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The Measurement of Folacin Content in Korean Foods

— Part 2. Folate Distribution in Fruits —

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=국문초록=

한국 상용 식품의 엽산 분석에 관한 연구

— 제 2 보. 과실류의 엽산치 분석 —

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과실류 식품에 포함된 엽산치를 Lactobacillus casei 미생물을 사용하여 분석하였다. 측정시 결합형으로 존재하는 엽산을 유리형으로 하기 위해서 conjugase 효소를 사용했고, 산화되기 쉬운 형태로 된 엽산을 보호하기 위하여 비타민 C를 첨가하였다. 과실류는 일반적으로 엽산을 소량 함유한 식품으로 나타났다. 각 과실에 포함된 엽산 분석치는 사과 7.5, 살구 8.6, 바나나 20.2, 앵두 3.0, 포도 11.2, 귤 26.6, 복숭아 3.5, 배 10.5, 자두(붉은색) 3.7, 자두(노란색) 2.0, 딸기 19.7, 수박 3.8, 감 7.5, 참외 3.7, 토마도 9.1μg으로 각기 식품 100g 중에 함유 되었음을 보였다.

Introduction

Man can not synthesize the pteridine ring structure which is one portion of folic acid molecule and therefore depends on dietary intake as his natural source of folates.

Folic acid is necessary for normal hematopoisis and its nutritional deficiency has reported in many cases.[1~12] In fact, the inclusion of an allowance for folacin in the United States set by National Research Council [13] has emphasized the need for information on the folacin content in food.

In order to evaluate the dietary adequacy of nutrient, the information on the requirement and the concentration of the nutrient in food are necessary although in the case of folic acid, some confusion exists with these respects.

Information available of the assay methods for folacin in food conflicts, also. Modifications in the microbiological assay method have resulted in improved values. Excluding assay in man, the food folate activity as determined with Lactobacillus casei using ascorbic acid to protect the labile forms of folacin and conjugase to free bound forms is presently considered the best approximation of the folate activity that man derives from his dietary intake as pointed out in part 1. [14] Data on the folate composition of individual foods has been reported by Lee et al,[15,16] although none of the Korean data on the improved assay method has been available.

Therefore, in view of the existing data and the need for current data as a source of dietary folates, a study of the folacin content in fruits available on the Korean market was carried out and the data was compared to clarify conflicting information in the literature.

Table 1. Folic Acid Content of Fruits

Food	No. of Assay*	Lactobacillus Casei			
		Free Folate μg/100g		Total Folate μg/100g	
		Range	Mean±S.D.	Range	Mean±S.D.
Apples	4	3.0~4.2	3.5±0.5	4.3~10.4	7.5±2.6
Apricots	4	2.3~8.1	4.4±2.5	4.7~11.7	8.6±2.9
Bananas	4	6.4~14.4	10.8±3.3	16.8~25.2	20.2±4.4
Cherries(Angdoo)	4	1.7~3.5	2.7±0.8	1.8~3.7	3.0±0.8
Grapes(blue)	4	4.8~6.1	5.6±0.5	8.7~13.8	11.2±2.6
Oranges(Mandarine)	4	7.5~18.4	14.9±3.9	15.9~36.4	26.6±8.6
Peaches	4	1.4~3.8	2.2±1.0	1.6~5.1	3.5±1.4
Pears	4	2.4~4.2	3.4±0.9	5.6~18.1	10.5±5.4
Plums(red)	4	1.1~1.9	1.5±0.3	2.4~5.2	3.7±1.1
Plums(yellow)	4	0.9~1.6	1.2±0.3	1.4~2.8	2.0±0.7
Strawberries	4	0.1~15.9	12.3±3.4	16.6~25.3	19.7±4.8
Watermelons	4	1.0~2.9	1.9±1.0	2.7~4.4	3.8±0.8
Persimmons(soft)	4	3.2~4.2	3.6±0.4	6.1~9.6	7.5±1.5
Korean Melons	4	1.0~3.4	2.3±1.1	1.8~5.8	3.7±2.1
Tomatoes	4	3.7~9.4	5.7±2.6	6.7~12.7	9.1±2.5

* Each assay represents triplicate

Materials and Methods

Food Samples

The fruits available on the Korean market were determined for the free and total folate activities. All of those food samples were purchased in near by markets in as fresh condition as possible. A representative laboratory sample was prepared from edible portions of the foods as soon as purchased them. All foods were analyzed in the raw state. The sequence of sampling and analysis were reported for a total of four sampling for each food representing triplicate assay.

