The Bioscan 8(2): 589-593, 2013
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EVALUATION OF NUTRITIONAL VALUE OF TWO LOCAL POTATO CULTIVARS (*ABERCHAIBI AND AMUBI*) OF MANIPUR, NORTH-EAST INDIA

N. LOKENDRAJIT[1], C. B. SINGH[1]*, N. SWAPANA[2] AND M. SUMARJIT SINGH[2]
[1]Institute of Bioresources and Sustainable Development, Takyelpat - 795 001, Imphal, Manipur, INDIA
[2]Central Agricultural University, Imphal - 795 001, Manipur, INDIA
e-mail: kishore.ibsd@nic.in

KEYWORDS
Local cultivar
Total phenolics
Proteins
Carbohydrates
Districts etc.

Received on :
21.11.2012

Accepted on :
12.04.2013

***Corresponding author**

ABSTRACT
Purple or red fleshed local potato cultivar (*Solanum tuberosum* Linn) was evaluated for their total phenolic, protein, carbohydrate and lipid contents. The total phenolic content of the local cultivar from the four districts of Manipur was found to be very high *i.e.* 263mg, 256mg, 270mg and 260mg per 100g of the dry weight. Significant differences were found between the purple or red fleshed and other varieties. There is not much variation in the fat content in the local cultivar and other varieties whereas the protein content is more than the average of the other genotype. Percentages of protein content in the four districts were 8.635, 8.124, 9.584 and 8.900 respectively. The cultivars were collected from four districts of Manipur, India. The indigenous people were using this potato during post-natal period and for diabetic patients too. The present work validates scientifically the information of the local indigenous people about the uses of this potato genotype in their day to day life.

INTRODUCTION

Potato is a member of the Solanaceae, family with more than 3,000 species. It is an important global food source. After wheat and rice, potato is the third most important food crop, with a world-wide production of 325 thousand tons in 2007 (FAO, 2007). It contains all major nutrients like proteins, vitamins, calcium and phosphorus and is a treasure house of carbohydrates which are essential for the body building. Potato is one of the richest sources of calories needed to maintain day to day output of human energy. It is a valuable food for those who seek to lower their blood pressure. There is no truth in the general belief that potato promotes fat accumulation (Pushkarnath, 1976).

The carbohydrate content of potato is mostly starch with some amount of sugar. Starch is the principal constituent of the dry matter. The cooked starch of potato is quickly digested by amylase of saliva. Because of its quick digestibility and low residue it is a valuable food for infants. As a staple food, potatoes have a dietary role, unique from vegetables and foods consumed in much lower quantities. Potato protein has a relatively high nutritional quality (Kapoor *et al.,* 1975; Knorr, 1978) and, thus has good potential for utilization in foods. Patatin, the tuber storage protein of potato exhibits antioxidant activity in vitro (Liu *et al*., 2003; Kudoh *et al*., 2003).

Varieties of phytochemicals, *e.g.* phenolics, carotenoids and flavonoids, have been shown to possess functional properties such as antimicrobial, antimutagenic and free radical scavenging activity (Friedman, 1997). Free radicals induce oxidative stress, which may result in damaging DNA, proteins and lipids, leading to chronic illnesses including cancer, cardiovascular diseases and inflammation (Gomes *et al*., 2003). Phenolic compounds can suppress free radical-induced oxidative stress and reduce the onset of these diseases. Potato (*Solanum tuberosum*Linn.) also contains significant levels of vitamins (Kolasa, 1993) and important antioxidant (Al-Saikhan *et al*., 1995; Al-Saikhan, 2000), including phenolic acids, carotenoids and flavonoids (Arai, *et al*., 2000; C. R. Brown, 2005).

