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Original Article

Cooking effects on oxalate, phytate, trypsin and α-amylase inhibitors of wild yam tubers of Nepal

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Abstract

Wild yams (*Dioscorea* spp.) are widely consumed and hold important place in the diet of local people of Nepal. The objective of this work was to investigate on the effect of different domestic cooking methods on antinutrients, such as oxalate (Ox), phytate (Phy), trypsin inhibitor activity (TIA) and α-amylase enzyme inhibitor activity (AIA), contents in these wild tubers. Four yam varieties (*D. bulbifera, D. versicolor, D. deltoidea* and *D. triphylla*), available in mid-central region of Nepal, were studied. The effect of three domestic cooking (boiling, pressure cooking and baking) on Ox, Phy, TIA and AIA was determined on raw and cooked samples. The different cooking methods studied showed considerable extent of deviation of antinutrients from the uncooked condition. The average reduction ranges on cooking were 10–45, 5–20, 90–95 and 10–25%, for Ox, Phy, TIA, and AIA, respectively. Cooking showed considerable reduction in TIA and OX, but Phy and AIA were fairly affected. The reduction of antinutrients on cooking is expected to enhance nutritional value of these wild tubers. The antinutritional factors, though showing a high concentration in raw tubers, should not pose a problem in human consumption if the tubers are properly processed.

Keywords: Wild yam; *Dioscorea*; Domestic cooking; Antinutrient

1. Introduction

Wild yam (*Dioscorea* spp.) tubers are freely available in the wild habitat and are consumed in several parts of Nepal. These wild tubers hold an important place in the diets of local people, especially in the Mid-hills and Terai region of Nepal (Singh, 1960). Wild yams are consumed either as staple or mixed with other vegetables, usually after cooking (Gurung, 1995). The types of cooking methods differ in many areas of the country and also vary with the ethnic background of the family. Generally, the yams are consumed as boiled; preferences of the peoples for cooking methods are increasingly changing. Although, wild yams make a significant contribution in diets, the local people, however, have minimal knowledge about nutritive values of raw and cooked wild yam tubers. Bhandari et al. (2003) studied the nutrient composition and antinutritional profiles in Nepali wild yam and reported that, despite its antinutritional factors, the tubers were comparable to commonly consumed root and tuber crops. The effects of different cooking methods on nutritive values of different species of domesticated yam tubers have been previously studied (Bradbury et al., 1988; Wanasundera and Ravindran, 1992). However, not much is known about the effect of various domestic cooking in reducing or eliminating the antinutritional factors in yam tubers.

Studies of the yam tubers from some species of *Dioscorea* have been reported to contain antinutritional factors (Adeyeye et al., 2000; Holloway et al., 1989; Oladimeji et al., 2000; Wanasundera and Ravindran, 1992). Several antinutritional factors are present in root and tuber crops that may adversely affect their

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nutritional properties. Enzyme inhibitors, such as amylase and protease are a class of these compounds, which occur in many tubers. The presence of these inhibitors could impair the digestion of starch and protein, thereby reducing the nutritional value of tubers and limiting their utilization as food (Prathibha et al., 1995). The occurrence of oxalates in root and tubers has been considered as either the cause of or contributing as cause of the acridity, which causes irritation, and swelling of mouth and throat (Holloway et al., 1989). Oxalic acid and its salts can have deleterious effects on human nutrition and health, particularly by decreasing calcium absorption and aiding the formation of kidney stones (Noonan and Savage, 1999). High-oxalate diets can increase the risk of renal calcium oxalate formation in certain groups of people (Libert and Franceschi, 1987). The majority of urinary stones formed in humans are calcium oxalates stones (Hodgkinson, 1977).

Phytate markedly decrease calcium bioavailability and forms Ca-phytate complexes that inhibit the absorption of Fe and Zn (Sirkka, 1997). Phytic acids intake of 4–9 mg/100 g DM is said to decrease iron absorption by 4–5-fold in humans (Hurrel et al., 1992). Phytate have also been implicated in decreasing protein digestibility by forming complexes and also by interfering with enzymes such as trypsin and pepsin (Reddy and Pierson, 1994). Phytic acids and starches are structurally capable of combining via phosphate linkages. It can also affect starch digestions by combining with digestive enzymes or bind minerals such as Ca, which are known as catalysts or cofactor of the enzyme activity (Sirkka, 1997).

The oxalate, phytate, trypsin and α-amylase inhibitors were found as principal antinutirtional factors in Nepali wild yam tubers and in order to reduce the effect of antinutrients, which may have some health-hazard potentials, a proper processing before consumption are recommended (Bhandari and Kawabata, 2004). In spite of the presence of substantial level of these antinutrients, to the best of author's knowledge, there are no published studies on the effect of domestic cooking on the levels of oxalate, phytate, trypsin and α-amylase inhibitors in wild yam tubers of Nepal and information are scanty or non-existent in the literature. Hence, the present work has been aimed at understanding to what extent the antinutrients can be eliminated or reduced after subjecting the tubers to various local cooking methods such as boiling, pressure cooking and baking.

2. Materials and methods

2.1. Materials

The sample selected for the investigation comprised fresh tubers of four wild yam species of *Dioscorea* genus: *D. bulbifera, D. versicolor, D. deltoidea* and *D. triphylla*. The samples were collected from forest of Narayani Zone of Nepal. Trypsin (from Bovine Pancreas) was purchased from Wako Pure Chemicals Industries Ltd. (Japan) and α-amylase (from Porcine Pancreas) was from Sigma Chemical Company (USA). All other chemicals and reagents used were of analytical grade and purchased from Wako Pure Chemicals Industries Ltd. (Japan).

2.2. Sample preparation and cooking treatments

Yam tubers (1 kg) were washed free of dirt, peeled, cut into pieces of about 50 g and given three different cooking treatments (Table 1), boiling, pressure cooking and baking, as suggested by Wanasundera and Ravindran (1992). After treatment the hot sample were exposed to the air to allow surface water to evaporate. The samples were then mashed, dried and ground to fine powder. Dried powdered sample were packed into airtight sealed plastic bags and stored in the refrigerator for later analysis. Each of the four sets (control, boiled, pressure cooked and baked) of homogenized samples from four species were analyzed in triplicate for their oxalate, phytate, trypsin and α-amylase inhibitors.

2.3. Analyses

2.3.1. Analysis of oxalate

The oxalate was determined by HPLC, using the extraction and analysis method developed by Holloway et al. (1989). With 30-mL capacity glass-stopper test tubes, 1 g of the dried powder was added to 25 mL of 0.25 M H_2SO_4, and 1 mL of internal standard (10 g glutaric acid in 100 mL of water) was added. The mixture was placed in a boiling water bath for 10 min,

Table 1
Cooking treatments (Boiling, pressure cooking and baking) given to yam tubers

Cooking method	Description
Boiling	Water was added to the cut pieces at the ratio of 1:1 (w/w) and cooked in a closed stainless steel vessel for exactly 30 min. Water was discarded after boiling
Pressure cooking	Cut pieces were cooked in a pressure cooker (Hawkins, India) for exactly 15 min
Baking	Cut pieces were wrapped in aluminum foil and baked in a hot air circulation oven at 180 °C for 45 min