Bio-chemistry. — "*On the Influence of the Composition of the Food on the Calcium output*". By Prof. B. SJOLLEMA. (Communicated by Prof. H. ZWAARDEMAKER).

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In my experiments on the influence of cod-liver oil on calcium-, and phosphorus metabolism I found that the economizing effect of cod-liver oil on calcium and on phosphorus, was attended with a decreased production of faeces [1]). The question naturally arose whether, conversely, an augmented production of faeces should result from an increase in the faecal output of calcium and of phosphorus.

The answer to this question is of great importance with regard to our understanding the metabolic phenomena and the physiology of the formation of faeces. The question may be looked at also from a practical point, especially because in experiments with milk-cattle results were repeatedly obtained of late years, which render it highly probable that among the dietetic factors the mineral components are often in the minimum.

In the experiments described below we observed especially the influence of the increase of the quantity of indigestible foodstuffs (ballast) on the calcium- and phosphorus-metabolism. Two ballast-experiments have been performed this summer, both with rabbit III, which since November 1921, was always used for metabolic experiments, and which for chief diet was given a ration of dextrin, lactose, oatstraw boiled with acid and alkali, a calcium-free salt-mixture, a pure protein, viz. casein (afterward partly substituted by gluten of wheat) and a few grammes of butter.

Besides this food-mixture, wheat (whole kernels) was given in the ratio 3 mixture to 1 wheat. In addition almost always 15 grms of cabbage was administered per day. For some weeks the boiled oat-straw was replaced by sawdust boiled with acid and alkali and the cabbage by mangels or carrots.

The calcium-determinations [2]) were made, after destructio of the urine or the faeces, titrimetrically after MC CRUDDEN, as well as nephelo-

[1]) Jubilee-Volume ZWAARDEMAKER. Arch. nêerl. de Physiol. t. VII, 1922.

[2]) The analyses were performed by Miss J. E. VAN DER ZANDE, conservatrix, and by Messrs H. HOOGHOUDT, analyst and H. GIETELING (volontaire).

metrically after LYMAN. The phosphorus-content was determined (also after destruction) nephelometrically and also colorimetrically, after BELL and DOISY's method altered by Briggs.

Both ballast-experiments consisted of: an initial, and a final period, each of a fortnight, in which the food-mixture contained 3 % ballast; intermediate periods of a week, in which the ballast was raised to 15 %, respectively lowered to 3 % and the experimental periods proper, each lasting a fortnight. In the first ballast-experiment there were three experimental periods proper, the middle one with an increased protein-content (10 % gluten of wheat) and cystin. During this experiment 40 mgrms of Ca. (as Ca acetate) was given separately per day, but only 15 mgrs in the final period. In the second ballast-test calcium was administered separately to such an amount (at the most 12.7 mgrms per day) that the calcium-content of the food was the same all through the experiment.

As the diet (without cabbage) was composed of 3 parts of the food-mixture and 1 part wheat, it contained less than 15 % oat-straw, viz. $11\frac{1}{4}$ %.

With a heightened percentage of ballast or protein, the procentic amount of dextrin plus lactose in the food-mixture was lowered in both experiments.

The food was always made into a pap with boiling distilled water. The green-fodder, and in other cases the calcium-acetate was administered separately. The animal was weighed every three days. The weight varied from 3530 to 3570 grammes. The average amounts per day of calcium given off in the faeces and present in the food in the various periods of the two ballast-experiments are expressed in mgr. Ca in the following table:

		Initial-period 3 % ballast	Experimental-period 15 % ballast	Final-period 3 % ballast
Output	1st exp.	30.4	88.4 en 69.3	12.5
	2nd exp.	44.1	66.76	21.1
Intake	1st exp.	59.—	76.—	46.3
	2nd exp.	33.6	35.—	36.4

It appears distinctly from both experiments that the calcium-output in the faeces is increased. The ratio of the output in the initial period to that in the experimental period in the first experiment is about 100 : 250; in the second experiment the ratio is about 100 : 150.

That in the one experiment the rise of the calcium-output differed from that in the other, is no doubt due to the very different amounts of calcium administered along with the ingested food.

The extra-ballast in the experimental period as compared with the initial-period (12 %₀ of the fodder-mixture) amounted in the first experiment to about 19 mgrms per day; in the second (when no sawdust plus straw, but only straw was given as ballast) to only 9.4 mgrms. The increase of the faecal calcium-output is therefore, much larger than the amount of calcium present in the extra-ballast. That the calcium in the faeces was only for a small part derived directly from the food is also clear from the fact that especially in the second experiment the faeces contained almost twice the amount of calcium present in the ingested food.

The increase of the amounts of faeces (air-dried) that were produced in the ballast periods, was very large.

The subjoined table gives the production in grammes.

	Initial-periods	Experimental-periods	Final-periods
1st exp.	5.62	11.9 and 10.5	3.35
2nd exp.	3.62	7.72	3.85

The 12 % extra-ballast in the experimental periods averaged per day in the first experiment about 6,6 grms, in the second 4.7 grms. These values do not differ much from those showing the increments of the faeces production.

In the first experiment the calcium-contents of the faeces (air-dried) were considerably higher during the ballast-periods than in the initial-period; they were lowest in the final-period. (This is most likely due to the smaller quantity of calcium-salts that were administered). In the second experiment the calcium-content of the faeces diminished after the initial-period, which is not surprising if we consider the very great losses and the consequent highly negative balance. In the second experiment the difference between the output and the calcium in the food was about double the difference of the first.

The negative balance is no doubt also answerable for the fact that in the final-period of the second experiment the metabolism of calcium was much more economical than in the initial-period.

Whereas in either period the amount of calcium administered was nearly equal, the output in the initial-period was about three times that of the final-period. When comparing the values of the fore-period and of the experimental period of the second experiment, we see that whereas the quantity of faeces was about the double, the Ca-loss in the faeces was about 1½ times greater than in the initial-period.

The calcium-output via the kidney was in the first experiment during the ballastperiods higher than in the initial- and final-period; in the second experiment there was a gradual decrease of calcium in the urine. This is also most likely attributable to the highly negative balance.

The figures warrant the assumption of a rise of the calcium-output in the urine resulting from a great amount of ballast, if the diet is not too poor in calcium. The quantity of calcium in the faeces was as a rule at least double the quantity of that in the urine.

Regarding the influence of ballast on the phosphorus output we only wish to observe that it was not quite parallel to the influence on the calcium-output. In the ballast-periods the phosphorus-content of the faeces decreased considerably in both experiments.

In a subsequent paper I intend to discuss the nitrogen-, and the iron-outputs in these experiments, and to give the results of the experiments in which we examined the influence of the alkali metals in the food on the calcium- and the phosphorus metabolism.

From the experiments here described it appears:

1. that an increase of the amount of indigestible matter in the food causes a greater loss of calcium via the intestinal canal.

2. that not all the calcium present in the faeces is necessarily derived directly from the food: a large portion of it may be given off by the organism, from which we may conclude that calcium plays a rôle in the production of faeces.

3. that in view of this it is only under certain conditions that an examination of the faeces can show whether in the food or in a part of it (e.g. calcium-salts) calcium occurs in an available form.

4. that in animals, yielding much milk, feeding with much ballast enhances the danger of a negative calcium balance.

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