Manipur, which is in the North Eastern most corner of India, bordering with Myanmar, is rich of its flora and fauna and is one of the hotspots of biodiversity. Potato is widely cultivated in both hills and valley areas of Manipur. Food security, employment and income generation are the critical growing concerns of the present state of Manipur. Potato being one of the important day today kitchen items in Manipuri families, the people of the state had been practicing potato cultivation since time immemorial. From traditional experiences and modern practices, the farmers of Manipur are advancing in the cultivation of potato but replacing the local cultivar year by year by the high yielding varieties in order to make up the food demand of the rapidly growing population. As a result the local potato is slowly vanishing and might be extinct in the near future. This potato needs to be conserved in order to protect the indigenous valuable one, the genetic resources of

the country. Moreover, no work has been done on the nutrient content of local cultivar potato *Aberchaibi and Amubi* till today and that is why the present study hasbeen taken up.

MATERIALS AND METHODS

Materials

A survey was done in potato farming fields of Manipur during winter (rabi) season of 2009-2010 and was observed that local potat cultivar *Aberchaibi and Amubi* was cultivated in four districts of Manipur by few farmers. The districts were Bishnupur, Thoubal, Imphal East and Chandel. Seven farmers were selected from each district and samples were collected for analysing total protein, total carbohydrate, total phenolic and total lipid contents.

Chemicals

Folin-Ciocalteu's phenol reagent, sodium carbonate, glucose, potassium sulphate, copper sulphate, sodium sulphate, sodium hydroxide, boric acid, chloroform and methanol were purchased from Merck Chemicals (Mumbai, India). Conc. sulphuric acid and conc. Hydrochloric acid were purchased from Fischer Scientific (Mumbai, India). Catechin, gallic acid and anthrone were purchased from Sigma Aldrich.

Sample preparation

Uniformly sized tubers were collected from each local cultivar and washed thoroughly with tap water. They were sliced (unpeeled) into ~ 4-5mm slices or cubes (approximately 1x1cm). The sliced tubers were shade dried. The dried pieces were grounded to powder with the aid of a Warring blender and used for subsequent analysis.

Total phenolic assay

The total phenolic content of local cultivar *Aberchaibi and Amubi* was determined by using Folin-Ciocalteu method (Singleton and Rossi, 1965). An aliquot (1mL) of the extractor standard solution of gallic acid (1, 2, 4, 5, 6, 8 and 10μg/mL) was taken in a test tube and made up to the volume of 1mL with distilled water. Then 0.5mL of Folin – Ciocalteu reagent (1:1 with distilled water) and 2.5mL of 20% sodium carbonate solution were added sequentially to the test tube. A reagent blank was prepared using double distilled water. The reaction mixture was mixed well and kept for incubation in the dark at room temperature for 1hr and the absorbance against prepared reagent blank was determined at 725nm with an UV- Visible Shimadzu Spectrophotometer. All determinations were performed in triplicate.The total phenolic content was calculated and expressed as mg Gallic acid equivalents (GAE)/ 100g weight.

Estimation of Total Carbohydrate

The total carbohydrate content of local cultivar *Aberchaibi and Amubi* was determined by using Anthrone method (Yemen and Willis, 1954).

Materials

Anthrone reagent was freshly prepared before being used by dissolving 200mg anthrone in 100mL of ice-cold 95% H_2SO_4. Stock solution of standard glucose was prepared by dissolving 100mg in 100mL water. Working standard was made by taking 10mL of stock and diluted to 100mL with distilled water. It was stored refrigerated after adding a few drops of toluene.

Procedure

About 100mg of the sample was weighed into a boiling tube. It was hydrolysed by keeping it in a boiling water bath for three hours with 5mL of 2.5 N HCl and cooled to room temperature and then neutralized with solid sodium carbonate until the effervescence ceases. The volume was made up to 100mL and centrifuged. The supernatant was collected and took 0.5 and 1mL aliquots for analysis. The standards were prepared by taking 0.00, 0.02, 0.04, 0.06, 0.08, 0.1, 0.2, 0.4, 0.6, 0.8 and 1mL of the working standard and '0' serves as blank. The volume was made up to 1mL in all the tubes including the sample tubes by adding distilled water. Then 4mL of anthrone reagent was added and heated for eight minutes in a boiling water bath. It was cooled rapidly and the absorbance was taken at 630nm at a UV-Spectrophotometer. A standard graph was drawn by plotting concentration of the standard on the X-axis versus absorbance on the Y-axis. From the graph, we can calculate the amount of carbohydrate present in the sample tube.

