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Research Article

Determination of Nicotinic Acid and Nicotinamide Forms of Vitamin B_3 (Niacin) in Fruits and Vegetables by HPLC Using Postcolumn Derivatization System

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Abstract

Background and Objective: Vitamin B_3 is an important water-soluble vitamin that occurs in two forms in foods, nicotinic acid and nicotinamide. In the literature, the studies of vitamin B_3 are based on the analysis of total vitamin B_3 in foods. This study aimed to determine the nicotinic acid and nicotinamide contents in fruits and vegetables and to identify the best fruits and vegetables suitable for vitamin B_3 intake. **Materials and Methods:** A total of 67 samples of fruits and vegetables were collected from Istanbul, Turkey. The nicotinic acid and nicotinamide contents of 28 fruits and 39 vegetables were determined by HPLC using a postcolumn derivatization system. This is the first comprehensive report on the vitamin B_3 profiles of fruits and vegetables commonly consumed in Turkey. **Results:** A low level of nicotinic acid and a high level of nicotinamide were found in fruits. Vegetables exhibited the highest amount of nicotinic acid (66%), while the highest amount of nicotinamide was noted in fruits (47%). The nicotinic acid and nicotinamide contents of fruits ranged from 12-100 and 0-88%, respectively. However, the nicotinic acid and nicotinamide contents of vegetables ranged from 6-98 and 3-94%, respectively. **Conclusion:** Food composition tables need to be expanded and improved regarding the quantity and quality profiles in food composition databases through the collection and analysis of foods. This study highlights the importance of publicly accessible food composition databases for estimating nicotinic acid and nicotinamide intake and provides a reference for tools that are available globally.

Key words: Fruits, HPLC, niacin, nicotinamide, nicotinic acid, vegetables, Vitamin B_3 profiles

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Vitamin B_3 (niacin) is an important water-soluble vitamin found as nicotinic acid ($C_6H_5NO_2$) and nicotinamide ($C_6H_6N_2O$) in foods[1]. Nicotinic acid is generally known as niacin and nicotinamide is known as niacinamide in the literature. These forms are similarly effective as a vitamin because they can be reciprocally converted within the body but their effects and usages are different. Nicotinic acid is used clinically as a pharmacological agent in large doses to lower serum lipids and cholesterol. However, nicotinamide is used in the treatment of psychiatric disorders[2]. Diet is considered an important factor for the development of dyslipidemia[3]. Vitamin B_3 performs an important metabolic process in living cells as a precursor of NAD^+/NADH and $NADP^+$/NADPH. Vitamin B_3 in the form of the dinucleotides plays a central role in energy metabolism such as in oxidative phosphorylation and protein, fat and carbohydrate metabolism in the body. It is responsible for neural and enzymatic functions and is actively involved in preventing many pathological processes[4-5]. Nutritional deficiency of Vitamin B_3 causes pellagra and is associated with low NAD^+ levels[6-7].

Vitamin B_3 is not stored in the body but should be ingested daily[8] with foods. The daily recommended amount of vitamin B_3 per day is 12-16 mg for humans. In periods of pregnancy or lactation, however, this requirement is 17-18 mg day^{-1} [9].

Niacin can also be synthesized in organisms from dietary tryptophan. In addition, riboflavin converts amino acids into niacin. However, a small amount of the vitamin can be synthesized from tryptophan, so most of the daily requirement must be met by food sources of niacin, which means humans need a regular supply of vitamin B_3 in their daily diet. Vitamin B_3 is found in various food sources[10].

Recently, consumers' awareness towards the association between food and health has increased their interest in healthy foods, especially fruits and vegetables. A diet rich in fruits and vegetables provides various health benefits. Fruits and vegetables are naturally rich in carbohydrates, vitamins, minerals, dietary fiber, polyphenols and phytochemicals and are consequently known as healthy foods[11-12]. Consumption of fruits and vegetables is thought to be beneficial in the prevention of cancer[13]. Increased consumption of vegetables and fruits has been associated with a delayed risk of all-cause mortality and of mortality due to cancer and stroke[14].

