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STUDIES ON THE EFFICIENCY OF AVAILABLE CALCIUM IN THE DIETS

By

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Introduction

Nutritional investigation in Japan shows the deficiency of calcium (Ca)-taking from the diets, though it is recognized that the Ca-taking increased year by year. These facts are seen, moreover, in the advanced countries having the higher food situation than that in Japan (1).

It is suggested, from the facts that milk is suited for Ca source, that Ca plays an important on the growth of the young animals. It is of great importance how much Ca is taken from the diets after the weaning period. Of cource, the effects of Ca-deficiency and its replenishment on both the growth and the bone-composition of the young animals are influenced by the degree or the period of Ca-deficiency and the other nutriments given at the same time (2) (3). It has been reported, moreover, by Nishimura (4) on the metabolism of Ca and phosphorus (P) during pregnancy and early lactation.

It has been reported by many investigators that the minerals are important nutriment not only as body tissue-composition but as the biocatalyzer, too. Especially, in the case of Ca-metabolism investigation, the relation between Ca and P or magnesium (Mg) is important and the studies on its relation has been reported by several groups of workers (5) (6). Gotoh *et al.* (7) have reported on the effects of dietary proteins and Mg levels on Ca-and P-metabolism in rats.

It has been found that the radioactive substances are contained in the air or the rain in recent years. Among them, the concentration of radioactive strontium (Sr^{90}) contained in the diets is especially an important problem, because Sr having much the same chemical and physiological natures with Ca has the possibility to accumulate in the animal bodies in place of Ca. But animals have the Ca-Sr discrimination factors, and their degrees are shown as observation ratio (8). Danbara *et al.* (9) (10) have investigated on the effects of the Sr contents in the diets on the Ca-Sr discrimination factors of rats, for the purpose of increasing Ca-deposition and Sr-excretion in animals through the variation of Ca-Sr discrimination factor in hard tissues (bone, teeth etc.). It has been shown that the Ca-supplement to the diets inhibit the accumulation of Sr^{90} in hard tissues.

On the other hand, in earlier papers (11)～(14) dealing with the metabolism between fluorine (F) and Ca, it was shown that the Ca contents in the diets or drinking water had an effect to control the appearance of fluorosis. Because it was recognized that F

in the diets or water was little absorbed by combining with to Ca. Accordingly, Ca-supplement to the diets inhibit the accumulation of F in hard tissues, in this case, too.

As mentioned above, it was found that Ca played an important part not only as body tissue-composition but as biocatalyzer or inhibitor against the accumulation of harmful minerals in hard tissues. It is natural, therefore, that the sufficient supplement of Ca in the diets is necessary for the nutrition or the health of animals.

Whereas, all of the Ca contained in the diets is not always utilized for the animals bodies. The purpose of the work reported here, therefore, has been to investigate the efficiency of available Ca in the diets. In a similar manner, Mg and P were determined, because it seemed that they had more direct basis for the comparison of Ca-utilization.

Experimental

Materials

The foodstuffs used in daily life or having comparatively higher contents of Ca, were obtained commercially and submitted to analysis. Samples were assigned to 3 groups as follows ; Group I (energy source Group)— rice bran, unpolished rice, polished rice, barley, hard wheat flour, soft wheat flour, crude sugar and sesame seed ; Group II (protein source group)— cow's milk, the yolk and white of an egg, sardine, dried sardine, short-neck clarm and soy-bean ; Group III (minerals and vitamins source group) — carrot, carrot leaf, turnip leaf, cabbage, Chinese cabbage, spinach, garland crysanthenum, pot herb mustard, Japanese honeywort, sweet pepper, agar-agar and seasoned laver.

Analytical methods

All foodstuffs were prepared as the samples by crushing with electric crusher or homogenizing with electric homogenizer.

Ca and Mg ; these were determined by EDTA method (15).

P ; this was determined by Fiske and Subbarow method(16).

Moisture, ash and fat ; these were determined by the usual methods.

