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Dietary fibre: the effectiveness of a high bran intake in reducing renal calcium excretion

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Summary. Fifteen healthy women were given a standardized calcium-rich diet (1800 mg calcium/day) with or without 36 g bran for 5 days. A similar study was also carried out with rice, soy and wheat bran. Urine samples were also collected 24 h. With all brans renal calcium excretion decreased and renal oxalic acid excretion increased. However, influence of rice bran was statistically significant. After 5 days of consuming 36 g rice bran/day 14 of 15 subjects showed decreased calcium excretion, but increased oxalic acid excretion. Relative supersaturation with calcium oxalate, as a measure for the risk of calcium stone formation, increased after addition of all brans.

Key words: Hypercalciuria – Bran – Renal calcium – Renal oxalic acid – Calcium oxalate supersaturation

The most frequent accompanying symptom of calcium oxalate stones is hypercalciuria. As a dietetic reduction of the calcium intake is often not sufficient to prevent recurrent stone formation, sometimes thiazides are given to reduce the excretion of calcium [4]. However, a long-term therapy with this pharmaceutical is not recommended because of possible side-effects. Controlled intake of dietary fibre is thought to be an alternative to reduce calcium absorption and hence its renal excretion. Several studies have shown that the rate of stone formation actually decreased when bran as a source of dietary fibre was given [2, 5, 7, 9, 11]. However, on the one hand the question arises whether a high bran intake also influences the absorption and renal excretion of oxalate, as previously demonstrated with sodium cellulose phosphate. On the other hand, it might be expected that different types of brans produce different results, since there are great differences with regard to their physical and chemical properties. In this study, we attempted to answer these two questions.

Materials and methods

Three similar studies were carried out using rice, soy and wheat bran, respectively. In each study 15 healthy women aged 18–35 years (mean age, 26.6 years) participated. During first 3 days of each study the subjects consumed 1800 mg calcium/day by eating 150 g Gouda cheese and drinking 1.4 l calcium-rich mineral water (calcium content 350 mg/l) which was added to their individual diets to induce hypercalciuria (preparatory period).

A standardized calcium-rich diet (1800 mg calcium/day) was then given for a period of 5 days. The composition of the diet is listed in Table 1. No bran was given during this period, and 24 h urine was collected. For the following 12 days the subjects consumed their

Table 1. Menu and details of the nutrient content of the standard diet

Breakfast	1 morning roll 1 slice of crispbread 10 g butter 13 g jam 30 g Gouda (45% fat in dry matter) 150 g fruit yoghurt (3.5% fat content) 270 ml coffee (decaffeinated) 30 ml milk
Lunch	60 g braised beef 120 g vegetable 150 g potatoes 30 g Gouda (45% fat in dry matter) 150 g fruit yoghurt 1 apple
Afternoon	1 chocolate bar
Supper	2 slices of wholemeal bread 10 g butter 25 g ham 30 g Gouda (45% in dry matter) 150 g fruit yoghurt 1 tomato
Drinks	1.4 l mineral water (calcium content 350 mg/l) 0.6 l rose-hip tea 0.2 l coffee

Energy: 8945 kJ (2140 kcal); carbohydrates: 242 g; protein: 80 g; fat: 88 g; calcium: 1810 mg; dietary fibre: 27 g

Table 2. Schematic representation of the test procedure

Preparatory period	Period I	Intermediate period	Period II
3 days Individual diet Without bran Calcium supply 1800 mg/day	5 days Standard diet Without bran Calcium supply 1800 mg/day	12 days Individual diet With addition of bran 36 g/ day Calcium supply 1800 mg/day from 10th day	5 days Standard diet With addition of bran 36 g/day Calcium supply 1800 mg/day

Table 3. The influence of 36 g bran on renal calcium and oxalic acid excretion and the relative supersaturation with calcium oxalate under calcium-rich diet; comparison between 5th day (without bran) and 10th day (with bran)

	Type of bran			
	Day	Rice	Soy	Wheat (fine)
Calcium (mmol/24 h)	5	5.75 (2.096)	6.16 (2.310)	5.31 (2.103)
	10	4.57 (1.533)	5.04 (1.932)	4.73 (1.884)
		**	**	NS
Oxalic acid (mmol/ 24 h)	5	0.194 (0.049)	0.198 (0.050)	0.229 (0.054)
	10	0.271 (0.052)	0.216 (0.038)	0.281 (0.072)
		**	NS	*
Relative supersaturation CaOx	5	2.054 (1.086)	1.784 (0.555)	1.897 (0.817)
	10	2.106 (0.793)	1.909 (0.906)	2.288 (1.283)
		NS	NS	NS

Mean (standard deviation), $n = 15$; * $P < 0.05$, ** $P < 0.01$, NS, not significant

individual diets with 36 g bran added to help them adjust to the high intake of dietary fibre (fibre run-in period). During the last 3 days of this period 1800 mg calcium/day with cheese and mineral water were again supplemented. For the next 5 days (period II) the standardized diet described below was ingested; however, 12 g bran was given three times a day and 24-h urines were collected. Table 2 shows the experimental protocol.

