International Journal of Science and Healthcare Research
Vol.7; Issue: 3; July-Sept. 2022
Website: ijshr.com
Original Research Article *ISSN: 2455-7587*

Nutritional Value of Sweet Potato (*Ipomoea batatas*) Cultivated in the Northern Part of Bangladesh

Hasi Rani Saha[1], Most. Lutfunnahar[2], Manoshi Sana[3], Samiron Sana[4], Md Shajedul Haque[5], Badhan Rani Dey[6], Bidhan Chandra Sarkar[7], Niranjan Kumar Sana[8]

[1]Department of Biochemistry and Molecular Biology, Primeasia University, 12 Kemal Ataturk Avenue, Dhaka-1213, Bangladesh
[2]Department of Biochemistry and Molecular Biology, University of Rajshahi, Rajshahi 6205, Bangladesh
[3]Dhaka Medical College, Dhaka
[4]Pharmacy Discipline, Khulna University, Khulna-9208, Bangladesh
[5]Department of Biochemistry and Molecular Biology, University of Rajshahi, Rajshahi 6205, Bangladesh
[6]Department of Biochemistry and Molecular Biology, Primeasia University, 12 Kemal Ataturk Avenue, Dhaka-1213, Bangladesh
[7]Department of Biochemistry and Molecular Biology, Primeasia University, 12 Kemal Ataturk Avenue, Dhaka-1213, Bangladesh
[8]Department of Biochemistry and Molecular Biology, University of Rajshahi, Rajshahi 6205, Bangladesh

Corresponding Author: Dr. Bidhan Chandra Sarkar

DOI: https://doi.org/10.52403/ijshr.20220737

ABSTRACT

Two varieties of sweet potato (Ipomoea batatas [L.] Lam.) were used for the nutritional analysis. Water soluble protein contents of Red sweet potato were higher than that of White potato. In the case of starch, total sugar, reducing sugar, non-reducing sugars of Red sweet potatoes were also higher than that of White sweet potatoes. The comparative amounts of minerals present in sweet potatoes were also studied. The calcium content of Red sweet potato was higher than that of White sweet potato. But potassium, Manganese, and Iron were slightly higher than that of Red sweet potatoes. The sweet potato was also a good source of Zinc, Lead, and Arsenic. The aim of the study comprises the determination of the nutritive value of sweet potato *(Ipomoea batatas)*.

Keywords: sweet potato, *Ipomoea batatas,* cancer, inflammatory disease, macronutrients.

INTRODUCTION

Sweet potato is an important root crop in tropical and sub-tropical countries like Bangladesh, China, USA, India, Japan, Indonesia, Philippines, Thailand, Vietnam, Nigeria, etc. Among the root and tuber crops grown in the world, sweet potato ranks second after cassava[1]. The sweet potato (*Ipomoea batatas*) is a dicotyledonous plant that belongs to the family *Convolvulaceae*. Its large, starchy, sweet-tasting, tuberous roots are a root vegetable[2]. The young leaves and shoots are sometimes eaten as greens. Sweet potato is native to the tropical regions in America. Of the approximately 50 genera and more than 1,000 species of *Convolvulaceae*, *Ipomoea batatas* are the only crop plant of major importance some others are used locally, but many are poisonous. The sweet potato is only distantly related to the potato (*Solanum tuberosum*) and does not belong to the nightshade family. The genus *Ipomoea* that contains the sweet potato also includes several garden flowers called morning glories, though that term is not usually extended to *Ipomoea batatas*. Some cultivars of *Ipomoea batatas* are grown as ornamental plants; the name tuberous morning glory may be used in a horticultural context[3]. The edible tuberous