Procedure

The determination of *the total Ca, Mg and P* ; crushed or homogenized samples were weighed exactly and burnt to ash at 600~700° for a day with electric muffle. After a little volume of the distilled water and 10 ml. of hydrochloric acid (1 : 1) were added and dried up on the water bath, the dried matters were dissloved in 30 ml. of hydrochloric acid (1 : 3) with slight warming on the water bath. The mixtures were filtered by washing with a little volume of hydrochloric acid (1 : 3) 3 or 4 times. The obtained filtrate was filled up to 100~200 ml. with the distilled water. The acidic solutions were submitted to determine total Ca, Mg and P after neutralization with ammonium hydroxide (1 : 4).

The determination of water-soluble Ca, Mg and P ; crushed or homogenized samples were suspended in the distilled water for a day by stirring sometimes. These suspensions, then, were filtered under reduced pressure and the filtrates were filled up to

200 ml. A portion of the filtrates was taken, and 8 per cent trichloro-acetic acid, the same volume with the sample solution, were added to it. After a day, the mixtures were filtered under reduced pressure, the filtrates were submitted to determine water-soluble Ca, Mg and P.

Hydrochloric acid-soluble Ca, Mg and P; these were determined with the same procedure as mentioned above by extraction not with the distilled water, but with 0.1 N hydrochloric acid at 35° for 3 hrs.

Acetic acid-soluble Ca, Mg and P; these were determined by extraction with 4 per cent acetic acid for 3 hrs. The analytical method was the same as mentioned above.

Forms of Ca-compounds; these were determined by the method of Kawakami *et al.* (17).

Results and discussion

The composition of the samples are shown in Table I.

Table I. The composition of the samples.

Group	Foodstuffs	Moisture (%)	Ash (%)	Fat (%)	Total (mg./100g.) Ca	Mg	P	Ca/P
I	Rice bran	12.1	9.0	18.4	115	976	1430	0.08
	Unpolished rice	14.3	1.7	2.5	16.7	103	278	0.06
	Polished rice	15.5	0.2	0.8	5.4	27.0	147	0.04
	Barley	15.0	0.7	0.9	20.4	30.5	139	0.15
	Hard wheat flour	12.0	0.4	1.0	19.8	18.3	95.3	0.21
	Soft wheat flour	11.8	0.7	1.1	19.0	17.9	90.1	0.21
	Crude sugar	7.5	3.0	0.0	268	16.4	68.3	3.92
	Sesame seed	6.7	5.1	51.2	1114	475	780	1.43
II	Cow's milk	88.6	0.6	3.3	104	113	88.0	1.18
	Yolk of egg	50.1	1.9	32.4	162	104	630	0.26
	White of egg	90.2	0.7	0.1	8.0	6.5	10.5	0.76
	Sardine	73.1	1.2	6.0	78.0	113	248	0.30
	Dried sardine	30.0	8.5	14.8	1210	756	1100	1.10
	Short-neck clarm	84.8	1.2	1.3	78.0	103	195	0.40
	Soy-bean	12.0	5.6	17.5	104	98.9	484	0.22
III	Carrot	85.8	0.7	0.2	43.3	23.3	40.0	1.08
	Carrot leaf	82.0	2.6	0.6	372	275	178	2.01
	Turnip leaf	93.2	1.3	0.3	112	30.1	59.6	1.88
	Cabbage	90.3	0.7	0.2	43.8	40.2	20.3	2.16
	Chinese cabbage	93.8	0.6	0.1	28.7	20.7	38.7	0.74
	Spinach	93.3	1.9	0.4	82.5	125	48.5	1.70
	Leaf-beat	91.7	1.7	0.1	97.3	70.1	18.5	5.26
	Garland crysanthenum	94.6	0.9	0.3	81.9	67.2	25.4	3.22
	Pot herb mustard	94.2	0.7	0.5	91.8	73.0	45.3	2.02
	Japanese honeywort	92.8	1.3	0.1	62.8	39.3	48.1	1.31
	Sweet pepper	89.4	0.4	0.4	19.2	9.6	29.9	0.64
	Agar-agar	21.2	2.9	0.1	385	213	117	3.29
	Seasoned laver	11.3	8.0	0.7	435	351	375	1.16

