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Fourier Transform Infrared Spectroscopic Study on Glycoalkaloid Concentration in Varieties of *Solanum tuberosum*

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Abstract

The potential of Fourier transform infrared spectroscopy used for predicting the concentration of glycoalkaloids in varieties of potato tuber, waxy and starchy (*Solanum tuberosum*) was investigated in this study, α-solanine and α-chaconine are the main glycoalkaloids of potato tubers. Potato glycoalkaloids are the cholinesterase inhibitors and cause poisoning which is leading to accumulation of acytylcholine and even death. This will happen after consuming of potatoes with excessive glycoalkaloid level by human. One of the major factors affecting glycoalkaloid concentration in potato is its variety. In the present investigation the most popular varieties of potatoes waxy and starchy are subjected to FT-IR spectral analysis to determine the concentration of glycoalkaloid contents and the various nutrients. The implications of the results in terms of food safety are discussed.

Key Words: Glycoalkaloids, Potato, FT-IR spectroscopy.

Introduction

Potato is certainly the most extensively grown tuber crop in the world and is the most efficient food for energy production. The energy produced through potato gets stored as glycogen in muscle and liver. Potato glycoalkaloids are belongs to class of compounds comprises of steroidal like base containing nitrogen to which one of four sugars may be attached to the serious of glycosidic linkages [1]. Because glycoalkaloids have been implicated as toxins, much interest has evolved in performing toxicological studies. The glycoalkaloid concentration varied for the different types of potato [2,3]. The FT-IR is a potential analytical technique that provides information about the chemical composition and molecular vibration of the samples. In the present work, the quantitative analysis has been performed by FT-IR method on the samples of two varieties of potatoes named as waxy and starchy and their nutritional values are taken into the study are compared.

Materials and Methods

The two varieties of potatoes were collected from the place Ooty and Salem in Tamilnadu State, India. The Waxy and Starchy type potatoes are shown in Fig 1 and 2. The samples were well sliced and dried at 120ºC in Hot air oven and powdered with Agate mortar. FT-IR spectra were recorded in the mid region 400-4000 cm-1 using RX-1 Perkin – Elmer spectrometer in KBr pellet method with spectral resolution of better than 0.8 cm -1.The nutritive values of the potatoes are evaluated by the various analytical methods such as Fehlings method for carbohydrates, Microkjeldhal method for proteins, Soxhlet method for fat, Calculation method for energy, Ape et al's method for Moisture [4].

Until recently, most markets sold potatoes under generic names, such as "baking potato" or "boiling potato," which helped shoppers choose the right potato for each recipe. But now many markets sell potatoes by varietal name, such as Yukon Gold and Red Creamer etc. So how does one use these potatoes? One find that potato varieties can be divided into two major categories based on texture and its starch content, first one is Starchy Potatoes It also known as "baking" potatoes or Floury potatoes, this group contains more total starch (20 % to 22 %) and amylose than other categories, giving these varieties a dry, mealy texture. Common Varieties: Russ et, Russ et Burbank Idaho is the second variety which is Waxy potatoes also known as "boiling" potatoes. These contain a relatively low amount of total starch (16 % to 18 %) and very little amylose, which mean they have a firm, smooth, waxy texture. Freshly dug potatoes, which are often called "new" potatoes, fall into this group. In case that is unsure of the variety of potato means , that can be clear by mixing one part salt to 11 parts water in a measuring jug and add the potato . A floury one will almost always sink to the bottom of the jug , while a waxy one will float [5].

Fig. 1. Estima potato (Waxy potato).

Fig. 2. Sante potato (Starchy potato).

Glycoalkaloids are naturally present toxins that probably evolved as protective compounds in response to tissue damage. Glycoalkaloids have anti-microbial, insecticidal and fungicidal properties. In low concentrations glycoalkaloids can have a positive impact on flavour. However, in higher concentration glycoalkaloids cause a bitter taste and can be toxic [6]. The molecular structure of the glycoalkaloid present in the potato is shown in Fig. 3.

Results and Discussion

FT-IR spectra of the samples of Starchy and Waxy type potatoes were given in the Fig 4 and 5. FT-IR exhibited in the respective spectra of the samples were tabulated and assigned tentatively from the assignment reported for similar studies are given in the Table 1. FT-IR spectra of the two samples are almost identical because these bands are originated from the amylose and amylopectin of the starch content in the samples [7].

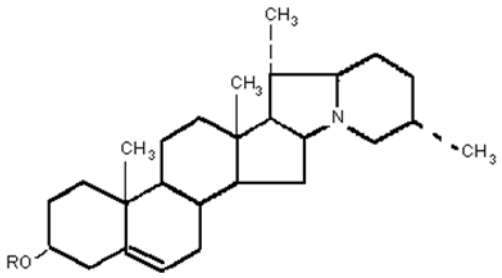

Fig. 3. Structure of the Glycoalkaloid in potato.

In the two samples the very strong intensity transmission band assigned at 3430, 3400 cm^{-1} and very weak band at 2360 cm^{-1}were attributed with O–H stretching vibration. The Medium intensity bands around 2934, 2820 and 1244 cm^{-1} are assigned to C–H asymmetric stretching vibrations. The very weak intensity bands at 2151, 2149 cm^{-1} occurred because of N–H stretching vibrations. Then the Pyranose ring skeleton vibrations are assigned around the very strong intensity band 1596, the strong intensity bands 1381, 1352 and medium intensity band 577 cm^{-1}. These are due to the vibrations of pyranose ring in the glucose unit of starchy [8, 9]. The weak intensity bands at 932, 849 cm^{-1} observed represented the ring symmetric vibrations which due to α-D glucose and β-D glucose of the starch content. The most significant spectral differences between these two samples were the medium intensity band at 530 cm^{-1} which assigned to N – H torsion vibration. This band was absent in the sample of starchy type potatoes. The C-O-C asymmetric stretching bands are assigned at 1155 and 1154 cm^{-1} in the two samples with medium and strong intensity respectively which due to glycoalkaloids [10]. These bands were referred that the glycoalkaloid concentration is higher in the waxy type potatoes than that of starchy one.