Urinary calcium was analyzed by atomic absorption spectroscopy [12] and urinary oxalate was analyzed using ion-exchange chromatography [3]. As a measure of the risk of urinary stone formation, the relative supersaturation with calcium oxalate was calculated with the EQUIL program of Finlayson [6]. Relative supersaturation was defined as the ratio between the activity product for each stone salt in solution and the solubility product of the salt [1].

The Wilcoxon matched-pairs signed-rank test was employed to check for any statistical differences between the test pairs.

Results

The results of the urinary analysis obtained on the last day of both test periods (days 5 and 10) are listed in Table 3. We assessed only the last day of periods I and II, as it is most probable that intra-individual variance is less ("steady state" is reached) on the last day of each period.

Calcium excretion

In all three test series the excretion of calcium decreased with the intake of bran. The reduction was significant with rice and soy bran. The most evident reduction of about 21% was achieved with rice bran. With soy bran the calcium excretion decreased by about 19%, but with wheat bran only by about 11%. Rice bran calcium excretion clearly decreased in 14 of the 15 subjects (Fig. 1a).

Oxalic acid excretion

The excretion of oxalic acid increased significantly with the intake of rice bran and wheat bran; with soy bran, however, the increase was not significant. A comparison of the values obtained in our study with rice bran (Fig. 1b) clearly shows the influence of bran, because the excretion of oxalic acid increased in 14 of 15 subjects.

Relative supersaturation of calcium oxalate

With all brans used in this study we demonstrated an increase in the relative supersaturation of the urines with calcium oxalate. However, the increase did not reach statistical significance. With rice bran a minor increase of 2.5% was achieved. However, the most significant increase (20.6%) was recorded with the intake of wheat bran. Thus, increased oxalic acid excretion has more influence on the relative supersaturation with calcium oxalate than decreased calcium excretion.

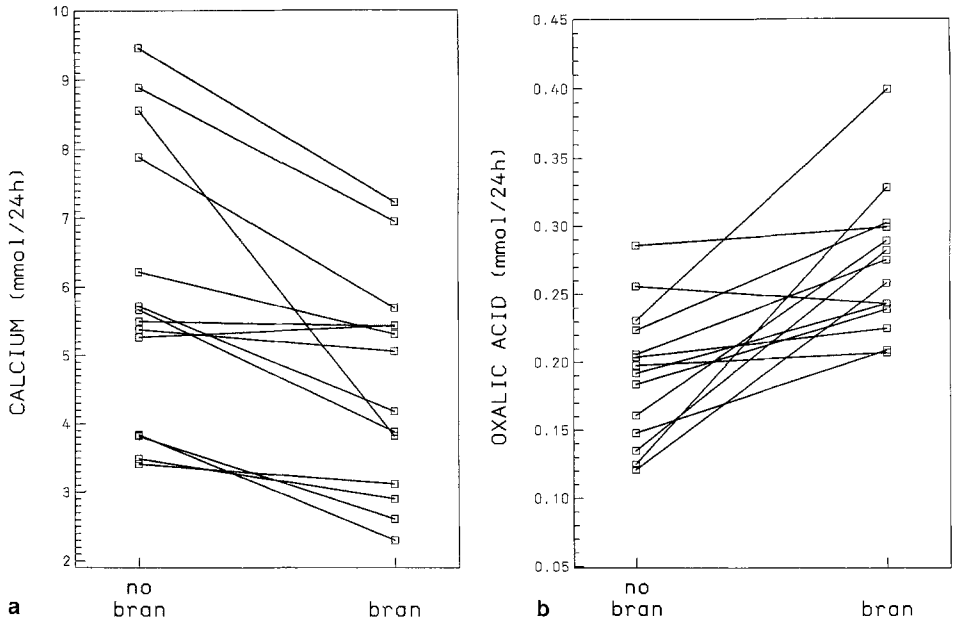

Fig. 1 a, b. Test with rice bran. Individual values for the excretion of calcium *(a)* and oxalic acid *(b)* on 5th day (without bran) and 10th day (with bran) of the test