It can be seen from Table I that rice bran, crude sugar, sesame seed, cow's milk, yolk of egg, dried sardine, soy-bean, carrot leaf, turnip leaf, agar-agar and seasoned laver showed higher contents of Ca than those in the other foodstuffs. It was reported by Hashimoto *et al.* (18) that the hulling was accompanied by the remarkable decrease in contents of the minerals in the case of rice. This fact was recognized in this experiment, too. The content of Ca in barly is higher than in polished rice, though the difference was not recognized in the contents of Mg and P. No difference of the contents of minerals between hard wheat flour and soft wheat flour was recognized. Crude sugar showed higher contents of minerals in sesame seed were recognized, especially in case of Ca. It may be concluded from the results of Table I that sesame seed was the best Ca source among the diets used in daily life. White of the egg showed very lower contents of minerals than those of yolk of the egg.

It has reported that the contents of Ca in most of the vegetable diets were generally higher than in animal diets, mostly over 30 mg. per 100 g (19). Such tendencies, however, were not recognized in the present investigation, because the selected foodstuffs had comparatively higher contents of Ca.

Hashimoto *et al.* (20) have reported that no remarkable difference was found in the total P in the vegetables examined and less Ca and Mg are contained in the sweet pepper than in the other leafy vegetables. It was found, in this experiment, that there was considerable variation of the content of total P in the vegetables. Essentially identical data, however, were obtained about the sweet pepper. The seaweed such as agar-agar showed higher contents of minerals than those in the other vegetable diets.

The ratio of Ca : P which has very great influence upon the Ca-absorption into the animal bodies showed more desirable in Group III than in Group I (except for crude sugar and sesame seed) and Group II (except for cow's milk and dried sardine).

It was suggested that the extraction ratios of water-soluble Ca, Mg and P were related to the temperature or the period of steeping in water. Accordingly, in an effort to determine the effects of these factors, the extraction with water of turnip leaves as sample were examined. The results are shown in Fig. 1 and Fig. 2.

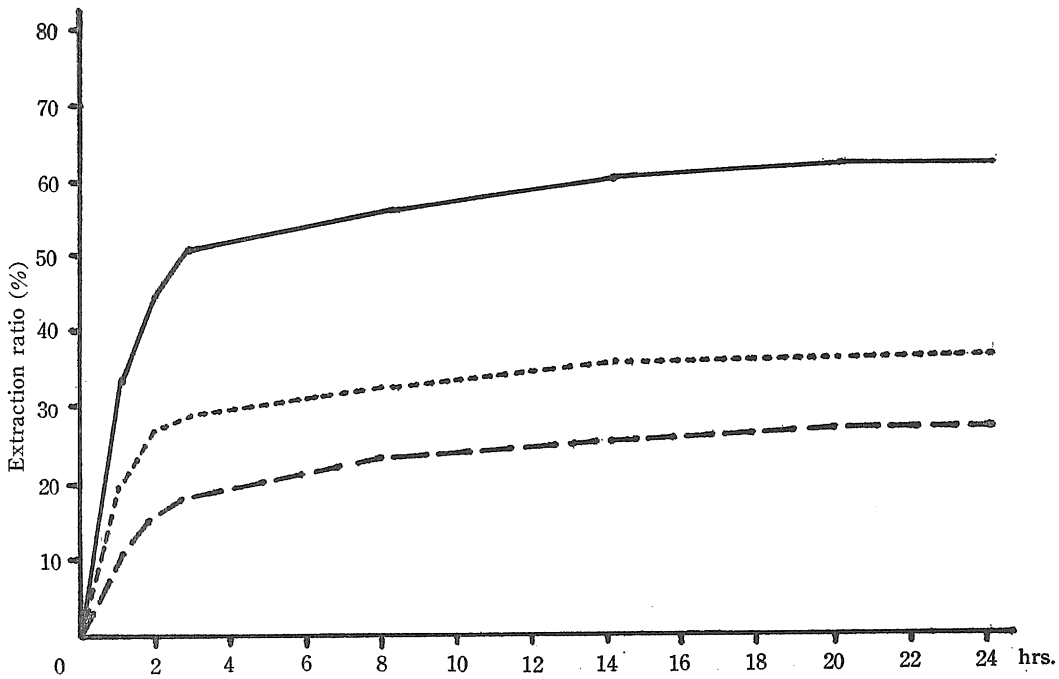

Fig. 1. The extraction of water-soluble Ca, Mg and P at 35°C.
——— *Ca* - - - - - *Mg* ····· *P*