The best approach for obtaining the daily requirement of essential vitamins is to eat a balanced diet that contains a variety of foods. Amounts of nicotinic acid and nicotinamide, which are the available forms of vitamin B_3, are different in every food. Nutritional adequacy should be assessed using vitamin profiles to determine individual diet composition. A country-specific food composition database is useful for assessing nutrient intake reliably through national nutrition surveys, research studies and clinical practice.

Currently, with the continuously increasing demand of natural, healthy and sustainable food, many studies have reported that vegetables have a great potential as a source of essential nutrients such as vitamins[15]. Fruits and vegetables are endowed with micronutrients, particularly vitamins but an understanding of their profiles is essential. Vitamin B_3 profiles of fruits and vegetables have emerged notably over time, though until now, food composition analysis was performed in terms of total vitamin B_3. The health benefits of fruits and vegetables, together with their popularity and cultural relevance in the Turkish diet, indicate the vitamin B_3 profiles of fruits and vegetables (as suitable foods) and should be included in Turkish Food Composition Databases. However, food composition tables need to be expanded and improved regarding the quantity and quality of profile data in food composition databases through the analysis of nationally representative food samples.

Niacin has many important biological functions in humans, e.g., playing a key role for biosynthesis and production of energy, that show the importance of determining niacin profiles in foods for assessing nutritional conditions. Translating vitamin B_3 intake data into nicotinic acid and nicotinamide outcomes is a crucial step in investigating potential health benefits. To our knowledge, there are no studies on the vitamin B_3 profiles of fruits and vegetables in Turkey.

In the literature, studies of vitamin B_3 in foods are generally based on the analysis of the total amount of vitamin B_3 in foods[9,16-18] and studies determining the profiles of vitamin B_3 in fruits and vegetables are limited; more importantly, their profiles should also be taken into account[19]. Therefore, the aims of this study were to obtain the profiles of vitamin B_3 in fruits and vegetables, which have been proven to have positive effects on health, to determine diet-derived nicotinic acid and nicotinamide consumption for estimated intake studies.

MATERIALS AND METHODS

A postcolumn UV derivatization system with HPLC was used to determine the presence and concentrations of nicotinic acid and nicotinamide in 67 samples consisting of 28 fruit samples and 39 vegetable samples.

Materials and research tools: Copper sulfate ($CuSO_4$), hydrochloric acid (HCl), hydrogen peroxide (H_2O_2), potassium dihydrogen phosphate (KH_2PO_4), sodium hydroxide (NaOH) and trichloroacetic acid ($C_2HCl_3O_2$) were purchased from Sigma (St. Louis, MO, USA). The vitamin standards (nicotinic acid and nicotinamide) and Teflon tubing (length: 20 m, diameter: 0.5 mm) used in this study were obtained from Sigma-Aldrich. A UVA lamp (20 W, 60 cm) was used for postcolumn derivatization. In this study, all other chemicals used were of high purity. Samples of fruits and vegetables were purchased from local markets in Istanbul, Turkey.

Standard preparation: Standard stock solutions of nicotinic acid and nicotinamide (100 µg mL^{-1}) were prepared in 0.1 N hydrochloric acid solution and each standard was freshly prepared daily. Working standards at 5 concentration levels were prepared from the stock solutions.

Sample preparation: Ten gram of the samples was homogenized and placed in a 250 mL Erlenmeyer flask. Sixty milliliters of 0.1 N hydrochloric acid (HCl) was added and the solution was autoclaved at 121°C for 30 min. Then, the samples were taken from the autoclave and cooled down to room temperature. Two milliliters of 20% tricyclic acetic acid ($C_2HCl_3O_2$) was added to the solution. Then, the volume was completed to 100 mL with 0.1 N hydrochloric acid (HCl) filtered through filter paper. The final solution was filtered through a 0.45 µm filter into HPLC vials.