root is long and tapered, with a smooth skin whose color ranges between yellow, orange, red, brown, purple, and beige. Its flesh ranges from beige to white, red, pink, violet, yellow, orange, and purple. Sweet potato varieties with white or pale yellow flesh are less sweet and moist than those with red, pink, or orange flesh[4,5]. In Bangladesh, sweet potato is the 4th most important source of carbohydrate after rice, wheat, and potato. It plays a significant role in increasing food security and income for the poor farmers of Bangladesh. It is mainly grown in the marginal land of Bangladesh from October to February. It is consumed in different forms mainly boiled, fried, and roasted. Sometimes it is also eaten as a vegetable in curry. Now a day, in Bangladesh it is commercially cultivated. Sweet potato is extensively grown in all the districts of Bangladesh, particularly by the side of rivers and the char land. In 2009-10, about 0.31 million metric tons of sweet potatoes were produced from 31.1thousand hectors of land in Bangladesh[6]. Bangladesh ranks 23 in the world in terms of sweet potato production in 2011[7]. In Bangladesh, sweet potato is the 4th most important source of carbohydrate after rice, wheat, and potato. The crop is highly nutritious and provides generous quantities of vitamin A, vitamin C, Beta carotene, and Iron. In our country, so far I know no detailed study has been conducted to determine the nutritive quality of sweet potatoes. Sweet potato is a nutritive & delicious vegetable, rich in various nutrients that have not properly been investigated. Keeping all of these in mind, in this study we attempted to assay enzyme activities & partial purification & characterization of amylase from sweet potato (*Ipomoea batatas*).

Plant under investigation:

Ipomoea batatas (sweet potato) were derived from the Greek words *ipos*, meaning "bindweed," and *homoios*, meaning "resembling." When this is put together to form "*Ipomoea*" the direct translation is "resembling bindweed." This name makes sense because the sweet potato has a twining habit, much like the bindweed. The species name "*batatas*" was originally the *Taino* name for sweet potato. This name was most likely spread by the Spanish who came in contact with sweet potatoes in Central

America and brought them to the West Indies. "*Batata*" is now the name for potato in Spanish[8].

Fig.1.1: Cultivation of sweet potato

Fig. 1.2: Flower of Sweet potato

Fig. 1.3: Sweet potatoes

Origin and distribution

The origin and domestication of sweet potatoes are thought to be in either Central America or South America. In Central America, sweet potatoes were domesticated at least 5,000 years ago[9]. In South America, Peruvian sweet potato remnants dating as far back as 8000 BC have been found. One author postulated that the origin of *Ipomoea batatas* was between the Yucatán Peninsula of Mexico and the mouth of the Orinoco River in Venezuela [15]. The 'cultigen' had most likely been spread by local people to the Caribbean and South America by 2500 BC[10]. Strong supporting evidence was provided that the geographical zone postulated by Austin is the primary center of diversity. The much lower molecular diversity found in Peru-Ecuador suggests this region should be considered as the secondary center of sweet potato diversity. Sweet potatoes are cultivated throughout tropical and warm regions wherever there is sufficient water to support their growth[11]. Due to a major crop failure, sweet potatoes were introduced to Fujian province of China in about 1594 from Luzon. The growing of sweet potatoes was encouraged by Governor Chin Hsüeh-tseng[12]. Sweet potatoes were introduced as a food crop in Japan and by 1735 planted in Shogun Tokugawa Yoshimune's private garden. It was also introduced to Korea in 1764[13]. Sweet potatoes became popular very early in the islands of the Pacific Ocean, spreading from Polynesia to Japan and the Philippines[14].

Nutritional composition

Sweet potato is a very nutritious vegetable. An analysis of this vegetable shows consists of moisture, protein, fat, carbohydrate-reducing sugar, starch, dietary fiber, vitamins, etc. It also contains trace metals such as Calcium Iron, Manganese, Magnesium, Sodium, Zinc, Phosphorus, Potassium, etc.[15]. Sweet potatoes are a great source of B_6 vitamins, which is brilliant at breaking down homocysteine, a substance that contributes to the hardening of blood vessels and arteries, according to the Harvard University School of Public Health. Sweet potatoes' potassium content is also helpful for your heart, as it lowers blood pressure by maintaining fluid balance, as explained by the American Heart Association. Potassium is also an important electrolyte that helps regulate your heartbeat. Sweet potatoes have a low glycemic index (which means they release sugar slowly into the bloodstream). Sweet potatoes unlike other starchy foods that elevate blood sugar rapidly after [they're consumed] due to their metabolism into sugar will help steady the levels of blood sugar. Sweet potatoes are a terrific source of manganese. Manganese helps the body metabolize carbohydrates and thus maintain healthy blood sugar levels, and it can even stabilize appetite. It also helps the body utilize antioxidants.