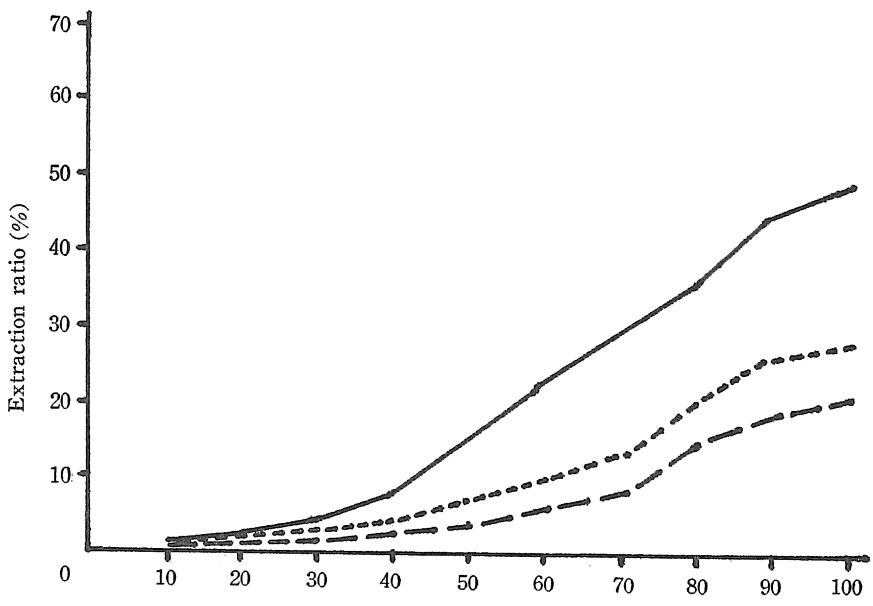

Fig. 2. The relation between the extraction ratio and the temperature for 10 minutes.

In all cases, constant values were obtained after about 20 hrs. as shown in Fig. 1. It was recognized, moreover, that the solubility was rapidly increased by boiling them as shown in Fig. 2.

In this experiment, water-soluble Ca, Mg and P were determined by suspension in the distilled water at 35° for a day. The results are given in Table II.

Table II. Water-soluble Ca, Mg and P.

Group	Foodstuffs	H_2O-soluble (mg./100g.)			Ca/P	Extraction ratio (%)		
		Ca	Mg	P		Ca	Mg	P
I	Rice bran	26.6	470	50.5	0.53	23.1	48.2	3.5
	Unpolished rice	8.4	58.0	13.4	0.63	50.3	56.3	4.8
	Polished rice	2.7	4.0	10.2	0.27	50.0	14.8	6.9
	Barley	10.1	20.3	12.6	0.80	49.5	66.5	9.1
	Hard wheat flour	7.5	14.1	9.8	0.77	37.9	77.0	10.3
	Soft wheat flour	7.0	15.8	20.3	0.35	36.8	88.3	22.5
	Crude sugar	263	13.5	30.3	8.68	98.1	82.3	44.4
	Sesame seed	143	39.4	59.3	2.41	12.8	8.3	7.6
II	Cow's milk	68.5	48.5	23.0	2.98	65.9	42.9	26.1
	Yolk of egg	103	57.6	33.1	3.11	63.6	55.4	5.3
	White of egg	5.0	3.0	5.4	0.93	62.5	46.2	51.4
	Sardine	35.3	27.2	31.3	1.13	45.3	24.1	12.6
	Dried sardine	180	75.2	230	0.78	15.7	9.9	20.9
	Short-neck clarm	40.2	47.3	87.2	0.46	51.5	45.9	44.7
	Soy-bean	82.7	47.3	203	0.41	79.5	47.8	41.9
III	Carrot	13.0	10.0	18.3	0.71	30.0	42.9	45.8
	Carrot leaf	183	20.3	77.0	2.38	49.1	7.4	43.3
	Turnip leaf	72.2	8.2	20.6	3.51	64.5	27.2	34.6
	Cabbage	27.8	7.9	10.3	2.70	63.5	19.7	50.7
	Chinese cabbage	16.2	4.8	8.4	0.88	56.4	23.2	47.5
	Spinach	4.3	40.0	24.2	0.18	5.2	32.0	49.9
	Leaf-beat	12.3	37.5	10.3	1.19	12.6	53.5	55.7
	Garland crysanthenum	32.0	22.3	13.0	2.46	39.1	33.2	51.0
	Pot herb mustard	35.6	31.3	23.4	1.52	38.8	42.9	51.7
	Japanese honeywort	16.0	13.0	26.3	0.61	25.5	33.1	54.7
	Sweet pepper	5.7	6.0	13.2	0.40	29.7	62.5	44.1
	Agar-agar	96.0	39.4	23.8	4.03	24.9	18.5	20.3
	Seasoned laver	97.0	117	93.0	1.04	22.3	33.3	24.8