Experimental design: The profile of vitamin B_3 was determined by an HPLC system consisting of a Shimadzu Nexera-İ LC-2040C 3D pump with a Shimadzu RF-20A fluorescence detector (Shimadzu Corporation, Kyoto, Japan) according to the procedure described by Lahely *et al.*[19] with some modifications. The Zorbax Eclipse X08-C18 column (5 µm, 4.6×150 mm) (Agilent, USA) was used at a flow rate of 1 mL min^{-1}. Postcolumn derivatization was required to determine the profile of vitamin B_3. For postcolumn derivatization, a photochemical derivatization system was established in the laboratory by wrapping Teflon tubing with a length of 20 m and a diameter of 0.5 mm on a 60 cm long UVA lamp. The system was connected between the analytical column and the fluorescence detector. The mobile phase was prepared daily by mixing 500 mL of deionized water and 9.5 g of potassium dihydrogen phosphate (KH_2PO_4) and protected from light. Then, 7.5 mL of hydrogen peroxide (H_2O_2) and 2 mL of copper (II) sulfate solution ($CuSO_4$) (0.12 copper (II) dissolved in 100 mL of deionized water) was added and the volume was completed with 1 L of deionized water. Finally, the mobile phase was filtered through a 0.22 µm filter. The fluorescence detector was set to an excitation wavelength of 322 nm and an emission wavelength of 380 nm. The column oven temperature was maintained at 25°C, the analysis time was 40 min and the injection volume was 20 µL.

Research procedure: The quality procedures of the analytical method were based on ISO/IEC 17025 requirements. A Standard Reference Material (SRM 1849a) Infant/Adult Nutritional Formula was obtained from National Institute of Standards and Technology (Gaithersburg, MD, USA) and was processed similarly to the unknown samples. For the quality of the research, we participated in the FAPAS® test (2018), a proficiency test for analyzing breakfast cereal, organized by FAPAS® (Food Analysis Performance Assessment Scheme in UK). All analyses were performed in triplicate and the average values were used. Our results were found in the acceptable range (-2 Z score +2).

RESULTS AND DISCUSSION

Profiles of vitamin B_3: HPLC is one of the most appropriate and accurate analytical techniques for analyzing vitamin B_3 from foods. The analytical method was successfully applied to determine the vitamin B_3 profiles of 67 samples in total, including 28 fruit and 39 vegetable samples. Nicotinic acid and nicotinamide forms were found together in a combination in nearly all fruit and vegetable samples. The results showing nicotinic acid and nicotinamide concentrations in fruits are given in Table 1. HPLC chromatograms of the standard, watermelon and tomato samples are presented in Fig. 1-3. Table 2 shows the vitamin B_3 profiles of vegetables.

Vitamin B_3 profiles of fruits: Twenty-eight fruit samples were examined and the results are shown in Table 1. Figure 1 and 2 show representative chromatograms for the standard solution and the watermelon sample, respectively.

Nicotinic acid (mg/100 g) was found mostly in chestnut, melon and nectarine samples. Most of the nicotinic acid amount was found in the chestnut sample (1.061 mg/100 g), while the lowest amount was measured in the apple sample (0.044 mg/100 g). Regarding the vitamin B_3 profiles of fruit samples (as percentages), fig (100%), cherry (92%), melon (81%) and seedless watermelon (79%) samples contained the most nicotinic acid, banana (12-25%), summer apple (21%), satsuma mandarin (20%) and red grape (21%) samples were the lowest nicotinic acid-containing fruits. In addition, the Fig. (a) sample profile showed only the nicotinic acid form (100%).

