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A comparative evaluation of antioxidant and antidiabetic potential of peel from young and matured potato

*K.B. Arun, Janu Chandran, R. Dhanya, Priya Krishna, P. Jayamurthy, P. Nisha**

Agroprocessing and Natural Products Division, National Institute for Interdisciplinary Science and Technology (NIIST), CSIR, Thiruvananthapuram 695019, Kerala, India

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ABSTRACT

In the present study antioxidant and antidiabetic potentials of potato peels at two different stages of maturity were evaluated and compared. Peels of young and mature potatoes (YP and MP) were sequentially extracted with hexane (HMP, HYP), ethyl acetate (EMP, EYP) and methanol (MMP, MYP). EMP and EYP were found to possess the highest phenolic content (83.2 and 44.14 mg GAE/g dry weight, respectively) and maximum radical scavenging efficacy for different antioxidant assays performed. EYP demonstrated better α-glucosidase inhibition activity (IC_{50}-197.13 μg), intracellular ROS scavenging and induce glucose uptake in L6 rat skeletal muscle cells. Phenolic profiling of compounds (gallic, caffeic, ferulic and chlorogenic acids) in the active extracts were established using HPLC. The study demonstrated that YP exhibited better bioactive potential than that of MP. YP could be an excellent source of bioactive phytochemicals with antioxidant and antidiabetic potential.

1. Introduction

Diets rich in natural antioxidant phytochemicals and dietary fibers have been associated with lower incidence of metabolic syndromes like Type 2 diabetes, cardiovascular diseases and cancer (Scalbert, Manach, Morand, & Remesy, 2005; Anderson et al., 2009). Oxidative stress has been linked to the onset of many of these metabolic diseases (Galisteo, Duarte, & Zarzuelo, 2008). Diabetes mellitus is a disease/disorder related to glucose metabolism, may lead to the reduction of endogenous antioxidants and an increase in oxidative stress in the human body. It is reported that antioxidants reduce the risk of diabetes onset, improve glucose disposal, and improve some of the associated complications (Pandey & Rizvi, 2009). Psaltopoulou et al. (2011) reported that consumption of antioxidants rich diets helps in better control of glycemic markers which can lead to the prevention of development of diabetes at the population level.

Plants with dietary fiber (DF) and antioxidant bioactive compounds are of growing interest because of their beneficial linkage to human health. Over the past years, there is increasing interest in new sources of dietary fibers with specific bioactive constituents that may add to new functional properties of traditionally commercialized products.

*Corresponding author. Tel.: +91 471 2515348.
E-mail address: bp.nisha@yahoo.com (P. Nisha).

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Many food processing waste streams, such as bran from cereal, grain and pulses, fruit processing waste, etc., have been evaluated for their dietary fiber content and antioxidant potential (Norah, Arendt & Gallagher, 2012).

Potato (*Solanum tuberosum* L.) is the world's fourth important food crop because of its high yield and great nutritive value. It is an economically important staple crop in both developed and developing countries. Potato is an excellent source of carbohydrate, protein, vitamins and minerals and is also one of the richest sources of antioxidants (Buono et al., 2009). The potato processing industry generates high amount of peel as by-product, which is a good source of several beneficial functional ingredients including antioxidant polyphenols. Although potato peel does not pose any serious disposal and environmental problems, meaningful utilization of this nutrient-rich waste has recently drawn much attention among the scientific community (Prasad & Pushpa, 2007; Mabrouk & El Ahwany, 2008; Sabeena Farvin, Grejsen & Jacobsen, 2012).

Potato peel is reported to be a good source of dietary fiber and polyphenols which demonstrates antihyperglycemic effect in experimental rats (Singh & Rajini, 2004; Singh, Vasudeva, & Rajini, 2005). Investigators reported that the diabetic rats fed with freeze dried powder of potato peel caused a significant decrease in blood glucose level and effectively attenuated diabetic alterations in rats. The nutritionally and pharmacologically important components such as phenolic compounds, glycoalkaloids and cell wall polysaccharides in potato peel may be used as precursors of steroid hormones (Schieber & Saldana, 2009). In another study by Mohdaly, Sarhan, Smetanska, and Mahmoud (2010), the methanolic extract of potato peel was found to have potential antioxidant capacity.