The extraction ratios of water-soluble Ca in the cereals showed about 40~50 per cent except for rice bran which had comparatively higher contents of Ca. Crude sugar showed the highest water-solubility among the samples examined in this experiment. On the base of these data, it seemed reasonable to assume that water-soluble Ca-salts were added in the rectification process of the sugar.

The extraction ratios of water-soluble P in Group I showed the lower value than

those in Group II and Group III. The extraction ratios of water-soluble Mg in cereals showed comparatively higher values, except for polished rice. It seemed reasonable to assume that the difference of water-soluble Mg between unpolished and polished rice depends upon the difference of the forms of Mg contained in the part of the rice albumen and rice bran, respectively. The lower water-solubility of sesame seed seemed to be due to the higher contents of fats in it.

Though the ratios of total Ca : P in Group I were lower in value than those in Group II and Group III as shown in Table I, and the ratios of water-soluble Ca : P showed fairly desirable values, since the water-solubilities of P showed lower values in all, except for crude sugar.

Water-solubilties of minerals in Group II showed generally higher values, except for sardine and dried sardine. In case of dried sardine, especially, it seemed the minerals were contained in the hard tissues as water non-soluble substances. It was recognized that there was the difference between water-soluble P in egg-yolk and that in egg-white. From a consideration of the composition of the egg, it seemed most reasonable to conclude that the difference was caused by the fats contents and the P-forms in the egg-yolk and white.

It was found that soy-bean, a good protein source among the vegetables, had high contents of minerals and, moreover, high water-solubilities of minerals as shown in Table I and Table II.

Water-soluble Ca in most of vegetables showed about 30～60 per cent, except for spinach and leaf-beat. Japanese depend a great part of Ca-taking upon the vegetable diets. Accodingly, the efficiency of available Ca in vegetable diets is a very important problem for us. Turnip leaf, cabbage and Chinese cabbage etc. showed higher extraction ratios. On the other hand, spinach and leaf-beat etc. showed very lower ratios because of the presence of the Ca-oxalate which was little dissolved in water. It is necessary, therefore, to eliminate the oxalic acid in these diets by cooking, Hasegawa (21) has reported that the oxalic acid was eliminated a certain extent by boiling.

Generally, vegetables with green leaves had high contents of Ca and Mg except for sweet pepper as shown in Table I, but water solubilities of Ca and Mg of sweet pepper showed higher values than those of spinach and leaf-beat.

Though the seaweed had higher contents of minerals than those of the other vegetables, their extraction ratios showed comparatively low values. An examination was carried out to clarify the availability of Ca in stomach by means of model experiments. The results are shown in Table III.