Table 1: Vitamin B_3 profiles of fruits

Fruit samples	Nicotinic acid (mg/100 g)	Nicotinamide (mg/100 g)	Total (mg/100 g)	Nicotinic acid (%)	Nicotinamide (%)
Apple	0.059	0.067	0.126	47.0	53.0
Apple (summer)	0.044	0.161	0.205	21.0	79.0
Apricot	0.216	0.224	0.440	49.0	51.0
Banana (a)	0.221	0.660	0.881	25.0	75.0
Banana (Anamur)	0.091	0.669	0.760	12.0	88.0
Banana (b)	0.126	0.655	0.781	16.0	84.0
Cherry (red)	0.428	0.037	0.465	92.0	8.0
Chestnut	1.061	0.358	1.419	75.0	25.0
Fig. (a)	0.365	0.000	0.365	100.0	0.0
Fig. (b)	0.385	0.021	0.406	95.0	5.0
Grapes (green)	0.066	0.042	0.108	61.0	39.0
Grapes (red)	0.065	0.243	0.308	21.0	79.0
Kiwi (a)	0.180	0.213	0.393	46.0	54.0
Kiwi (b)	0.126	0.180	0.306	41.0	59.0
Mandarin	0.159	0.213	0.372	43.0	57.0
Mandarin (satsuma)	0.060	0.241	0.301	20.0	80.0
Melon	0.727	0.172	0.899	81.0	19.0
Nectarine (a)	0.757	0.266	1.023	74.0	26.0
Nectarine (b)	0.538	0.259	0.797	68.0	32.0
Orange (WS)	0.181	0.068	0.249	73.0	27.0
Peach	0.468	0.476	0.944	50.0	50.0
Pear (Develi)	0.169	0.107	0.276	61.0	39.0
Pear (summer)	0.077	0.247	0.324	24.0	76.0
Plum (Japanese)	0.243	0.155	0.398	61.0	39.0
Quince	0.073	0.146	0.219	33.0	67.0
Strawberry	0.198	0.093	0.291	68.0	32.0
Watermelon	0.123	0.079	0.202	61.0	39.0
Watermelon (seedless)	0.139	0.038	0.177	79.0	21.0
Mean				53.0	47.0

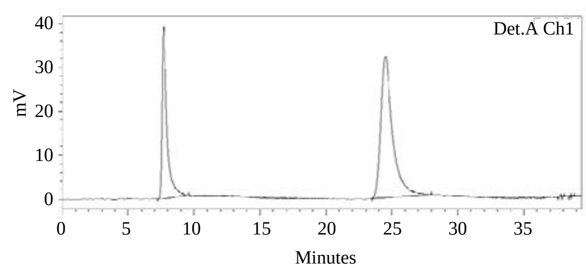

Fig. 1: HPLC chromatogram of the standards for nicotinic acid and nicotinamide

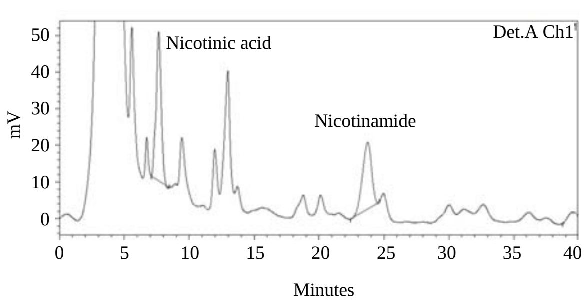

Fig. 2: HPLC chromatogram of nicotinic acid and nicotinamide in the watermelon sample under chromatographic conditions of the analytical method

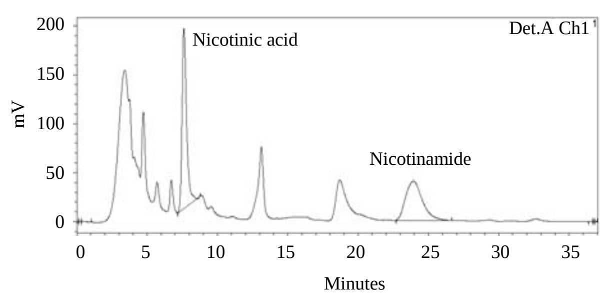

Fig. 3: HPLC chromatogram of nicotinic acid and nicotinamide in the tomato sample under chromatographic conditions of the analytical method

However, nicotinamide (mg/100 g) was found mostly in banana and peach samples. Regarding the content of nicotinamide, the highest nicotinamide amount was found in the banana sample (0.669 mg/100 g), while the lowest amount was found in the fig samples (0-0.021 mg/100 g). For vitamin B_3 profiles of fruits (as percentages), banana (75-88%), satsuma mandarin (80%) and summer apple (79%) samples contained the most nicotinamide, while the fig (0-5%) sample was contained the lowest of nicotinamide.