Assay Procedure

Using Lactobacillus casei (ATCC 7469) as test organism, the assay method was adopted as described previously pursuant to part 1.[14]

Results and Discussion

The free and total folate distribution of fruits assayed by Lactobacillus casei is presented in Table 1. The folate activity ranged free 1.2~14.9, total 2.0~26.6μg per 100g of fresh weight.

Among those assayed fruits, banana 20.2 and strawberry 19.7 had considerably higher folate activity levels. The least contained fruit was plum(yellow) 2.0 and the most contained one was orange(Mandarine) 26.6 particularly. Some considerable increase in folate activity released to the assay organism by conjugase treatment indicated that a large proportion of the folate in foods is in the polyglutamyl form,[17,18] though the variation of individual foods is great.

Comparison with published values of folate content of fruits is given in Table 2. Using ascorbic acid to protect labile folate with and without conjugate treatment, the data shows increased to the food folate values. Our data corresponds the results in which was pointed out many fold differences in other reports,[17,19~21] however, valiability in individual fruits is large. This indicates that more research is needed to improve the reliability and reproducibility of the assay method for folate in food. Our data assayed with and without conjugase agrees with the figure published by Hoppner et al[21] in all fruits. In contrary, the report [22] does not agree well, even a similar

Table 2. Comparison of Published Values of Folate Content of Fruits

Food	Folate Content*	LC, AsA (this study) μg/100g	LC, AsA (Taguchi, 1972) μg/100g	LC, AsA (Hoppner, 1972) μg/100g
Apples	Fr	3.5	4.0	3.3
	To	7.5	10.0	5.8
Apricots	Fr	4.4		
	To	8.6		
Bananas	Fr	10.8	35.0	11.6
	To	20.2	65.0	20.4
Cherries(Angdoo)	Fr	2.7		
	To	3.0		
Grapes(blue)	Fr	5.6	7.0	4.4
	To	11.2	22.0	6.4
Oranges(Mandarine)	Fr	14.9		13.4
	To	26.6		24.0
Peaches	Fr	2.2		1.5
	To	3.5		3.3
Pears	Fr	3.4	2.3	4.4
	To	10.5	19.1	11.3
Plums(red)	Fr	1.5		1.4
	To	3.7		3.5
Plums(yellow)	Fr	1.2		0.8
	To	2.0		1.6
Strawberries	Fr	12.3	55.5	15.0
	To	19.7	121.5	15.7
Watermelons	Fr	1.9		1.8
	To	3.8		3.3
Persimmons(soft)	Fr	3.6	6.0	
	To	7.5	24.6	
Korean melons	Fr	2.3		
	To	3.7		
Tomatoes	Fr	5.7	29.8	
	To	9.1	56.0	

* Fr="free" folic acid
To="total" folic acid
Lc=Lactobacillus casei
AsA=Ascorbic acid

assay technique was employed. It seems remarkable that the data for the folate in strawberry is six times that of ours and Hoppner's.[21]

Orange appears to be a good source of folate among fruits and Hurdle et al[17] found the similar amount of folate in fresh orange as we did, but Dong and Oace[23] and Streiff[24] found twenty-five times in the frozen orange juice. This seems to be due to the increased among of pulp in commercially squeezed juice. Our data of banana agrees with Butterfield and Calloway[25] and Hurdle et al.[17]

In assaying fresh fruits, there was a large variation in folate levels between individual fruits, as well as between the individual assays of the same fruit. The factors caused variation were probably actual differences in folate content from one of the individual fruits to another, variation in maturity, soil being produced food and differences affected by season.

Substancial amounts of folate were not found in fruits, practically in all fruits. As a source of dietary folate, fruits contain low levels of folacin.

Summary

The fruits available on the Korean market were measured by microbiological assay using Lactobacillus casei with and without conjugase treatment. Some considerable increase in folate activity released to the

assay organism by conjugase treatment indicated that a large proportion of the folate in foods is in the polyglutamyl form, though the variation of individual foods is great. The use of ascorbic acid in assay was reflected the protective effect in both free and total folate. The data was compared with some published values.

Total folate in fruits was apple 7.5, apricot 8.6, banana 20.2, cherry (Angdoo) 3.0, grape (blue) 11.2, orange (Mandarine) 26.6, peach 3.5, pear 10.5, plum(red) 3.7, plum(yellow) 2.0, strawberry 19.7, watermelon 3.8, persimmon 7.5, Korean melon 3.7, tomato 9.1μg per 100g of fresh weight. As a source of dietary folate, fruits contain low levels of folacin, practically in all fruits assayed.

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