It was evident from these data that the extraction ratios of minerals in all foodstuffs increased more or less, generally. Though water-solubilities of P in Group I had shown lower values than those in the other groups as shown in Table II, it was found that the considerable contents of P were extracted with 0.1 N hydrochloric acid. The extraction ratios of minerals in sesame seed showed very high values compared with those of the water-solubility. It seemed, accordingly, that sesame seed had high contents of minerals and was one of the good diets of minerals source, especially of Ca. The rise of extraction ratios of minerals in the dried sardine was recognized conspicuously. One may conclude that water non-soluble substances in hard tissues of

Table III. Hydrochloric acid-soluble Ca, Mg and P

Group	Foodstuffs	0.1 N HCl-soluble (mg./100g.)			Ca/P	Extraction ratio (%)		
		Ca	Mg	P		Ca	Mg	P
I	Rice bran	62.6	620	212	0.14	54.4	63.5	14.8
	Unpolished rice	14.2	73.6	102	0.14	85.0	71.5	36.7
	Polished rice	4.2	16.2	50.5	0.08	75.9	60.0	34.4
	Barley	16.3	22.6	41.5	0.39	79.9	74.0	29.9
	Hard wheat flour	15.8	16.2	33.5	0.47	79.8	88.5	35.2
	Soft wheat flour	13.3	16.5	34.2	0.39	70.0	92.2	38.0
	Crude sugar	264	15.9	49.6	5.32	98.5	97.0	72.6
	Sesame seed	656	216	217	3.02	58.9	45.5	29.1
II	Cow's milk	70.1	88.5	63.1	1.11	67.4	78.3	71.7
	Yolk of egg	143	80.6	314	0.46	88.2	77.5	49.8
	White of egg	6.2	4.5	7.2	0.86	77.5	69.2	68.6
	Sardine	53.2	73.4	117	0.45	68.2	65.0	47.2
	Dried sardine	487	280	870	0.56	40.0	37.0	79.1
	Short-neck clarm	53.2	73.2	163	0.33	68.2	71.1	83.6
	Soy-bean	88.4	76.2	392	0.23	85.0	77.1	81.0
III	Carrot	32.5	20.2	23.5	1.38	75.1	86.7	58.8
	Carrot leaf	265	117	126	2.10	71.2	42.5	70.8
	Turnip leaf	90.3	21.3	39.9	2.26	80.6	70.8	66.9
	Cabbage	33.5	24.2	16.7	2.00	76.5	60.2	82.3
	Chinese cabbage	22.7	13.3	29.0	0.78	79.1	64.3	74.9
	Spinach	28.7	79.4	33.3	2.38	34.8	63.5	68.7
	Leaf-beat	39.4	63.4	15.4	2.56	40.5	90.4	83.2
	Garland crysanthenum	49.3	43.3	20.2	2.44	60.2	64.4	79.5
	Pot herb mustard	51.2	60.9	31.1	1.65	55.8	83.4	68.7
	Japanese honeywort	31.5	25.2	33.9	0.93	50.2	86.3	70.5
	Sweet pepper	6.9	8.3	21.0	0.33	35.9	86.5	70.2
	Agar-agar	202	126	60.5	3.34	52.5	59.2	51.7
	Seasoned laver	243	226	211	1.15	55.9	64.4	56.3

dried sardine were dissolved with 0.1 N hydrochloric acid.

It has been found, moreover, that the extraction ratios of Ca contained in spinach and leaf-beat increased conspicuously compared with water-solubilities. This fact showed that the Ca-oxalate which hardly dissolved in water was extracted with 0.1 N hydrochloric acid.

Ca in the seaweed showed a high extraction ratio, too, that is, 0.1 N hydrochloric acid-soluble Ca was about 2 times water-soluble Ca. Little attention has been paid to the nutritive value of agar-agar, because it had little protein, fat, vitamin and mineral in it, and furthermore, galactan which is the main composition of agar-agar was not digested by the digestion organs of human. It was recognized, however, that there was a great volume of Ca in agar-agar and its Ca was digestible by more than 50 per cent with 0.1 N hydrochloric acid. This fact has been reported by Isakari *et al.* (22),

and they concluded that the rise of extraction ratio of agar-agar was caused by the dissolution of Ca combined with the high-molecule organic acids. It seemed, accordingly, that agar-agar was one of the good diets as a Ca source. This tendency was essentially identical to that in seasoned laver which a good diet as a protein source, too.