Calculation

Amount of carbohydrate present in 100mg of the sample = mg of glucose X100
Volume of test sample

Estimation of Total Protein

The total protein content of local cultivar *Aberchaibi and Amubi* was determined by A.O.A.C. Kjeldahl method (AOAC, 1970) for plants. This method consists of three steps. First one is the digestion of plant samples, second is the distillation of plant samples and the third one is the titration.

Procedure for digestion

We have loaded the tubes with 0.3g of plant sample, 10mL of conc. H_2SO_4 and 3g of catalyst mixture (K_2SO_4:$CuSO_4$ in 5:1) in insert rack. Then placed the manifold over the tubes and loaded the insert rack and manifold in the digestion block. The temperature was set initially at 250ºC, if frothing was not there, increase 50ºC in the gap of 15 mins and upto 400ºC. The digestion time was approximately 2- 3h and the end point of digestion was condensation which will. Now the samples were ready for distillation.

Procedure for distillation

First, load the conical flask with 20mL 4% boric acid and 3 drops of mixed indicator in the receiver side which will be in pink colour initially. Then load the digested sample and add 40 ml of 40% NaOH.Then set the process time 9 mins. After 9 mins the colour in the conical flask changes from pink colour to green colour. This was the end point of distillation of a sample.

Procedure for titration

The distillated solution was titrated with 0.1N HCl till the colour changes from green colour to permanent pale pink one. This was the end point of titration.

Percentage of Nitrogen was calculated using the formula given below

$$\frac{\text{1000 X Sample Weight}}{\text{Protein = \% of Nitrogen X 6.25}} \quad \frac{\text{\% of Nitrogen = 14 X Titrant value X Normality of acid X 100}}{}$$

Total lipid estimation

The total lipid estimation of local potato cultivar *Aberchaibi and Amubi* was determined by using Bligh and Dyer Method (Bligh and Dyer, 1959).

Materials Required

5g of grind potato, Methanol, Chloroform, 1:1 (v/v) chloroform/ methanol, Sodium sulfate anhydrous, Homogenizer, Separatory funnel and Rotary evaporator.

Procedure

5g of potato was homogenized in 10mL of methanol and added 5mL of chloroform. It was again homogenized for 2min. 5mL with the additional chloroform being added and homogenized for 30 sec. At last 5mL water was added and homogenized for 30 sec. It was filtered through a sintered glass funnel or through Whatman No. 1 filter paper in a Buchner funnel with slight suction and the liquid was retained. The above process was repeated on the resulting solids, together with filter paper if applicable, by adding 20mL 1:1 (v/v) chloroform/methanol and the liquids were retained. The liquids were combined and transferred into a separatory funnel and passed the chloroform layer through a 2.5-cm thick layer of anhydrous sodium sulfate using Whatman No.1 filter paper in a funnel and washed with 20mL 1:1 (v/v) chloroform/ methanol. The solvent was removed using a rotary evaporator under vacuum, at 40ºC and calculated the weight of the lipid:

Weight of lipid = (weight of container + extracted lipid) " (weight of container)

Lastly, the content of lipids in the sample was determined by weight difference:

Lipid content (%) = amount of lipid extracted (g)/ weight of original sample (g) × 100

RESULTS AND DISCUSSION

Soils

The available nitrogen content in Bishnupur(Nambol) district is 389.0 kg/ha, Thoubal(Wangjing) is 326.0 kg/ha, Imphal East (Pourabi) is 504.4 kg/ha and Chandel (Kamenkhu) 439.0 kg/ha. And P_2O_5 is 31.50, 21.00, 80.99 and 21.17 kg/ ha in the above districts respectively. In the same way K_2O is 147.80, 174.72, 430.4 and 22.40 kg/ha respectively in the four above given districts (Sharma and Arora,1988)also reported that applied nitrogen significantly decreased the starch, increased proteins but did not affect the sugar content of potato tubers. Phosphorus application did not affect the proteins or non-reducing sugars but significantly increased the starch and reducing sugar contents of potato tubers. Potassium application had a non-significant effect on these parameters. Application of nitrogen, phosphorus and potassium increased the yields of starch and proteins in potatoes.