In contrast, samples of the chestnut, nectarine, peach and banana contained the highest amount of total vitamin B_3.

Table 2: Vitamin B_3 profiles of vegetables

Vegetable samples	Nicotinic acid (mg/100 g)	Nicotinamide (mg/100 g)	Total (mg/100 g)	Nicotinic acid (%)	Nicotinamide (%)
Eggplant	0.249	0.561	0.810	31.0	69.0
Bell pepper (green)	0.466	0.365	0.831	56.0	44.0
Bell pepper (red)	0.495	0.386	0.881	56.0	44.0
Bell pepper (yellow)	0.564	0.418	0.982	57.0	43.0
Black radish	0.209	0.142	0.351	60.0	40.0
Broad bean	0.651	0.180	0.831	78.0	22.0
Broccoli	0.755	0.059	0.814	93.0	7.0
Brussels sprouts	0.532	0.210	0.742	72.0	28.0
Carrot	0.816	0.021	0.837	97.0	3.0
Cauliflower	0.772	0.127	0.899	86.0	14.0
Chard	0.112	0.087	0.199	56.0	44.0
Corn (sweet)	1.510	0.115	1.625	93.0	7.0
Cowpea	0.678	0.107	0.785	86.0	14.0
Cress	2.165	0.050	2.215	98.0	2.0
Dill	1.975	0.171	2.146	92.0	8.0
Knotweed	0.599	0.904	1.503	40.0	60.0
Leek	0.036	0.253	0.289	12.0	88.0
Lemon	0.098	0.152	0.250	39.0	61.0
Lettuce	0.297	0.043	0.340	87.0	13.0
Long green pepper	0.435	0.129	0.564	77.0	23.0
Mint	0.920	0.536	1.456	63.0	37.0
Mushrooms	3.555	1.829	5.384	66.0	34.0
Nettle	0.470	0.505	0.975	48.0	52.0
Okra	0.889	0.226	1.115	80.0	20.0
Onion	0.085	0.222	0.307	28.0	72.0
Parsley	0.920	0.766	1.686	55.0	45.0
Pea	1.385	0.432	1.817	76.0	24.0
Pepper (ornamental)	1.410	0.071	1.481	95.0	5.0
Potato	1.398	0.213	1.611	87.0	13.0
Pumpkin	0.741	0.223	0.964	77.0	23.0
Purslane	0.275	0.191	0.466	59.0	41.0
Red cabbage	0.245	0.075	0.320	77.0	23.0
Rocket	1.163	0.524	1.687	69.0	31.0
Savoy cabbage	0.688	0.498	1.186	58.0	42.0
Scallion	0.042	0.622	0.664	6.0	94.0
Spinach	0.757	0.095	0.852	89.0	11.0
Tomato	0.555	0.128	0.683	81.0	19.0
Tomato (cherry)	0.363	0.558	0.921	39.0	61.0
White cabbage	0.213	0.113	0.326	65.0	35.0
Mean			66.000	34.0	

Vitamin B_3 profiles of vegetables: The results of the vitamin B_3 profile analysis of 39 vegetable samples are shown in Table 2. Figure 3 shows a representative chromatogram for a tomato sample.

Among the vegetable samples, the highest amount of nicotinic acid was found in mushrooms (3.555 mg/100 g), while the lowest nicotinic acid-containing sample was the leek (0.036 mg/100 g). The highest amounts of nicotinic acid of the samples in mg/100 g in descending order were mushrooms, cress, dill, sweet corn, ornamental peppers, potatoes, peas and arugula. For vitamin B_3 profiles as percentages, cress (98%), carrot (97%), ornamental pepper (95%), sweet corn (93%), broccoli (93%) and dill (92%) samples contained the most nicotinic acid, while the scallion (6%) sample contained the lowest amount of nicotinic acid.

The highest amount of nicotinamide was found in knotweed (0.904 mg/100 g), while the lowest amount of nicotinamide was found in carrots (0.021 mg/100 g). When considering vitamin B_3 profiles, the scallion sample (94%) contained the most nicotinamide.

