A New Efficient Method for Extracting Glycoalkaloids from Dehydrated Potatoes

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A quick and effective method has been developed for extracting potato glycoalkaloids from dehydrated potatoes and potato products. Hydration was not required. Samples were extracted for 10 min in a Waring blender at medium speed with a solvent system of tetrahydrofuran–water–acetonitrile–glacial acetic acid (500:300:200:10 v/v). A comparison using 17 dehydrated samples was made between this new procedure and two existing methods. It was demonstrated that this new extraction technique was far superior to the existing ones.

Potato breeders and toxicologists spend much time investigating potato glycoalkaloids because of their known acute toxicity (Jellema et al., 1980; Willimott, 1933; McMillan Thompson, 1979), their possible chronic toxicity (Mun et al., 1975; Keeler et al., 1975, 1976), and their characteristic bitter flavor (Sinden et al., 1974; Filadelfi, 1980). Furthermore, new potato varieties that are to be released commercially are checked for glycoalkaloid levels. In many instances it is inconvient to perform glycoalkaloid analysis on the raw product so they are freeze-dried and stored for future work. Also, some commercial products are sold in the dehydrated form.

Recently it was demonstrated by Mondy and Ponnampalam (1983) that glycoalkaloid recoveries from dehydrated potatoes and potato products were inadequate when using previously developed extraction techniques. Therefore, they developed an extraction method in which the samples must be hydrated before being extracted.

In this paper a method is described that does not require hydration and is more effective in extracting glycoalkaloids from dehydrated samples than other methods.

MATERIALS AND METHODS

Samples. Ten samples were freeze-dried tubers (different varieties) obtained from the International Potato Center in Lima Peru. They were grown in four areas of Peru (San Ramon, Yurimaguas, Lima, and Huancayo). Four samples were freeze-dried experimental tubers from Alaska. Finally, three samples were commercial dehydrated products.

Reagents. All solvents were obtained from Fisher Scientific Co., Medford, MA. Tetrahydrofuran and acetonitrile were ACS certified grade while the glacial acetic acid was ACS reagent grade. Water was glass distilled. HPLC-grade solvents were used for HPLC analysis of glycoalkaloids. Glycoalkaloid standards, α-chaconine and α-solanine, were isolated by using the procedure of Bushway (1983).

Sample Extraction. For the new method, 10 g of sample was extracted for 10 min in a Waring blender at medium speed with 125 mL of tetrahydrofuran–water–acetonitrile–glacial acetic acid (500:300:200:10 v/v). Extracts were vacuum-filtered and brought to a volume of 250 mL with extracting solvent. A 100-mL aliquot (placed in a 250-mL round-bottom flask) was rotary evaporated to 20–25 mL, followed by the addition of 2 mL of glacial acetic acid. Before centrifugation at 38000g for 10 min, the mixture was sonicated for 2 min. The supernatant was poured into a 125-mL Erlenmeyer flask, along with 25 mL of concentrated ammonium hydroxide. Samples were placed in a 70 °C water bath for 30 min and then refrigerated overnight. The contents of the flask were centrifuged at 38000g for 10 min at 4 °C with the pellet being saved. Once the ammonia vapors had dissipated, the pellet was dissolved in 5 mL of tetrahydrofuran–water–acetonitrile (50:30:20 v/v, HPLC grade). Samples were analyzed by HPLC using the method of Bushway et al. (1979).

Samples analyzed by Mondy and Ponnampalam's (1983) procedure were all hydrated for 4 h in this study while those analyzed by Wang et al.'s (1972) method were not hydrated. The solvent system for these two methods use MeOH–$CHCl_3$ in place of tetrahydrofuran–acetonitrile–water–glacial acetic acid.

Table I. Comparison of Glycoalkaloid Extraction Methods for Freeze-Dried Tubers from Peru

	mg of glycoalkaloid/20 g of product	
sample no.	TGA value—method of Mondy and Ponnampalam[a]	TGA value—new method[a]
1	13.58	15.95
2	12.41	16.55
3	10.87	16.69
4	6.39	8.53
5	7.64	9.80
6	8.23	7.45
7	33.23	33.24
8	3.04	20.19
9	33.31	37.65
10	5.63	19.98
	av % extracted:[b] 82	
	range % extracted:[b] 15–110	

[a] Average of duplicate analyses. [b] Values based on a comparison with the new method.