The nutrient content of the soils where potato had been collected is given in Table 1:

Protein Content

Percentage of protein content in the four districts were 8.635 in Bishnupur (Nambol), 8.124 in Thoubal (Wangjing), 9.584 in Imphal-East (Pourabi) and 8.900 in Chandel (Kamenkhu) district. Imphal East has got the maximum protein content 9.584 % in this local cultivar potato followed by 8.900 % of Chandel (Kamenkhu), then Bishnupur (Nambol) 8.635 % and Thoubal (Wangjing) 8.124 %. The difference in the protein content of the same cultivar at different districts may be due to the difference in nutrient status in soils of four districts of Manipur where this local cultivar potato had been cultivated. Different authors like (Pushkarnath, 1976) have reported the protein content to be 8.5g/100g while (Ereifej *et al*., 1997) have reported 7-10g/100g from ten potato cultivars grown in Jordan (Angela *et al*., 1998) also reported protein content of 8.5g/100g from *S. polytrichon*, a local genotype from Mexico (Lachman *et al*., 2005) have reported the protein content to be from 4-6 g/100g in their study from 1995 to 1997 in Czech Republic. From this literature survey, we can conclude that the protein content of our local genotype is more than the average of the other genotype. This could be one of the reasons why this local genotype potato was given to post-natal women after childbirth by our forefathers rather than other varieties.

Carbohydrate content

The carbohydrate content in the local cultivar potato is 50.66, 56.73, 63.35 and 60.98 g/100g in Bishnupur, Thoubal, Imphal East and Chandel districts. These results show the same trend of ascending as in the case of protein content in the four different districts. Where the soil fertility is more, the content of carbohydrates is also more which is supported by Table 1. It is observed that the carbohydrate content is much lower than the previous one reported by (Pushkarnath, 1976). *i.* e. Carbohydrate content in the potato is 81.7 % which has got the difference of about 20%. It may be due to this reason that people of Manipur who are suffering from diabetic used to consume it more than the other varieties (Angela *et al*., 1998) also reports six local cultivar from Mexico having carbohydrate content of 83.5%, 80.4%, 74.80 %, 81.58 %, 84.08% and 81.09 % while (Ereifej *et al*., 1997) reports from the Jordanian potato cultivar having average of 80 % carbohydrate content. Thus, we can conclude that there is some difference of about 20 % carbohydrate with our local cultivar as compared to other varieties which were previously reported.

Total Phenol and Lipid Content

Purple and red fleshed potatoes provide a natural source of phenolic compounds (Reyes and Cisneros, 2003; Reyes *et al*., 2004). Phenolic compounds have been associated with health promotion due to their antioxidant activity (Epsin *et al*., 2000; Velioglu *et al*., 1998; Simon, 1997). The functional properties of purple and red- fleshed potato as natural colorants and antioxidants (Reyes and Cisneros, 2003; Reyes *et al*., 2004; Brown *et al*., 2000) and the increased concern regarding the toxicological safety of their synthetic counterparts (Bridle and Timberlake, 1997; Francis, 1989), indicate that potatoes have a potential use for the food and nutraceuticals. From our experiment, it was found that the total phenolic content of the local cultivar from the four districts of Manipur was found to be very high *i.*e. 263mg, 256mg, 270mg and 260mg per 100g

Table 1: Nutrient status in soils of the four districts of Manipur

Sl.No.	Districts	Available N kg/ha	P_2O_5 kg/ha	K_2O kg/ha
1)	Bishnupur(Nambol)	389	31.50	147.80
2)	Thoubal(Wangjing)	326	21.00	174.72
3)	Imphal East(Pourabi)	504.4	80.99	430.4
4)	Chandel(Kamenkhu)	439.00	21.17	22.40

