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Study of dietary fibre content in cucumber by gravimetric and spectrophotometric methods

Ma. D. Rodriguez, A. Redondo & Ma. J. Villanueva

Departamento de Nutrición y Bromatología II, Bromatología y Tecnicas Analíticas Farmaceuticas, Facultad de Farmacia, Universidad Complutense, 28040–Madrid, Spain

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Five different methods have been used to determine the content of insoluble and soluble fibre in the skin and pulp of cucumber: (1) acid detergent method (ADF); (2) neutral detergent method (NDF); (3) Asp enzymatic method determining insoluble fibre, soluble fibre, and total fibre (IF, SF, TF); (4) carbazole method (C); and (5) *m*-hydroxyphenyl method (*m*-H). For both skin and pulp the results obtained depend on the method used. The results obtained by the Asp method are significantly higher than those of NDF and ADF, leading to important differences between fibre contents in pulp and skin. On the other hand, SF values were significantly higher than those of the C and *m*-H methods, which show no important differences between skin and pulp.

INTRODUCTION

The Asp enzymatic–gravimetric method is quick and easy. It avoids some of the difficulties of previous enzymatic methods, gelatinizing starch and making corrections in the results obtained, for fibre caused by protein and ash.

It also allows the determination of both insoluble and soluble fibre. The Asp method (Asp *et al.*, 1983) has been used by Prosky *et al.* (1984) together with Furda's (1981) and Schweizer & Wursch's (1979) methods to elaborate the AOAC method used at present. There are a large number of reports in which the results of dietary fibre obtained by enzymatic–gravimetric methods are compared to those obtained by the neutral detergent method; these results differ from each other depending on the type of sample considered.

With cereals, the neutral-detergent method gives higher values than the Furda and Hellendoorn methods (Heckman & Lane, 1981). In green vegetable and fruit the detergent method gives lower results than those obtained by the Prosky *et al.* method (1984), whilst in berries the differences between these two methods are not significant (Visser & Gurnsey, 1986).

In this study the contents of insoluble and soluble dietary fibre (IF and SF) in cucumber by the Asp method are compared with the results obtained by two other methods which determine insoluble fibre (NDF and ADF) and two others which determine soluble fibre (carbazole and *m*-hydroxyphenyl).

MATERIALS AND METHODS

Cucumber samples were obtained at a fruit market in Madrid in different weeks. After peeling, the pieces, skin and pulp were freeze-dried; they were then ground to obtain homogeneous samples and stored in perfectly closed flasks. The methods used can be classified into two large groups:

— gravimetric methods
— colorimetric methods

Gravimetric methods

Acid detergent method
This consists of a boiling treatment with a solution of cethyl trimethyl ammonium bromide in 1 N sulphuric acid (Van Soest, 1963).

Neutral detergent method
This is similar to the previous method using a solution of sodium lauryl sulphate with neutral pH (Van Soest & Wine, 1967).

Asp method
This isolates dietary fibre by means of an in-vitro digestion with pepsin and pancreatin (Asp *et al.*, 1983).

Spectrophotometric methods

They are based on the coloured reaction produced by phenolic compounds with uronic acids.

Carbazole method
This was performed using the method described by Dekker and Richards (1972).

m-Hydroxyphenyl method
The method described by Blumenkrantz and Asboe-Hansen (1973) was used.

RESULTS AND DISCUSSION

Tables 1–4 contain the experimental values obtained for the different samples, by the different methods along with means, standard deviations and variation coefficients.

Inspection of the methods used shows that, within the gravimetrics, detergent methods are more precise than the Asp enzymatic method (Redondo *et al.*, 1987) and, among those that evaluate soluble fibre, colorimetric methods are more precise than the Asp method (Villanueva *et al.*, 1990).

It has been proved that the values obtained are normally distributed (statistical test of Kolmogorov, α = 0·05).

From the results obtained in the analysis of the samples, there is greater homogeneity in those values obtained for the skin than those obtained for the pulp by the detergent methods and by the Asp method (IF).

When the quantities of insoluble fibre which the pulp and skin provide are compared, it is easily seen that, in every case, 100 g of skin contains more fibre than 100 g of pulp. The quantitative differences obtained by the three analytical methods are statistically significant in every case, but there is no correlation between the two parts of the green vegetable.

NDF values (Table 1) are always higher than those of ADF. This difference is statistically significant and not very important from the quantitative point of view; it could be considered to be hemicelluloses (Dreher, 1987).

After regression analysis it follows that there is a clear correlation between the contents of ADF and NDF in the pulp (r = 0·938) and skin (r = 0·855).

The differences between the Asp method and the colorimetric methods are generally greater than those between colorimetric methods (Table 2). This fact can be explained if we consider that the basis of the carbazole and *m*-hydroxyphenyl methods is the same, varying only the colour reagent. The differences between the three methods used are statistically significant (student's t-test α = 0·05). The content of the total fibre obtained in the samples studied is calculated by adding the values of insoluble and soluble fibre (Table 3).

In the case of the Asp enzymatic method, the two fractions are added; in the neutral detergent method the percentage of the pectic substances is added so that, as two methods have been considered, i.e. carbazole (C) and *m*-hydroxyphenyl (*m*-H), different results are obtained, NDF + C and NDF + (*m*-H). The values of total fibre (IF + SF) are still higher than each of these.

These results show that any one of these methods used for the analysis of fibre in this sample is correct, because there is a good correlation between the methods studied; it is necessary to indicate the method used in each case, the investigation of the components present in each residue and their physiological behaviour.