RESULTS AND DISCUSSION

A recent glycoalkaloid extraction method developed by Mondy and Ponnampalam (1983) demonstrated that adding water at different amounts and for varying times before extraction of dehydrated potatoes caused an increased amount of glycoalkaloids to be extracted. Because of these water variables, a new method was developed and studied whereby no hydration time was required; only a constant water volume was incorporated into the solvent system. A comparison of both procedures was made on 17 dehydrated samples that were classified into one of three groups: (1) freeze-dried tubers stored less than a month; (2) freeze-dried tubers stored at room temperature more than 4 months; (3) dehydrated commercial potatoes.

Results of glycoalkaloid analyses on 10 samples from the first group are shown in Table I. This set consisted of 10 different South American potato varieties grown in four locations in Peru that had been freeze-dried not more than a month before being analyzed. As presented in Table I, the largest glycoalkaloid contents (8 times in 10) were obtained by using the new method. Of the two other samples, one (sample 6) had a TGA (total glycoalkaloid)

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Table II. Comparison of Glycoalkaloid Extraction Methods for Stored Freeze-Dried Tubers from Alaska

	mg of glycoalkaloid/20 g of product	
sample no.	TGA value—method of Mondy and Ponnampalam[a]	TGA value—new method[a]
1	9.68	11.78
2	3.28	4.28
3	26.63	32.04
4	11.02	17.08
	av % extracted:[b] 77	
	range % extracted:[b] 65–83	

[a] Average of duplicate analyses. [b] Values based on a comparison with the new method.

Table III. Comparison of Glycoalkaloid Extraction Methods for Dehydrated Commercial Potatoes

	mg of glycoalkaloid/20 g of product	
sample no.	TGA value—method of Mondy and Ponnampalam[a]	TGA value—new method[a]
1	0.96	1.15
2	3.98	4.55
3	0.67	1.18
	av % extracted:[b] 75	
	range % extracted:[b] 58–85	

[a] Average of duplicate analyses. [b] Values based on a comparison with the new method.

value 10% higher from Mondy and Ponnampalam's method than this new technique while the other (sample 7) had the same TGA content for both procedures. Furthermore, the average TGA level (all 10 samples) obtained by the Mondy and Ponnampalam (1983) method was 82% that of our procedure while the range varied from 15% to 110%. Two of the samples, 8 and 10, when analyzed by the Mondy and Ponnampalam method were extremely low, 15 and 28%, in their TGA content compared to the values from this new method.

A second set of samples, dehydrated tubers stored 6 years at room temperature, were also evaluated for TGA content by both methods (Table II). Samples from this group had to be hydrated for at least an hour according to the study performed by Mondy and Ponnampalam (1983). However, this new procedure requires no hydration time. As with the above potatoes, lower TGA values were observed with Mondy and Ponnampalam's procedure as compared to those from this new method. The average percent extracted for all four samples when compared to that for this new method was 77 with a range of 65–83%.

The last group, commercial dehydrated potatoes, comprised three samples. Results are given in Table III. Like the previous two groups Mondy and Ponnampalam's procedure yielded lower glycoalkaloid amounts. The average values were 25% lower than the ones obtained by the new method and the range was 58–85%.

A comparison was also made between our procedure and Wang et al.'s (1972). One extraction of each sample from all the different groups was performed by using the method of Wang et al. (1972). The results were very similar to the ones Mondy and Ponnampalam observed. Average recoveries for all 17 were 38% with a range of 6–72% when compared to the values obtained by the new method.

CONCLUSION

As Mondy and Ponnampalam (1983) have previously demonstrated, water must be present to effectively extract glycoalkaloids from dehydrated potatoes and their products. However, the results of this study have shown that the method of Mondy and Ponnampalam (1983) was inadequate for extracting the greatest amounts of TGA. The technique described here will yield on the average 18–25% more glycoalkaloids from dried potato samples than that of Mondy and Ponnampalam's (1983). Furthermore, this new procedure is much quicker since no hydration time is needed. Therefore, to obtain the best possible TGA results, researchers and processors should use this new method.

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