According to the Los Angeles Department of Public Health, sweet potatoes contain magnesium, the go-to mineral for distressing. It promotes relaxation, calmness, and a good mood, as well as

artery, blood, bone, muscle, and nerve health, according to Psychology Today. Due to the color-pigmented vitamins, sweet potatoes are high in anti-inflammatory benefits. One sweet potato contains about half of the daily recommended intake of vitamin C. Vitamins A and E also support a healthy immune system and are powerful disease-fighting antioxidants. While orange sweet potatoes contain more vitamin A, purple sweet potatoes are packed with the antioxidant anthocyanin, which is responsible for red, blue, and purple colors in fruits and vegetables. According to the Linus Pauling Institute, pigment-related antioxidants have anti-inflammatory properties, which are beneficial to overall health and help mitigate inflammatory disorders. Vitamin A may help protect against sun damage. Vitamin C and E are well-known for their beauty benefits. They encourage healthy, glowing skin and collagen growth. Sweet potatoes are a good source of dietary fiber, which helps the body maintain a healthy digestive tract and regulates digestion. Orange sweet potatoes have been shown to have anti-carcinogenic properties, and the NIH reports that some studies have suggested that beta-carotene may reduce the risk of breast cancer in premenopausal women and ovarian cancer in postmenopausal women. However, purple sweet potatoes may be even more effective than orange sweet potatoes in staving off cancer. Purple sweet potatoes have been shown to have better cancer-fighting abilities, with a positive effect on cancer cell growth.

Nutritional analysis

Material and methods

Collection of Samples

Two varieties of sweet potato were brought to the Protein and Enzyme Research Laboratory of Biochemistry and Molecular Biology Department from various places in Rajshahi for experimental purposes. The physical and chemical parameters were studied by the following methods.

Determination of Moisture: Moisture content was determined by the conventional procedure.

Materials

a) Porcelain crucible
b) Electrical balance
c) Oven
d) Desiccator

Procedure: About 5 g of the tuberous root of sweet potato was weighed in a porcelain crucible (which was previously cleaned, heated to 100°C, cooled, and weighed). The crucible with the sample was heated in an electrical oven for about six hours at 100°C. It was then cooled in desiccators and weighed again.

Calculation: Percent of moisture content (g per 100 g of sweet potato*)*

$$= \frac{\text{Weight of moisture obtained}}{\text{Weight of the sample}} \times 100$$

Determination of Dry Matter

Dry matter content was calculated from the data obtained for a percentage of moisture content.

Determination of ash

Ash content was determined following the method:

Materials

a) Porcelain crucible
b) Muffle furnace
c) Electrical balance (Mettler H-18)
d) Desiccator

Procedure: About 5 g of tuberous roots of white and red color sweet potato were weighted in a porcelain crucible (which were previously cleaned and heated to about 100°C, cooled, and weighted). The crucibles were placed in a muffle furnace for about four hours at about 600°C. They were then cooled in a desecrator and weighed. To ensure completion of ashing, the crucibles were again heated in the muffle furnace for

half an hour, cooled, and weighed again. These were repeated till two consecutive weights were the same and the ash was almost white.

Calculation: Percent of ash content (g per 100 g of sweet potato*)*.

$$= \frac{\text{Weight of ash obtained}}{\text{Weight of the sample}} \times 100$$

Determination of Water-Soluble Protein

Water-soluble protein contents of sweet potato were determined following the method of Lowry [16].

Reagents

a) 2% Na_2CO_3 solution in 0.1N NaOH
b) 0.5 copper sulfate in 1% sodium-potassium tartrate.
c) Folin-Ciocalteau Reagent (FCR): (Diluted with an equal volume of H_2O, just before use).
d) Standard protein: 15mg/100ml in water.

Procedure

a) Reagents (a) and (b) were mixed in the ratio of 50:1 and diluted reagent (c) just before use.
b) In nine glass test tubes, 0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, and 0.8 ml of the standard protein solution, respectively were taken and the volume was made up to 1 ml of distilled water. The sample was transferred to a 50 ml volumetric flask and the volume was made up to the mark by distilled water. Water was carefully added to avoid the formation of the emulsion. 1 ml of the sample was taken in a test tube and a duplicate was made. To each of the tubes 5.0 ml of (a: b) mixture was added and after 10 minutes, 0.5 ml (FCR) solution was added. The absorbance of the solutions was recorded after 30 minutes at 650 nm. A standard curve was constructed with the data obtained from the standards and the amount of protein in the sample was calculated from the standard curve (figure-2.1).

