulphur associated with lowering in serum copper levels of affected animals was obtained. GOODRICH and TILMAN (1966) gave further explanation for the process that lower copper level in animals is due to the effect of increased sulphate intake but not elemental sulphur. The association between pasture elemental sulphur and copper on the status of grazing animals were also discussed in several reports (HARTMAN and VANDER GRIFT, 1964; SPAIS, 1962 and DICK, 1956 a).

Both inorganic and organic forms of sulphur produce sulphide in the rumen of sheep (ANDERSON, 1956). Much evidence supports the idea that the utilization of copper was impaired through the formation of cupric sulphide in

the gut (SUTTLE, 1974).

some animals in the investigated areas although they did not exhibit clinical signs of copper deficiency, yet their serum copper level showed highly significant decrease.

Our investigation showed also a clear relationship between urine copper and sulphur levels. The nearer the area to the factory, the more excretion of urine copper and sulphur occurred.

The wool copper showed significant lowering in both clinical and subclinical cases till 1.50 Km. far from the factory accompanied by higher sulphur level. Although in the animals without clinical signs at Ilwan (1.75 Km.) the wool copper values were within normal limits, yet sulphur level was still higher than normal. We can safely suggest that wool sulphur determination may thus be a more sensitive indicator than serum in assaying animal sulphur status.

The results indicated also a lowering in serum molybdenum level in animals exposed to increased intake of sulphate. Hypomolybdenosis was previously explained by MASON and CARDIN (1977) in similar conditions which was due, in their openion, to suppression of molybdenum absorption. On the other hand, DICK (1954 a,b) explained it on the basis of reabsorption from kidney tubules due to close chemical similarities between $Mo\bar{\bar{O}}_4$ ions and $S\bar{\bar{O}}_4$ that tends to increase flushed molybdate by increase sulphate intake.

Urine molybdenum showed highly significant increase that correlated positively with distance relationship. The relationship between sulphur and wool molybdenum was not determined in these investigations and still need further study.

TABLE (1)

Localities and number of the investigated sheep exposed to sulphur pollution

Areas	Distance from factory (Km.)	Number of animals	Animals with clinical signs		Animals without clinical signs	
			Male	Female	Male	Female
1. El-Gazira :						
A) Gaziret El-Akrad	Adjacent to the factory	28	6	18	1	3
B) Ezbet-Mohamed	1.5	36	-	13	-	23
2. El-Tawabiya	0.75	40	-	17	2	21
3. Manquabad	1.00	11	-	-	-	11
4. Ilwan	1.75	47	-	12	3	32
Total		162	6	60	6	90

REFERENCES

Anderson,C. (1956): "The metabolism of sulphur in the rumen of sheep". N.Z. J. Sci. Tech., 37 : 379.

Dick,A.T. (1954 a): "Preliminary obsevations on the effect of high intakes of molybdenum and inorganic sulphate on blood copper and on fleece in crossbred sheep". Aust. Vet. J., 30: 197.

Dick,A.T. (1954 b): "Studies on the assimilation and storage of copper in crossbred sheep". Aust. J. Ag. Res., 5: 511.

Dick,A.T. (1956 a): "Molybdenum in animal nutrition". Soil Sci., 81 : 229.

Dick,A.T. (1956 b): "Inorganic nitrogen metabolism, P. 445". Ed. W.D. McELYOV. Johns Hopkins Press, Baltimore.

Goodrich,R.D. and Tillman,A.D. (1966): "Copper, sulphate and molybdenum interrelation-ships in sheep". J. Nutr., 90 : 76.

Gubler,C.J.; Lahey,M.E.; Helen,A.; Cartwright,G.E. and Wintrope,M.M. (1952): " Studies on copper metabolism ". A. Method for the detemination of copper in whole blood, R.B.Cs. and plasma. J. Biol. Chem., 196 : 209.

Hartman,J. and Vander Grift,J. (1964): " Jaarbi Inst. Biol. Scheik. Onderz. Landbgewass P. 145 ". Cited by Suttle, 1974.

