EFFECT OF CALCIUM SOURCES ON DOUGH PROPERTIES AND CALCIUM BIOAVAILABILITY

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(Manuscript received 7 December, 1998)

Abstract

No significant differences were observed in the relative bioavailability (R.B) of calcium among the studied sources of calcium. Organic sources such as calcium and calcium lactate had the highest (R.B)104%, while calcium sulphate gave 102.7% and the supplement gave 102.4% R.B. compared to calcium carbonate (100% absorption). These data suggest that calcium carbonate and calcium sulphate may be considered as a good sources for bread fortificat. Calcium was equally well available from all studied calcium sources , This is based on the results and status of calcium femur content and calcium absorption. Meanwhile, calcium sources had no effect on the rheological properties of studied doughs.

INTRODUCTION

A large percentage of Americans fail to meet currently recommended guidelines for optimal calcium intake NIH (1994). Although dairy products, a naturally rich calcium sources, are considered the major source of calcium in human diet (Bemer et al., 1990), calcium fortified food and other foods may provide significant amounts to reach optimal calcium intake. Calcium fortified foods may serve as an important source of calcium only when the added calcium show biovailability equal, or near equal, to that of calcium in dairy products or calcium supplements which are now widely consumed (Ranhotru et al. (1980). This study was conductted to determine the effect of calcium sources on both rheolo~oical properties of the doughs and the bioavailability of calcium of the produced bread as rats diet. MATERIALS AND METHODS

MATERIALS AND METHODS

Different calcium sources were used in this study. Calcium carboate and calcium sulfate as inorganic sources while calcium citrate and calcium latate were used as organic sources, on the other hand a brand name Ca supplement was tested. The brand name Ca supplement contained Ca gluconate, Ca lactate and Ca carbonate. Al1 sources were analyzed for Ca content and were used to fortify flour used in making bread. Calcium was added to flour at twice the level mandated under the flour enrichment standardses (CFR,1996). Straight dough method was used for pan bread making. The tested pan bread made from 73% extraction commercial flour was made according to the AACC (1995) method.

The methods of the AACC (1995) were used for the rheological properties, farinogrames and extensogrames of the dough. Diets were formulated with air-dried and finely ground breads to contain 0.3% calcium. This level represents 60% of the requirement for rats ENRC (1987).Table 1 shows the tested model used in this study. Diets were complete in nutrients required by the rat including phosphorus which was provided at lt 0.05% level. Male tested rats were housed individually in suspended mesh-bottom stainless-steel cages (fecal collection trays underneath) controlled, under environment (25^{o}C, 60% RH, 12 hr. light and dark cycle). After two days as adaptation period, and mals were weighed and assigned by selective randomization to five groups, 10 animals each. They were then fed test diets for four weeks. Four rats were scarified on day 0 to obain base line tissue Ca contents.

Animals were fed daily. Their food intake was increased gradually but differed minimally among the groups. These minimal differences were also adjusted so that food intake was identified among the groups. Animals were weighed weekly and feaces were collected for each individual rat for the entire four-week period-air-dried finely ground and stored for Ca determination. At the end of the study period, the animals were lightly anestthettized under ether and 2 ml of blood was taken by cardiac puncture. The clotted blood was centri fuged (10 minutes) to obtain serum for Ca analysis. Rats were then killed and the right femurs were removed, cleared of adhering tissues, dried and saved for Ca determination. On the other hand, total phosphorus, protein, fat and dietary fiber in bread products were determined according to the AACC (1995) method. Calcium in calcium sources, finely ground breads, test diets, serum and femurs (ether extracted and vacuum-dried) was determined using atomic absorption spectrophotometery according to the AOAC (1990) methods. Finally, the given data were subjected to analysis of variance using Sigma state statistical software (Jandel Scientific Soft ware, San Rafael, CA).

RESULTS AND DISCUSSION

The results presented in table 1 show that calcium carbonate had the highest Ca than the other sources 36.5% followed by calcium sulfate 21%, while calcium lactate had the lowest value 12.01%. Meanwhile calcium carbonate is also less expensive. Also, other sources have been introduced, i.e, Ca sulfate which is used in many food products, Ca carbonate is the major and/or the only Ca source in many countries and Ca supplements, Ranhotra *et al.* (1980) and Ranhotra *et al.* (1997).

Table 1. Calcium sources and the composition of the test diets.

Content	Calcium sources				
	Citrate	Lactate	Carbonate	Sulfate	Supplement*
Ca in Ca source %	19.93	12.01	36.50	21.06	17.33
Diet composition %					
Bread	71.4	72.0	70.96	73.36	76.76
Casein	9.08	9.0	9.16	8.92	8.58
Corn oil	3.25	3.0	3.0	3.08	3.17
Cellulose powder	0.33	0.25	0.3	0.25	0.08
Wheat starch	15.37	15.37	16.54	14.29	11.79
Dietary Ca%	0.30	0.30	0.30	0.30	0.30
Dietary phosphorous %	0.40	0.40	0.40	0.40	0.40
Dietary protein %	15	15	15	15	15
Dietary fiber %	3	3	3	3	3
Dietary fat %	5	5	5	5	5
Constants**	6.85	6.85	6.85	6.85	6.85

* Contained Ca lactab, Ca gluconate as svell as Ca carbonate.