Discussion

Our investigation have shown that a reduction of calcium excretion can be achieved by an increased intake of bran as a source of dietary fibre. Our findings are therefore in agreement with the observations by Ohkawa et al. [9] who demostrated that the excretion of calcium decreased under rice bran treatment. However, in contrast to the results of the experiments by Jarrar et al. [7], a significant reduction of calcium excretion was not found with wheat bran. Physical and chemical properties of the different brans used may help explain the discrepancy. Our investigations have shown that the phytic acid content of rice bran (97.53 mg/g) is twice the amount found in wheat bran (48.7 mg/g) and nearly 40 times the amount in soy bran (2.46 mg/g). Moreover, the water-holding capacity and content of soluble dietary fibres is relatively higher in rice and soy bran compared to wheat bran. As the phytic acid content in rice bran is nearly 40 times higher than in soy bran, but the effect on renal calcium excretion is similar with both brans, the intestinal formation of insoluble calcium-phytate complexes is unlikely to be the major reason for the reduction of renal calcium excretion. However, the high water-holding capacity and the relatively high content of soluble dietary fibres in rice and soy bran could explain their efficacy due to physical or mechanical effects, such as shortening of the transittimes [11] or changes of the epithelial surface [10]. Leeds [8] found that soluble dietary fibres reduced intestinal peristaltic movements and the intermixture of the intestinal content, which therefore limits the contact between nutrients and mucosal surface.

The increased excretion of oxalic acid that we observed can only partly be explained by the content of oxalic acid in bran. Although rice bran contains half as much oxalic acid as when bran does, with both brans oxalic acid excretion increased significantly. In the case of rice bran it has to be assumed that a reduced intestinal formation of insoluble calcium oxalate complexes was also responsible for the significant increase in oxalic acid excretion. As at the same time excretion of calcium is significantly reduced, the increase in oxalic acid excretion is more likely to be explained by an intestinal reduction of calcium oxalate formation than by the oxalic acid content of the bran.

The increased excretion of oxalic acid that we observed in all our studies suggested that in spite of the reduced calcium excretion, a reduction of the relative supersaturation with calcium oxalate was not achieved. The increase in oxalic acid excretion was not, however, found to be significant. To what extent this tendency continues with long-term intake of bran cannot be resolved by this study.

Jarrar et al. [7] observed an increase in the excretion of oxalic acid until the 18th week of therapy. Therefore, it is doubtful whether the results obtained in this short-term test represent evidence that bran cannot be used effectively in the treatment of hypercalciuria. On the contrary, it has to be assumed that in patients with absorptive hypercalciuria a high bran intake will be more effective in reducing renal calcium excretion than in increasing oxalic acid excretion. Further studies under standardized conditions on patients with absorptive hypercalciuria are necessary to help determine the efficacy of bran or dietary fibre in the treatment of recurrent hypercalciuric stone patients.

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References

1. Ackermann D, Brown C, Dunthorn M, Purich DL, Finlayson B (1989) Use of the computer program EQUIL to estimate pH in model solutions and human urine. Urol Res 17:157

2. Busch B, Hesse A, Vahlensieck W (1988) Rezidivprophylaxe beim Calcium-Oxalat-Steinleiden durch Anwendung eines Ballastoffpräparates (Farnolith®) – ein Langzeitversuch. Urologe B 28:289
3. Claßen A, Hesse A (1987) Measurement of urinary oxalate: an enzymatic and an ion chromatographic method compared. J Clin Chem Clin Biochem 25:95
4. Danielson BG, Backman U, Fellström B, Johansson G, Ljunghall S, Wikström B (1979) Prophylaktischer Einsatz von Thiaziden, Magnesium und Zellulosephosphat. Fortschr Urol Nephrol 14:391
5. deleted in proof
6. Finlayson B (1977) Calcium stones: some physical aspects. In: Davids DS (ed) Calcium metabolism in renal failure and nephrolithiasis. Wiley, New York, p 377
7. Jarrar K, Graef V, Guttmann W (1984) The use of wheat bran in the calcium oxalate metaphylaxis and the decrease of calcium excretion. Urol Res 12:42
8. Leeds AR (1987) Dietary fiber: mechanism in action Int J Obesity 11 [Suppl 1]:3
9. Ohkawa T, Ebisuno S, Kitagawa M, Morimoto S, Miyazaki Y (1983) Rice bran treatment for hypercalciuric patients with urinary calculous disease. J Urol 129:1009
10. Oku T, Konishi F, Hosoya N (1982) Mechanism of inhibitory effect of unavailable carbohydrate on intestinal calcium absorption. J Nutr 112:410
11. Shah PJR, Williams G, Green NA (1980) Idiopathic hypercalciuria: its control with unprocessed bran. Br J Urol 52:426
12. Wurst RE (1973) High precision high-speed analysis for calcium and magnesium in serum and urine. Clin Chim Acta 45:105

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