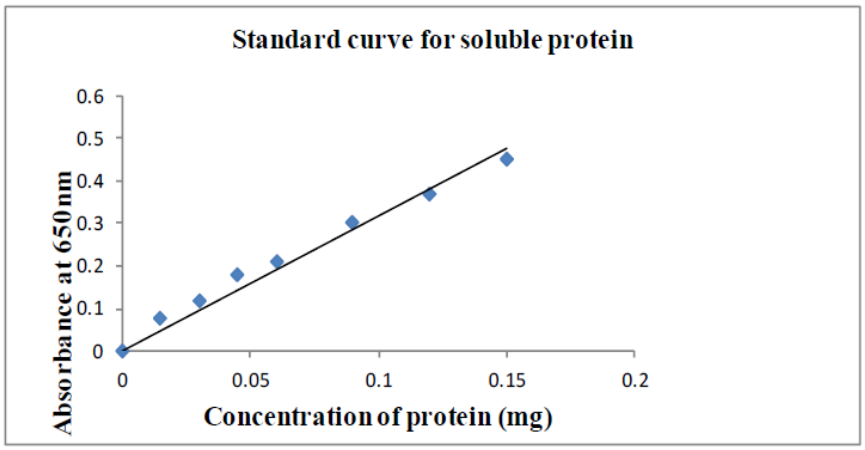

Fig.: 2.1: Standard curve for the determination of protein concentration by Lowry method.

Calculation

Percent of protein content (g per 100 g of sweet potato)

$$= \frac{\text{Weight of water soluble protein}}{\text{Weight of the sample}} \times 100$$

Determination of Total Sugar:

Total sugar contents of Sweet potato were determined calorimetrically by the anthrone method as described in Laboratory Manual in Biochemistry[17].

Reagents:

a) **Anthrone reagent:** The anthrone reagent was prepared by dissolving 2 gs

of anthrone in 1 liter of concentrated H_2SO_4.

b) **Standard glucose solution:** A standard solution of glucose was prepared by dissolving 10 mg of glucose in 100 ml of distilled water.

Extraction of sugar from sweet potato

Extractions of sugar from two varieties of sweet potato were performed following the method described by Loomis and Shull[18].About 5 g of tuberous root from white and red color sweet potatoes were separately plunged into boiling ethyl alcohol and allowed to boil for 5-10 minutes (5 to 10 ml of alcohol was used per G of flesh pulp). The extract was cooled and pasted thoroughly in a mortar with a pestle. Then the extract was filtered through two layers of muslin cloth and re-extracted the pasted tissue for three minutes in hot 80 percent alcohol, using 2 to 3 ml of alcohol per G of the sample. This second extraction ensured the complete removal of alcohol soluble substances. The extract was cooled and passed through a muslin cloth. Both the extracts were filtered through Whatman No-41 filter paper. The volume of the extract was evaporated to about one-fourth the volume over a steam bath and cooled. This reduced volume of the extract was then transferred to a 100 ml volumetric flask and made up to the mark with distilled water. Then 1 ml of the diluted solution was taken into another 100 ml volumetric flask and made up to the mark with distilled water (working standard).

Procedure

Aliquots of 1 ml of the tuber extract were pipetted into test tubes and 4 ml of the anthrone reagent were added to each of these solutions and mixed well. Glass marbles were placed on the top of each tube to prevent loss of water by evaporation. The test tubes were heated for 10 minutes in a boiling water bath and then cooled. A reagent blank was prepared by taking 1 ml of water and 4 of anthrone reagent in a tube and treated similarly. The absorbance of the blue-green solution was measured at 680 nm in a colorimeter.