Source: Nutrient status in soils of Manipur Part-I *

Table 2: Average percentage of total phenol, protein, lipid and carbohydrate content in the local cultivar potato *Aberchaibi* collected from four different districts

Sl.No.	Districts	Protein %	Carbohydrate (g/100 g)	Total Phenol(mg/100g)	Lipid %(g/100g)
1)	Bishnupur (Nambol)	8.635	50.66	263	0.488
2)	Thoubal (Wangjing)	8.124	56.73	256	0.554
3)	Imphal East (Pourabi)	9.584	63.35	270	0.608
4)	Chandel(Kamenkhu)	8.900	60.98	260	0.589

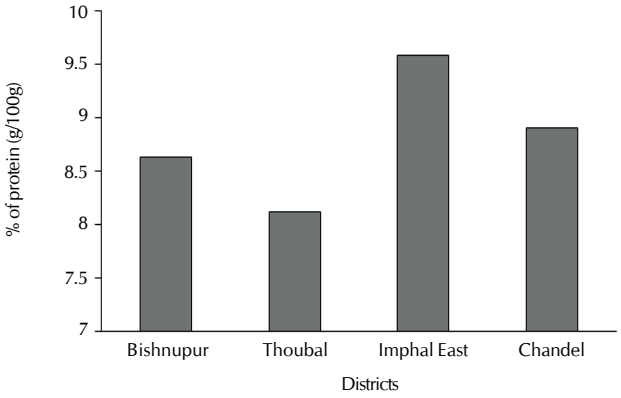

Figure 1: Protein content of *Aberchaibi* collected from different districts of Manipur.

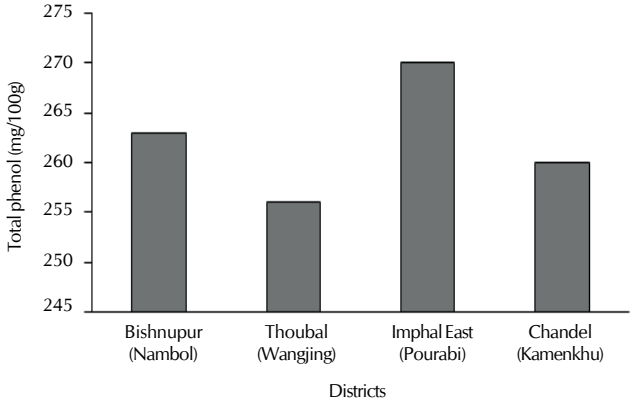

Figure 2: Total phenol content of *Aberchaibi* collected from different districts of Manipur

of the dry weight. So consumption of this variety of local cultivar for the general health of the people will be very good as compared to other varieties (Reyes *et al*., 2005) have calculated the phenolic content from four local potato varieties in chlorogenic acid /100g fresh weight and found to have average content of 80mg/ 100g (Sweetie *et al*., 2005) reported the local cultivar Kufri Chandramukhi having 88 mg / 100 g with catechin equivalent.

Lipids

There was not much variation in the fat content in the samples in almost all the four districts and nearly similar to what were reported earlier by different authors (Pushkarnath, 1976) reported value of fat content per 100g at 0.4g while other authors have reported value of 0.58g (Angela *et al*., 1998) from one local Mexico cultivar *S. ehrenbergii* and *S. tuberosum* (cultivated).

CONCLUSION

In summary, these results provide useful important information for potato breeders and researchers supporting the use of purple- or red - fleshed potato by selecting novel potato genotypes with high protein levels, total phenolic contents and low carbohydrate concentration. This could result in higher production and commercialization of potato genotypes with high functional and commercial value for the food and neutraceutical industries. Last but not the least, this work also validates the local indigenous knowledge of the uses of the local variety for post – natal women and diabetic patient scientifically confirming their observation of the uses of potato that were passed through generation after generation.

ACKNOWLEDGEMENTS

We thank the Department of Biotechnology, Govt. Of India and Central Agricultural University, Imphal for support. We also thank our technical staffs for their timely help.

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