Samples of the mushrooms, cress and dill contained the most vitamin B_3. In terms of nicotinic acid profiles in vegetables, the highest amount of nicotinic acid was found in the mushrooms sample but the highest percentage was found in the cress sample. The cress sample contained (2.165 mg/100 g) nicotinic acid but also contained 0.05 mg/100 g nicotinamide, so the presence of nicotinic acid and nicotinamide in the cress sample was found to be 98% and 2%, respectively.

When we evaluated our results, the rates of nicotinic acid and nicotinamide presence were determined in the fruit samples as 53 and 47% and in the vegetable samples as 66 and 34%, respectively. Nicotinic acid concentrations were found in the range of 12-100% in the fruit samples with a mean value of 53%. However, nicotinamide concentrations were found in the range of 0-88% in the fruit samples with a mean value of 47%. In the vegetable samples, nicotinic acid concentrations were found in the range of 6-98% with a mean value of 66% while nicotinamide concentrations were found in the range of 3-94% with a mean value of 34%. All of the vegetable profiles showed both nicotinic acid and nicotinamide forms together.

The total vitamin B_3 content of vegetables was higher than the fruits. Mushrooms had the highest nicotinic acid (3.555 mg/100 g) and nicotinamide (1.829 mg/100 g) contents with a total amount of 5.384 mg/100 g. Grapes (green) had the least total vitamin B_3 content (0.1 mg/100 g). Additionally, leek had the least nicotinic acid content and fig had the least nicotinamide content. In general, although the total content of vitamin B_3 was low in the fruits and vegetables, mushrooms, cress and dill samples were high in vitamin B_3 with values of 5.384, 2.215 and 2.146 mg/100 g, respectively. Of the fruits tested, chestnut and nectarine (a) samples were high in vitamin B_3 with values of 1.419 and 1.023 mg/100 g, respectively.

The profiles of fruits showed nearly the same presence percentages, while the profiles of vegetables showed that nicotinic acid was two times higher than nicotinamide. In vegetables, nicotinic acid was found to be significantly higher than in the fruits. Nicotinamide was low in all of the samples. As can be clearly seen from Table 1 and 2, the vitamin B_3 profiles of the fruit samples show combinations of the nicotinic acid and nicotinamide forms, while the profiles of vegetable samples show predominantly the nicotinic acid form.

In fruits, the fig sample exhibited the highest nicotinic acid percentage (100%), while the highest nicotinamide percentage was observed in bananas (88%). High levels of nicotinic acid in the range of 95-100% were observed in figs (a, b) and high levels of nicotinamide in the range of 84-88% were observed in bananas. However, in vegetables, the cowpea sample exhibited the highest nicotinic acid percentage (98%), while the highest nicotinamide percentage was noted in scallions (94%).

Vitamin B_3 profiling showed that regular tomatoes and cherry tomatoes differed: nicotinic acid was higher in tomatoes, nicotinamide was higher in cherry tomatoes. The results indicated that 100 g of tomato contained 0.555 mg nicotinic acid and 0.128 mg nicotinamide, while cherry tomatoes contained 0.363 mg nicotinic acid and 0.558 mg nicotinamide. When cherry tomatoes and regular tomatoes were compared, the nicotinic acid form was predominant in the regular tomato, while nicotinamide was predominant in cherry tomato. When the results of total vitamin B_3 were evaluated, tomatoes contained a higher amount of total vitamin B_3.

Karnopp *et al.*[20] reported that grapes (*Vitis* spp.) are one of the most cultivated fruit crops in the world with more than 60 million tons produced annually. According to the results of the present study, the levels of nicotinic acid are the same in both green grapes and red grapes but the concentration of nicotinamide is 6 times higher in red grapes than in green grapes.

Each variety of fruits and vegetables showed its own unique vitamin B_3 profile with significant variation within each individual vitamin B_3 form. Is well known that fruits and vegetables should be consumed as part of a balanced diet as a source of vitamins, minerals, fibers and phytochemicals[21-22]. The consumption of a variety of fruits and vegetables is important for a high-quality diet. Nutritional adequacy depends on nutrient intake that strongly varies with respect to the vitamin profiles of foods.