** Contained % ntarnin m~x 2.2; rnina.~l rnix Ca free P free 3-5 and sodium phosphate 1.15%.

Because 60% of the recommended Ca intake for the studied rats may be sufficient for adequate growth, weight gains of the studied rats did not differ significantly where the weight ranged from 166 to 171 g. Table, 2.

Concerning the concentration of Ca in serum, results in the same table show that serum calcium levels for all diets were in the normal range (6-12 mg/100 ml) and the diet of calcium sulfate produced the lowest calcium serum concentrate 11.9 mg/ 100 ml. This may be a very efficient homeostatic mechanism that keeps serum Ca levels within the normal range except when dietary Ca levels may exceptionally low, NIH (1994).

Femure weights of the studred rats ranged from 245.5 to 216.3 mg, calcium sulfate produced the lowest value while the supple nent produced the highest one. The data cleared that femur weights did not differ significantly p70.05 among groups. Same trend was indicated for femur ash where differences in femur ash content were also not significant ($P<0.05$). The femur ash content ranged from 50.2 for calcium carbonate to 54.6 for calcium sulfate.

Femur calcium values ranged from 40.9 to 42.2, this means that femur calcium status did not differ significantly ($P>0.65$) among the studied groups. On the other hand, femur calcium % showed slight differences.

From the presented data it is clear that the apparent calcium absorption ranges from 94.5 to 98.5% and the organic sources had the highest values 98.5 and 98.3 while calcium carbonate had the lowest one (94.50%). Same trend occured for calcium biovailability where calcium citrate and calcium lactate had the lowest value (100%). This data are in agreement with Ranhotra et al. (1981) and PonerosSchneiner and Edtman (1989).

Data in Table 3 indicate that the studied calcium sources had no effect on both farinograme and extensiograme values of the studied doughs. Slight differences were noticed only for dough elasticity (510 Bu) which ranged from 550 Bu to 560 Bu. Control and calcium carbonate had 550 Bu calcium lactate and calcium suppiement had 555 Bu while calcium citrate and calcium sulfate had 560 Bu. This means that there is no clear trend for the effect of organic or inorganic calcium sources on dough elasticity.

Table 2. The tissue concentation and absorption and bioavailability of calcium of breads fortified with different calcium sources.

Content	Calcium sources				
	Citrate	Lactate	Carbonate	Sulfate	Supplement*
Diet	A	B	C	D	E
Dietary calcium (Ca%)	0.30	0.30	0.30	0.30	0.30
Diet intake, g	420	420	420	420	420
Ca intake mg	1.05	1.05	1.05	1.05	1.05
Body weight gain, mg	171.0	168.0	170.0	166.0	170.0
Tissue concentration					
Serum Ca, mg/dl	12.0	12.4	12.4	11.9	12.0
Femur weight, mg	226.5	243.4	243.5	216.3	245.5
Femur ash %	53.6	51.5	50.2	54.6	52.7
Femur Ca total mg	40.9	41.5	40.9	41.0	42.2
Demur Ca %	18.05	17.05	16.79	18.95	17.19
** Calcium intake, mg	1.050	1.050	1.050	1.050	1.050
Fecal calcium, mg	0.015	0.078	0.057	0.030	0.033
Apparent absorption%	98.5	98.3	94.5	97.1	96.8
Relative bioavailability	104.2	104.0	100	102.7	102.4

Table 3. Effect of the addition of different calcium sources on the rheological properties of the pan bread doughs.

Content		Calcium sources				
		Citrate	Lactate	Carbonate	Sulfate	Supplement*
Farinograme properties						
Dough water apsorbion %	59.5	59.5	59.5	59.5	60.2	59.8
Dough arrival time min.	7.5	1.5	1.5	1.5	1.5	1.5
Dough development min.	2.0	2.0	2.0	2.0	2.0	2.0
Dough stability min.	2.0	2.0	2.0	2.0	2.0	50.0
Dough weaking Bu.*	50.0	50.0	50.0	50.0	50.0	
Extensogram properties						
Dough extensibility (mm)	135	133	13.2	135	132	135
Dough resistance to extention Bu*	550	560	555	550	560	555
Proportional number (P)	4.07	4.21	4.20	4.07	4.24	4.11

* Brabender unit.

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تأثير المصادر المختلفة للكالسيوم علي صفات العجينة وقابليته للإمتصاص والاستفاده منه في الفئران

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أوضحت الدراسة أنه لاتوجد فروق واضحة في القابلية الحيوية للهضم بين مصادر الكالسيوم تحت الدراسة مقارنة بكربونات الكالسيوم علي أساس أنها تمتص بنسبة ١٠٠٪ حيث أن المصادر العضوية المضافة وهي سترات الكالسيوم أعطت دلاكتات الكالسيوم أظهرت أعلى قابلية ١٠٤٪ بينما كبريتات الكالسيوم أعطت ١٠٢,٧٪ ومحلول التغذية أعطي ١٠٢,٤٪ معني ذلك أن كربونات الكالسيوم وكبريتات الكالسيوم يمكن استخدامها في تدعيم الخبز من جانب أخر فإنه إعتماداً علي نسبة الكالسيوم في عظام الفخذ ونسبة الامتصاص الظاهرية له فإن مصادر الكالسيوم تحت الدراسة أوضحت أنها جيدة في مجال التغذية – أما فيما يختص بتأثير مصادر الكالسيوم المختلفة علي الصفات الريولوجية للعجائن فإن النتائج أوضحت أنه لاتاثير واضح سواء بإضافة الكالسيوم أو إختلاف مصادره.