Kalton,G. (1967): "Introduction to statistical ideas from social scientists". 2nd. Ed. Acad. Press (London).

Kellogg,W.W.; Cadle,R.D.; Allen,D.R.; Lazrus,A.L. and Martell,E.A. (1973): " The sulphur cycle ". Science, Vol. 175 pp. 587.

Mason,J. and Cardin,C.J. (1977): " The composition of molybdate and sulphate ions for a transport system in the ovine small intestine ". Res. Vet. Sci., 22 : 313.

Sandle,E.B. (1944): "Colorimetric determination of traces of metals". Inerscience publishers, Inc., New York. NY.

Suttle,N.F. (1974): "Effect of organic and inorganic sulphur on the availability of dietary copper to sheep". Brit J. Nutr., 32 : 559.

Suttle,N.F.(1975): The rule of organic sulphur in the copper-molybdenum-s interrelationship in ruminant nutrition. Br. J. Nut., 34 : 411.

Spais,A. (1959): "Rec.Med.Vet., 135 : 161". Cited by Spais et al. (1968).

Spais,A.G., Laza,T.K. and Agiannidis,A.K. (1968): Studies on sulphur metabolism in sheep in association with copper deficiency. Res. Vet. Sci., 9 : 337.

Stockholm,M. and Koch,F.C. (1923): "Quantitative Method for the Determination of total Sulphur in Biological Material". J. Am. Chem. Soc., 45 : 1953.

Underwood,E.J. (1962): "Trace elements of human and animal nutrition". 2nd. Ed., pp. 26 Academic Press, N.Y.

Wynne,K.N. and McClymont,G.L. (1956): " Copper-molybdenum-Sulphate interaction in induction of ovine hypocupra and hypocuprosis ". Aust. J. Agr. Res., 7 : 45.

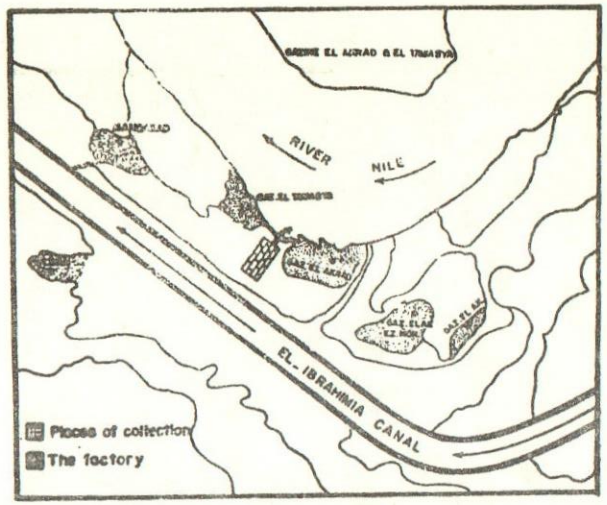

Fig.1:Tepographical Map of the factory and the places of collection of bleed samples from sheep and goats.

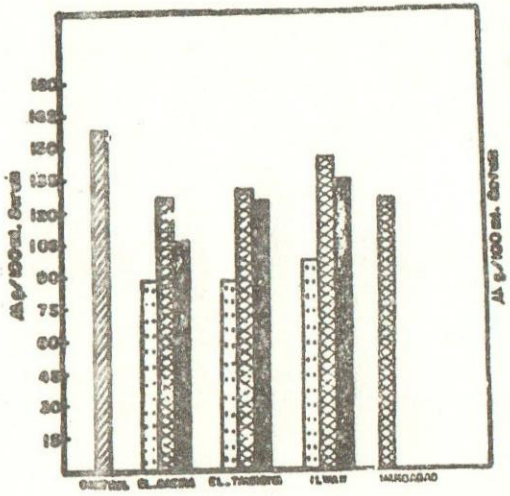

Fig:2 Serum copper level (Ug/100 ml) in animals from different selected areas.