As there are many oppotunities to use acetic acid in daily cooking, the observation of extraction with 4 per cent acetic acid was investigated. The results were given in Table IV.

Table IV. Acetic acid-soluble Ca, Mg and P.

Group	Foodstuffs	4% CH_3COOH-soluble (mg./100g.)			Ca/P	Extraction ratio (%)		
		Ca	Mg	P		Ca	Mg	P
I	Rice bran	55.8	503	168	0.17	48.6	51.5	11.7
	Unpolished rice	10.3	60.3	62.3	0.17	61.7	58.5	22.4
	Polished rice	3.3	11.2	35.3	0.09	61.1	41.5	24.0
	Barley	12.3	20.9	26.0	0.47	60.3	68.5	18.7
	Hard wheat flour	9.0	15.0	20.3	0.44	45.5	82.0	21.3
	Soft wheat flour	9.2	16.0	26.2	0.35	48.4	89.4	29.1
	Crude sugar	263	14.0	35.2	7.47	98.1	85.4	51.5
	Sesame seed	231	172	162	1.43	15.4	36.2	20.8
II	Cow's milk	70.0	62.5	51.5	1.36	67.3	45.6	58.5
	Yolk of egg	121	63.4	170	0.71	74.7	61.0	27.0
	White of egg	6.0	3.5	6.0	1.00	75.0	53.8	57.5
	Sardine	40.3	43.2	76.3	0.53	51.7	38.2	30.8
	Dried sardine	272	206	532	0.51	22.5	27.2	48.4
	Short-neck clarm	45.2	53.2	118	0.38	57.9	51.7	60.5
	Soy-bean	84.0	56.5	293	0.29	80.8	57.1	60.5
III	Carrot	18.3	13.3	20.5	0.89	42.3	57.1	51.3
	Carrot leaf	202	83.3	93.2	2.17	54.3	30.3	52.4
	Turnip leaf	74.4	16.2	25.2	2.95	66.4	53.8	42.3
	Cabbage	28.2	13.3	12.4	2.27	64.4	33.1	61.1
	Chinese cabbage	18.3	10.1	23.2	0.79	63.8	48.8	59.9
	Spinach	16.4	56.2	27.5	0.60	19.9	45.0	56.7
	Leaf-beat	27.2	50.5	12.0	2.27	28.0	72.0	64.9
	Garland crysanthenum	38.2	30.9	15.2	2.51	46.6	46.0	59.8
	Pot herb mustard	40.7	43.5	26.9	1 51	44.3	59.6	59.4
	Japanese honeywort	20.3	16.2	29.0	0.70	32.3	41.2	60.3
	Sweet pepper	6.0	7.0	14.6	0.41	31.3	72.9	48.8
	Agar-agar	178	72.2	33.3	5.35	46.2	33.9	28.5
	Seasoned laver	151	163	135	1.12	34.7	46.4	36.0

In all cases, it can be seen from Table IV that the extraction ratios showed higher values than those in the extraction with water, and lower than in the extraction with 0.1 N hydrochloric acid. It is suggested that the weak acid-soluble Ca in the diets dissolved in the acid solution.

There are 2 types of Ca contained in the diets, that is, organic-and inorganic-forms. The experiments, therefore, were undertaken to see the forms of Ca in the diets. The results are summarized in Table V.

Table V. Ca contents extracted with various solvents.