Apart from the matured potatoes, the new or young potatoes, harvested before complete maturity, are being used widely in many cooking recipes (Navarre, Shakya, Holden, & Kumar, 2010). They have thin skin that is considered to be a good source of fiber, whereas mature potatoes have thick skin and their flesh is drier than young ones.

To the best of our knowledge antioxidant and antidiabetic potential of potato peels of different maturity levels have never been evaluated and compared. The bioactive potential of potato peel, which is otherwise often wasted, may be utilized for health and disease management and also as a source of antioxidant dietary fiber. Therefore, the present work is a comparative evaluation of the total antioxidant and antidiabetic efficacy of peels of potatoes at two different maturity levels.

2. Materials and methods

2.1. Chemicals

2,2′-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) diammonium salt (ABTS), 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2′-7′-Dichlorodihydrofluorescein diacetate (DCFH-DA), α-glucosidase, acarbose and polyphenol standards were procured from Sigma Aldrich Chemicals, Bangalore, India. 2-(N-(7-nitrobenz-2-oxa-1, 3-diazol-4-yl) amino)-2-deoxyglucose (2-NBDG) was procured from Invitrogen Bioservices Pvt. Ltd., Bangalore, India. All other reagents used were of analytical grade.

2.2. Sample preparation

Potatoes at two different stages of maturity – Mature and Young, were collected from a farm at Nilgiris, Tamilnadu, India. The young and matured potatoes were harvested after 14 and 20 weeks from the planting, respectively. The raw materials were hand rinsed thoroughly under a stream of tap water to remove the dirt and were blotted with cotton cloth. Potatoes were peeled manually. The peel of young potato (YP) was easy to remove and softer as compared to the peel of matured potato (MP). The peels were then freeze dried using lyophilizer (VirTis genesis, USA). The lyophilized peels were powdered (40–60 mesh) and stored under refrigeration until further use.

2.3. Nutritional composition

YP and MP were analysed for moisture, ash, protein, fat, and carbohydrate contents according to specified procedures set down for analysis (AOAC, 2005). Soluble, insoluble and total fiber contents were determined according to the AOAC method 991.43 (AOAC, 1991).

The total dietary fiber from mature and young potato was isolated according to Bureau of Indian Standard Method (IS: 11062, 1984) with slight modifications. Briefly, 3 g of defatted, moisture free sample was mixed with 50 mL water and autoclaved at 120 °C for 20 min. It was then cooled and the pH was adjusted to 1.5 with 5 M HCl followed by the addition of 50 mg pepsin and 200 μL of chloroform. It was incubated at 37 °C for 20 h with mild stirring. After incubation the pH was adjusted to 6 with 3 N NaOH and 25 mL phosphate buffer, 100 mg pancreatin, 20 mg glucoamylase and few crystals of thymol were added. This mixture was incubated for 18 h at 37 °C with mild stirring. After incubation the contents were centrifuged at 3000*g* for 30 min, the residue was collected and washed with acetone and diethyl ether and lyophilized to constant weight to obtain the insoluble dietary fiber. To the supernatant ethanol was added in 1:4 ratio and again centrifuged for 30 min at 3000*g*. The residue was collected and washed with alcohol, acetone and diethyl ether and lyophilized to constant weight to obtain the insoluble dietary fiber.

2.4. Preparation of extracts

Freeze dried peels of mature and young potato were crushed to powder and sequentially extracted using hexane (HMP, HYP), ethyl acetate (EMP, EYP) and methanol (MMP, MYP) (1:10, w/v) at ambient temperatures (30 ± 2 °C). The extraction was repeated until the solvent became colorless, filtered and the extraction of the residue was continued with the next solvent in the increasing order of polarity. The extracts were filtered through Whatman No. 1 filter paper under reduced pressure in rotavaporator (BUCHI R215, Switzerland) followed by lyophilisation. The lyophilized extracts were stored at 4 °C until further biochemical analysis.

2.5. Total phenol content (TPC)

TPC of the lyophilized extracts was determined using Folin–Ciocalteau reagent and was expressed in mg GAE/g of dry