A NOTE ON THE EFFECT OF MOLASSES ON LIVER COPPER CONCENTRATIONS IN CATTLE

By R. M. BEAMES, B.Agr.Sc., Animal Research Institute, Yeerongpilly.

SUMMARY.

Three groups of four Hereford heifers were fed individually in stalls for 16 weeks on rations of low quality hay, hay plus molasses, and hay plus molasses and urea. It was found that the last two treatments significantly depleted liver copper concentrations over this period, while the first treatment had no effect in this regard.

I. INTRODUCTION.

The observations in this paper were made in conjunction with an experiment reported by Beames (1959) which was designed to evaluate molasses and urea as a supplement to poor quality hay. In that experiment, three groups of four maiden Hereford heifers were chosen by random selection and individually fed in stalls on the following rations:—

Group 1: Hay *ad lib.*

Group II: Hay *ad lib.* + 1·5 lb. molasses per head per day.

Group III: Hay *ad lib.* + 1·5 lb. molasses + 3·6 oz. urea per head per day.

In addition, all animals received 2 oz. per day of a 50/50 coarse salt-bonemeal mixture. The bonemeal was degelatinised (phosphorus 12·2 per cent., calcium 31·2 per cent., crude protein 10·2 per cent. in the bonemeal). Cobalt chloride was incorporated to supply 17 mg. cobalt per head per day.

The experimental animals were taken from pastures which were known to give low liver copper concentrations in cattle. Copper treatments were given therefore to each animal at the commencement of the experiment. Liver biopsy samples were taken for analysis for copper at the 2nd and 16th weeks of the experiment.

II. METHODS AND MATERIALS.

The feed was analysed by the methods of the Association of Official Agricultural Chemists (1955); molasses as in Laboratory Manual for Sugar Mills (Bureau of Sugar Experiment Stations, Queensland 1954); copper in liver and feed as in Clare, Cunningham and Perrin (1945); and molybdenum and sulphate in feed by the methods of Dick and Bingley (1951), and Bingley and Dick (private communication, 1953) respectively.

Liver samples were obtained by biopsy with the instruments described by Dick (1944) and using the technique of Loosmore and Allcroft (1951). Copper treatments were given intravenously by flutter valve, using 0·5 per cent. copper sulphate ($CuSO_4.5H_2O$) in distilled water.

III. EXPERIMENTAL.

Each animal was given two injections of 50 ml. 0·5 per cent. copper sulphate solution, the first at the commencement of the experiment, the second one week later. Liver samples were taken one week after the second injection and again 14 weeks later, at the conclusion of the experiment.

Representative samples of hay, bonemeal, salt and molasses were analysed.

IV. RESULTS.

Proximate analysis of feeds are given in Tables 1a and 1b. Copper, molybdenum and inorganic sulphate content of all feedstuffs and the average intake of each group are shown in Table 2.

Table 1a.

PROXIMATE ANALYSIS OF BUSH HAY.

—	Percentage Composition (Air-dry Basis).							
	Moisture.	Protein.	Ether Extract.	Fibre.	N.F.E.	Ash.	Calcium (Ca).	Phosphorus (P).
Hay as fed	4·9	3·3	1·0	36·6	44·7	9·5	0·41	0·11

Table 1b.

ANALYSIS OF MOLASSES.

	Per cent.		Per cent.
Moisture	25·5	Potassium (K)	1·99
Sucrose	34·6	Nitrogen (N)	0·8
Reducing Sugars	9·4	Phosphorus (P)	0·05
Ash	14·6	Calcium (Ca)	0·81

Molasses with 17 p.p.m. copper raised the copper intake in Groups II and III. Sulphate intake was increased considerably in Groups II and III because of the high sulphate content (2·33 per cent.) of the molasses. Molybdenum content of the ration was not substantially altered by the addition of molasses. The urea was chemically pure and consequently did not contribute to the copper, molybdenum or inorganic sulphate content of the ration.

Table 2.

COPPER, MOLYBDENUM AND INORGANIC SULPHATE CONCENTRATIONS OF AIR-DRY FEEDSTUFFS AND AVERAGE INTAKES OF GROUPS I., II. AND III.

Copper, Molybdenum and Inorganic Sulphate Concentration.

——	Copper. (p.p.m.).	Molybdenum. (p.p.m.).	Inorganic Sulphate. (%).
Hay	4·4	0·56	0·065
Molasses	17.0	0·21	2·33
Urea		Chemically pure	
Salt	0·6	0·15	0·34
Bonemeal	1·8	0·25	0·59

Mean Proportions in Ration and Mean Daily Intake.

Group.	Total Intake (lb. Air-dry).	Copper.		Molybdenum.		Inorganic Sulphate.	
		(p.p.m.).	(mg.).	(p.p.m.).	(mg.).	(%).	(g.).
I. ..	10·38	4·37	20·6	0·555	2·6	0·07	3·3
II. ..	11·40	6·02	31·3	0·505	2·6	0·37	19·0
III. ..	16·08	5·49	40·58	0·517	3·8	0·27	20·2

Liver copper levels are given in Table 3. There was no significant difference in liver copper level between groups one week after the final injection. Over the experimental period the rise in liver copper concentration in Group I from mean 148 p.p.m. to mean 153 p.p.m. was not significant. The mean falls from 157 p.p.m. to 78 p.p.m. in Group II and 139 p.p.m. to 50 p.p.m. in Group III were significant ($P<0 \cdot 01$). At the conclusion, liver copper level in Group I was significantly greater ($P<0 \cdot 01$) than those in Groups II and III.

Table 3.

LIVER COPPER CONCENTRATIONS.

Group.	Liver Copper (p.p.m.) on Dry-matter Basis.	
	One Week after Injections.	Completion of Experiment.
I.	148	153
II.	157	78
III.	139	50
Difference between I. and II.	N.S.	*
Difference between I. and III.	N.S.	*
Difference between II. and III.	N.S.	N.S.

* P>0·01.
N.S. Not significant.

V. DISCUSSION.

The results show that the supplementing of hay with molasses, either alone or in combination with urea, caused significant reduction in liver copper concentration. This was despite the fact that copper intake was greater in the two groups receiving molasses than in the control group.

These results indicated that some factor or combination of factors in molasses limits copper storage, and led to an examination of the molybdenum and inorganic sulphate levels in the ration components.

The level of molybdenum in these rations (approximately 0·5 p.p.m.) is lower than limiting levels discussed by either Marston (1950) or Wallace (1950), though Dick (1953) stated that an intake of molybdenum of 0·3–0·5 mg. per day for sheep (0·3–0·5 p.p.m. on an intake of 1 kg.) is sufficient to limit copper storage in the presence of sufficient inorganic sulphate. According to Dick, the level of sulphate (0·37 and 0·27 per cent.) in the ration for Groups II and III respectively would be considered sufficient to permit molybdenum to limit copper storage in sheep, while the 0·07 per cent. inorganic sulphate in the ration of Group I would be insufficient. Making the assumption that the above data in sheep would apply to cattle, the reduction in liver copper reserves in Groups II and III could be explained on the basis of a copper-molybdenum-inorganic sulphate interaction.

The findings of Allcroft and Lewis (1956) tend to contradict this hypothesis. These workers recorded levels of copper, molybdenum and inorganic sulphate, similar to those in Table 2, in pastures which did not produce copper deficiency in cattle, and postulated that further potent factors affecting copper metabolism remained to be discovered. Such factors may be present in molasses.

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