Although, we have performed an extensive literature survey on this subject, unfortunately, there was insufficient data regarding the profiles of vitamin B_3 to which we could compare our results of nicotinic acid and nicotinamide forms in foods. These studies were based on total niacin content of foods, so the obtained values of total vitamin B_3 were compared with the values available in the published literature of the United States Department of Agriculture (USDA) and the Turkish Food Composition Database (TURCOMP). For example, consistent with the results of this study, the total niacin content of fruits and vegetables according to the USDA include: watermelon (0.178 mg/100 g), cherry (0.400 mg/100 g), chestnut (1.500 mg/100 g), orange (0.282 mg/100 g), lettuce (0.375 mg/100 g) and pumpkin (0.920 mg/100 g)[23]. In addition, consistent with the findings of this study, according to Turkish Food Composition Database (TURCOMP), the total niacin content of fruits and vegetables include: Watermelon (0.199 mg/100), cherry (0.382 mg/100 g), chestnut (1.190 mg/100g), orange (0.281 mg/ 100 g), lettuce (0.348 mg/100 g) and pumpkin (0.836 mg/100 g)[24].

This study was the first and largest study that focused among fruits and vegetables in Turkey and its results are consistent with the literature in terms of total niacin content. Lahely *et al.*[19] reported that the total niacin content in tomatoes was 0.42 mg/100 g and the pea's total niacin content was 1.82 mg/100 g, which was in accordance with our results.

Considering that nicotinic acid and nicotinamide have protective health effects, their low consumption could be a risk factor for developing cardiovascular diseases, neurodegeneration, diabetes and cancer. A higher nicotinic acid to nicotinamide ratio is desirable for good health; however only some of the analyzed foods were found to have this high ratio. Therefore, there is a need to determine the nicotinic acid and nicotinamide content of foods and to reconstruct food composition tables so they are usable and more accurate.

This study is the first to report on the vitamin B_3 profiles of fruits and vegetables in Turkey. Such data are necessary to more accurately estimate the dietary intake of the local population and evaluate the health characteristics of these foods. We believe understanding these food compositions and profiles can give greater insight into the Turks gastronomic culture and changes in eating habits. We expect this information to play important roles as part of the Turkish food composition tables. Monitoring changes in the composition of foods is critical in keeping food composition databases updated so that they remain a vital tool in assessing the nutrient intake of national populations, as well as for providing dietary advice. The Turkish Food Composition Database needs to maintain relevant and updated food records that reflect the composition of foods commonly consumed in Turkey and that follow the guidelines of the Food Agricultural Organisation of the United Nations/International Network of Food Data Systems (FAO/INFOODS).

CONCLUSION

The study was conducted to determine the nicotinic acid and nicotinamide levels in fruits and vegetables. Our aim was to develop a reference for nutritional composition in terms of niacin profiles for fruits and vegetables. Vitamin B_3 profiles and nicotinic acid and nicotinamide ratios of 28 fruits and 39 vegetables consumed in Turkey were determined. Nicotinic acid content was higher in vegetables than in fruits. Similarly, nicotinamide content was higher in fruits than in vegetables. The highest analyzed mean nicotinic acid content was found in vegetables (66%, range = 6-98%), while the nicotinamide content was highest in fruits with a mean of 47% and a range between 0-88%.

Vitamin B_3 profiles of fruits and vegetables are important for understanding the nutritional value of these foods for consumption. A clearer understanding of the association between fruit/vegetable intake and nicotinic acid/nicotinamide content would provide health professionals with important information in terms of nutritional composition and public health.

SIGNIFICANCE STATEMENT

This study presents the vitamin B_3 profiles of fruits and vegetables in Turkey that can be beneficial for estimating dietary intake more accurately and for evaluating the health characteristics of these foods. This study will help researchers investigate the critical areas of nicotinic acid and nicotinamide forms that others have been unable to explore. Thus, a new theory regarding these profiles may be developed.

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