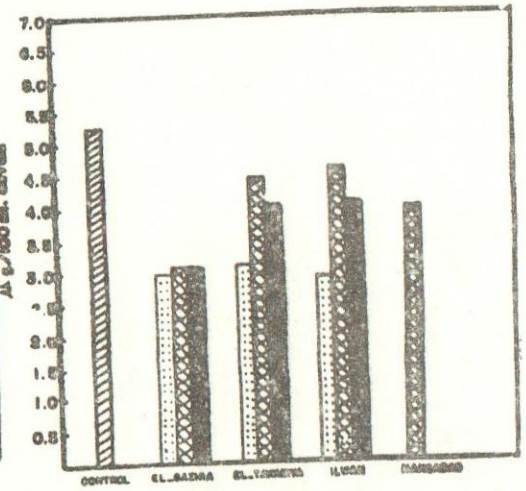

Fig. 3 Serum molybdenum level in animals from different Selected areas.

Animals showing clinical signs of intoxication
Animals showing no clinical signs
Allover mean of tested animals
Control animals

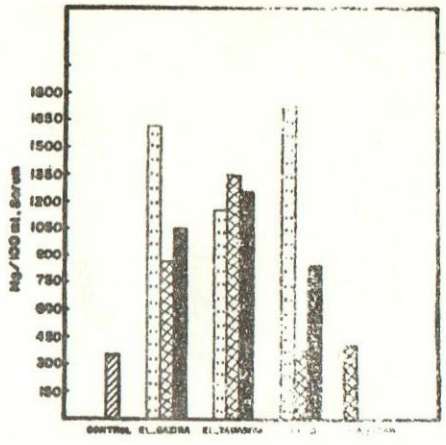

Fig.4: Serum sulpher content (mg/100 ml) in animals from different selected areas.

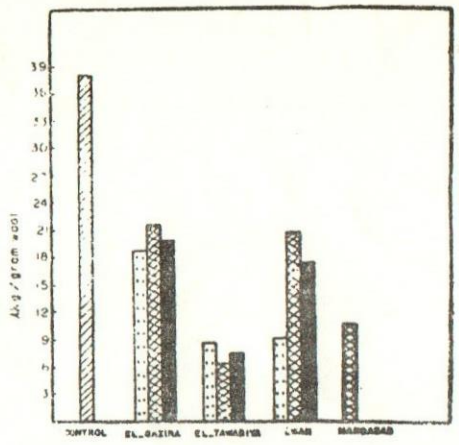

Fig.5 Wool copper content (ug/gram) in animals from different selected areas.

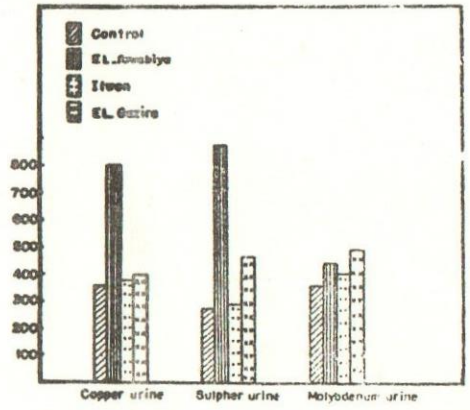

Fig. 7 : Copper, sulpher & molybdenum in urine of tested animals

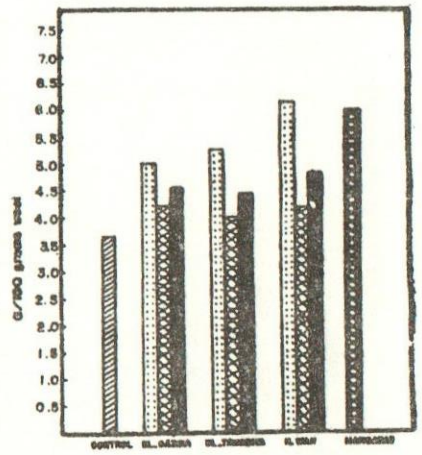

Fig.6 Wool sulpher cotent (g/100) in animals from different selected areas.