Group	Foodstuffs	Soluble Ca (mg./100g.)				
		80% C_2H_5OH	H_2O	0.5% NaOH	0.1 N CH_3COOH	5% HCl
I	Rice bran	14.8	22.4	10.2	40.3	21.2
	Unpolished rice	1.9	6.4	2.1	6.2	3.3
	Polished rice	0.7	2.0	0.9	1.2	1.1
	Barley	0.8	9.7	4.3	2.2	3.1
	Hard wheat flour	1.2	6.2	2.2	7.3	3.3
	Soft wheat flour	1.3	5.9	2.7	6.4	4.0
	Crude sugar	15.0	220	1.1	10.2	0.1
	Sesame seed	264	132	123	360	212
II	Cow's milk	18.9	53.2	9.3	12.3	8.2
	Yolk of egg	13.5	98.1	10.2	29.3	10.7
	White of egg	1.0	3.2	0.8	2.9	0.3
	Sardine	8.7	26.9	9.8	18.2	12.1
	Dried sardine	217	176	50.5	212	542
	Short-neck clarm	6.2	38.2	8.4	10.3	11.2
	Soy-bean	9.6	70.3	7.5	8.3	8.9
III	Carrot	3.2	9.5	5.9	10.3	15.8
	Carrot leaf	18.3	161	17.3	52.4	30.2
	Turnip leaf	6.4	67.1	5.7	16.5	9.9
	Cabbage	4.1	22.2	3.1	9.8	4.5
	Chinese cabbage	3.4	13.2	2.0	4.2	3.1
	Spinach	4.1	2.2	2.5	3.5	69.3
	Leaf-beat	5.2	8.1	3.9	14.3	60.3
	Garland crysanthenum	8.6	24.3	5.7	15.4	30.2
	Pot herb mustard	5.7	30.3	9.8	27.2	18.4
	Japanese honeywort	5.2	15.3	3.2	12.8	24.0
	Sweet pepper	2.1	3.0	3.3	6.8	4.3
	Agar-agar	30.7	90.2	85.9	55.5	83.7
	Seasoned laver	17.3	29.8	59.3	161	30.7

As shown in Table V, it seemed the Ca-nitrate, Ca-chloride, Ca-phosphate and many Ca-salts of the organic acids were found in cereals, except for the rice bran which had high contents of Ca-carbonate and Ca combined with the protein etc. It was found that a large quantity of the various Ca-forms exsisted in the sesame seed. It was generally recognized that the soluble inorganic-and organic-forms of Ca in

animal diets showed higher values than those in vegetable diets. In dried sardine, there were a large quantity of non-soluble Ca with the various solvents, and the high contents of Ca were extracted with 5 per cent hydrochloric acid.

Soy-bean was a good diets not only as a protein and fat source but also as a Ca source, because in which a great deal of soluble Ca was contained in it. There were comparatively many contents of soluble Ca in vegetable diets. It was found especially in the case of spinach and leaf-beat. It may be concluded that the Ca-oxalate which hardly dissolved in water was contained in them.

It was clear from the facts that a great deal of Ca was soluble 5 per cent of hydrochloric acid. It was recognized that there were some differences of Ca-forms between agar-agar and seasoned laver, though these belong to the seaweed group, that is, the former showed higher contents of alcohol-, water-and 0.5 per cent sodium hydroxide-soluble Ca than those of the latter.

As mentioned above, it was found that there were many forms of Ca contained in the diets and it was said that Ca of the organic-forms was better absorbed in the animal bodies than those of the inorganic-forms, generally. This problem, however, can be answered only by further experimental work.

Summary

The object of this paper is to investigate the efficiency of available Ca contained in the diets used in daily life. At the same time, Mg and P were determined, because it seemed that they had a more direct basis for comparison of Ca-utilization. The following results were obtained.

A great deal of the minerals were recognized in rice bran, sesame seed, cow's milk, dried sardine, soy-bean, carrot leaf, agar-agar and seasoned laver.

The ratios of Ca : P showed more desirable values in vegetables and seaweed than in cereals and animal diets. The extraction ratio of Ca with water showed lower values in rice bran, sesame seed, dried sardine, spinach and leaf-beat. This was probably due to the fact that many contents of fat, or Ca-salts which were hardly dissolved in water were contained in the samples.

An examination was carried out to clarify the availability of Ca in stomach by means of model experiments. The rises of the extraction ratios with 0.1 N hydrochloric acid were found in all cases.

In the case of 4 per cent acetic acid, which has many opportunities to be used in the daily cooking, the extraction ratios showed higher levels than those with water and lower levels than those with 0.1 N hydrochloric acid.

Generally, it was recognized that the soluble inorganic-and organic-forms of Ca in animal diets showed higher values than those in vegetable diets.

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