Table 1. Vibrational Observed Frequencies, Relative Intensities and Tentative Vibrational Assignment of starchy and waxy potatoes.

SPS		BPW		Tentative Vibrational Assignment
Frequencies in cm^{-1}	Relative intensity	Frequencies in cm^{-1}	Relative intensity	
3430	VS	3400	VS	O-H stretching
2934	M	2928	S	C-H asymmetric stretching
2820	W	-----	-----	C-H stretching overtone
2360	VW	2360	VW	O-H stretching
2151	VW	2149	VW	N-H stretching overtone
1596	VS	1596	VS	Pyranose ring skeleton
1381	S	------	-----	Pyranose ring skeleton
1352	S	1353	S	Pyranose ring skeleton
1244	VW	1244	W	C-H overtone
1155	M	1154	S	C-O-C asymmetric stretching
1025	M	1024	VS	C-O-C asymmetric stretching
932	VW	-----	-----	Ring symmetric stretching
-----	-----	849	VW	Ring deformation
764	W	763	M	Ring deformation
577	M	577	M	Pyranose ring skeleton
-----	-----	530	M	N-H torsion

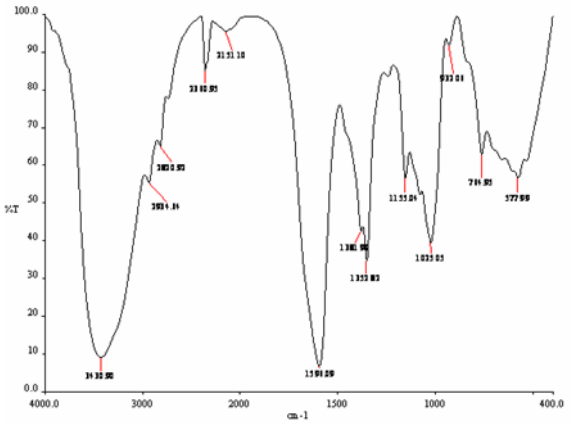

Fig. 4. FT-IR spectrum of startch potato samples.

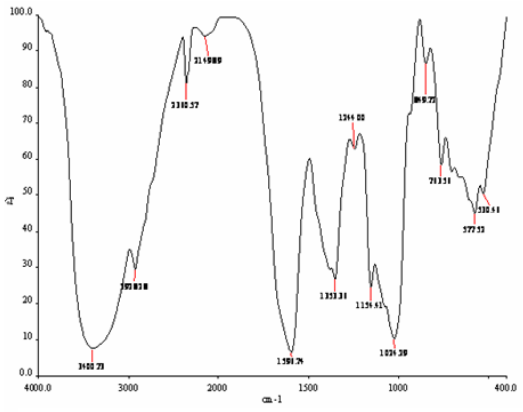

Fig. 5. FT-IR spectrum of waxy. potato sample.

Nutrient Analysis

By analysing the nutrient values of these two varieties it is found that the major nutrients are higher in the starchy type potatoes than that of the waxy type. In this study five nutrients analysis of carbohydrate, protein, fat, energy, and moisture were carried out and the results are given in the table 2.

Nutrition is the provision, to cells and organisms, of the materials necessary in the form of food to support life. Many common health problems can be prevented or alleviated with the sufficient nutrition in the food. Among the several nutrients in potato carbohydrates, Protein, Fat, Energy and Moisture are the dominants. Carbohydrates are the main source of energy and provide the ideal fuel (glucose) for our body to function optimally, as well as many essential vitamins and minerals. They are also the only form of energy used by the brain. Proteins are essential to growth and repair of muscle and other body tissues. Fats play as one of the sources of energy and important in relation to fat soluble vitamins. Moisture is essential to normal body function as a vehicle for carrying other nutrients and because 60% of the human body is water.

Table 2. Nutrient analysis of the potatoes varieties.

Nutrients	SPS	BPW
Carbohydrates(g)	22.6	19
Protein (g)	7	6.5
Fat (g)	0.1	0.1
Energy (Kcal)	97	88
Moisture %	75	74.2

There are some other factors to reduce the glykoalkaloid concentration in potatoes. To avoid toxic levels of glycoalkaloids, potato cultivar selection is very important. However, improper post harvest handling conditions are the main cause of toxic levels in potatoes. To keep glycoalkaloid content low, store potatoes at lower temperatures, such as 7°C(45°F), keep potatoes away from light, market in opaque plastics films and paper bags, and rotate frequently on retail displays [11].

Conclusion

The two familiar varieties of potato samples (starchy and waxy) were subjected to FT-IR spectroscopic analysis. The concentration of glycoalkaloid content has been compared in the two varieties by analysing the peaks observed in the FT-IR spectra. The most significant spectral differences were appeared in the N – H torsion vibration and the C – O asymmetric stretching vibrations. These two vibrational bands clearly denoted that the glycoalkaloid concentration is higher in the waxy type potatoes than that of starchy one. From the study of varies nutrients it confirmed that the important nutrients are rich in starchy potatoes than the waxy type. It has been concluded that the starchy type potatoes having less glycoalkaloid level and rich in nutritional level than the waxy type. So it is quite better to consume starchy potatoes than waxy type.

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