Table 1. Insoluble fibre content determination by different methods in cucumber (% dry substance)

Sample no.	Pulp				Skin			
	IF	NDF	ADF	NDF–ADF	IF	NDF	ADF	NDF–ADF
1	14·16	11·37	9·23	2·14	43·40	32·03	28·83	3·20
2	13·00	12·25	10·26	1·99	44·81	34·74	32·92	1·82
3	15·40	12·62	11·30	1·32	41·20	35·82	33·77	2·05
4	11·86	9·06	6·93	2·13	46·73	30·17	29·48	0·69
5	14·35	11·78	11·78	0·00	45·55	38·00	33·92	4·08
6	14·24	12·68	10·43	2·25	51·78	38·82	38·16	0·66
7	15·40	11·07	10·94	0·13	44·80	41·22	35·96	5·26
8	13·70	12·92	12·81	0·11	47·00	35·35	35·14	0·21
9	14·03	12·89	11·90	0·99	43·53	34·07	33·86	0·21
10	22·10	19·56	17·41	2·15	46·24	38·00	35·68	2·32
$\bar{X}$	14·82	12·62	11·30	1·32	45·50	35·82	33·77	2·05
SD	2·76	2·70	2·70	0·95	2·82	3·31	2·85	1·71
CV	18·62	21·39	23·89	71·96	6·20	9·24	8·44	83·41

IF, Insoluble fibre determination by the Asp method; NDF, neutral detergent fibre determined by the Van Soest method; ADF, acid detergent fibre determined by the Van Soest method.

Table 2. Soluble fibre content determined by different methods in cucumber (% dry substance)

Sample no.	Pulp			Skin		
	SF	PS(C)	PS(*m*-H)	SF	PS(C)	PS(*m*-H)
1	4·10	1·55	0·60	3·58	2·22	0·92
2	3·34	1·75	0·77	2·66	2·84	1·89
3	2·54	3·03	1·28	5·35	2·77	0·80
4	1·75	2·82	1·65	1·83	0·93	0·72
5	3·74	1·63	1·74	1·48	1·80	1·41
6	4·51	2·95	0·92	3·21	1·96	2·41
7	4·19	1·11	1·34	7·73	2·50	0·84
8	3·67	1·62	1·50	5·28	2·64	0·73
9	5·62	1·94	1·37	6·38	2·61	1·09
10	3·01	1·65	1·26	3·84	2·15	0·66
$\bar{X}$	3·65	2·00	1·24	4·13	2·24	1·15
SD	1·08	0·67	0·37	2·01	0·58	0·58
CV	29·59	33·50	29·84	48·67	25·89	50·43

SF, Soluble fibre determined by the Asp method; PS(C), pectic substances determined by the carbazole method; PS(*m*-H), pectic substances determined by the *m*-hydroxyphenyl method.

Table 3. Total dietary fibre analyzed by different methods in cucumber (% dry substance)

Sample no.	Pulp			Skin		
	IF + SF	NDF + PS(C)	NDF + PS(*m*-H)	IF + SF	NDF + PS(C)	NDF + PS(*m*-H)
1	18·26	12·92	11·97	46·98	34·25	32·95
2	16·34	14·00	13·02	47·47	37·58	36·63
3	17·94	15·65	13·90	46·55	38·59	36·62
4	13·61	11·88	10·71	48·56	31·10	30·89
5	18·09	13·41	13·52	47·03	39·80	39·41
6	18·75	15·63	13·60	54·99	40·78	41·23
7	19·59	12·18	12·41	52·53	43·72	42·06
8	17·37	14·54	14·42	52·28	37·99	36·08
9	19·65	14·83	14·26	49·91	36·68	35·16
10	25·11	21·21	20·82	50·08	40·15	38·66
$\bar{X}$	18·47	14·62	13·86	49·64	38·06	36·97
SD	2·92	2·66	2·69	2·86	3·53	3·50
CV	15·81	18·19	19·41	5·77	9·27	9·47

IF + SF, Insoluble fibre + soluble fibre determined by the Asp method; NDF + PS(C), neutral detergent fibre + pectic substances determined by the Van Soest method; NDF + PS (*m*–H), neutral detergent fibre + pectic substances determined by the *m*-hydroxyphenyl method.

Table 4. Total dietary fibre analyzed by different methods in cucumber (% fresh substance)

Sample no.	Pulp			Skin		
	IF + SF	NDF + PS(C)	NDF + PS(*m*-H)	IF + SF	NDF + PD(C)	NDF + PS(*m*-H)
1	0·89	0·62	0·58	3·75	2·74	2·61
2	0·73	0·62	0·57	3·86	3·05	2·97
3	0·64	0·56	0·49	4·16	3·45	3·27
4	0·62	0·54	0·48	5·68	3·64	3·61
5	0·84	0·63	0·63	4·01	3·40	3·37
6	0·81	0·73	0·58	4·68	3·47	3·50
7	0·86	0·54	0·55	4·47	3·72	3·58
8	0·86	0·69	0·71	4·00	2·90	2·76
9	0·95	0·72	0·70	3·97	2·92	2·79
10	1·11	0·94	0·93	4·65	3·72	3·58
$\bar{X}$	0·83	0·66	0·62	4·32	3·30	3·20
SD	0·14	0·12	0·13	0·58	0·37	0·39
CV	16·87	18·18	20·96	13·42	11·21	12·19

IF + SF, Insoluble fibre + soluble fibre determined by the Asp method; NDF + PS(C), neutral detergent fibre + pectic substances determined by the Van Soest method; NDF + PS (*m*-H), neutral detergent fibre + pectic substances determined by the *m*-hydroxyphenyl method.

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