A standard curve of glucose was prepared by taking 0.0, 0.1 0.2, 0.4, 0.6, 0.8, and 1 ml of standard glucose solution in different test tubes containing 0.0, 10, 20, 40, 60, 80, and 100 μg of glucose respectively and made the volume up to 1 ml with distilled water. Then 4 ml of anthrone reagent was added to each test tube and mixed well. The absorbance was measured at 680 nm using the blank containing 1 ml of water and 4 ml of anthrone reagent. The amounts of total sugar were calculated from the standard curve of glucose (figure 2.2). Finally, the percentages of total sugar present in the sweet potato tuber were determined using the formula given below*:*

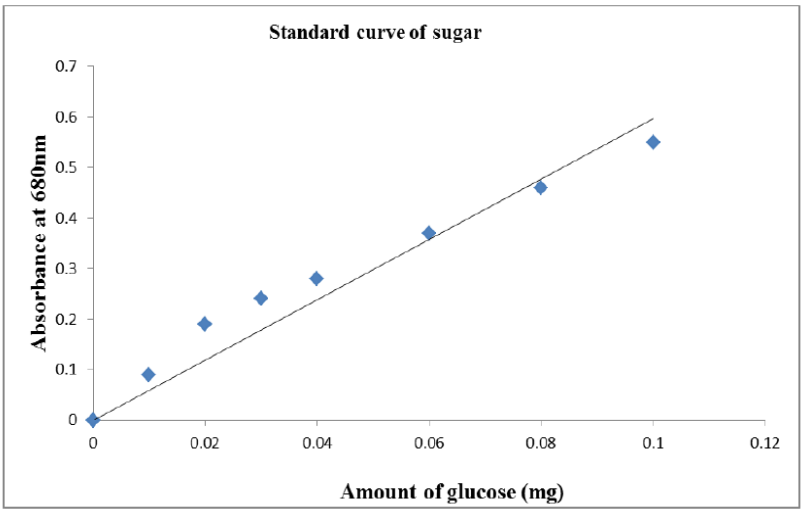

Fig. 2.2: Standard curve of glucose for estimation of total sugar and starch.

Calculation: Percent of total sugar (g per 100 g of sweet potato*)*

$$= \frac{\text{Weight of sugar obtained}}{\text{Weight of sample}} \times 100$$

Determination of Reducing Sugar:

Reducing sugar contents of the sweet potato was determined by the dinitrosalicylic acid method.

Reagents:

a) Dinitrosalicylic acid (DNS) reagent. Simultaneously 1 G of DNS was mixed with 50ml distilled water then add 30 G of Na-K tartrate and mixing. Add 20 ml 2M NaOH solution and makeup to 100 ml by adding distilled water.
b) 40% solution of Rochelle salt.

Extraction of sugar extracts from sweet potato

Sugar was extracted from the sweet potato by the method:

Procedure:

An aliquot of 3 ml of the extract was pipette into test tubes and 3 ml of DNS reagent was added to each of the solutions and mixed well. The test tubes were heated for 5 minutes in a boiling water bath. After developing the color, 1 ml of 40% Rochelle salt was added while the contents of the tubes were still warm. The test tubes were then cooled under running tap water. A reagent blank was prepared by taking 3 ml of water and 3 ml of DNS reagent in a tube and treated similarly. The absorbance of the solutions was taken at 575 nm in a colorimeter.

The amounts of reducing sugar were calculated from the standard curve of glucose (figure 2.3).

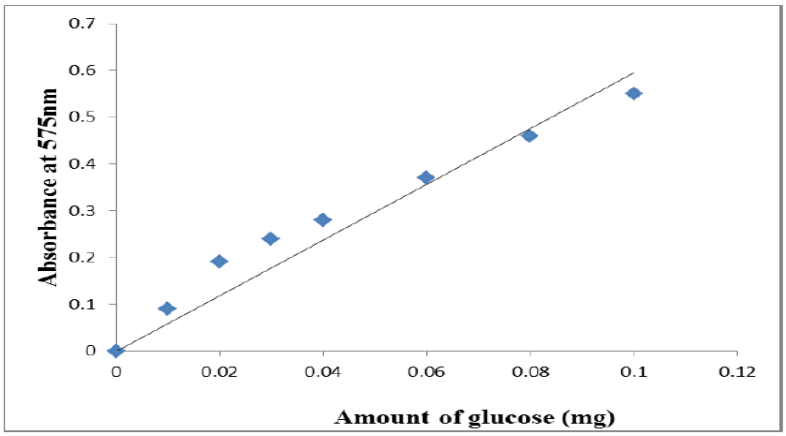

Fig. 2.3: Standard curve of glucose for estimation of reducing sugar

Calculation:

The percent of reducing sugar (g per 100 g of sweet potato)

$$= \frac{\text{Weight of reducing sugar obtained}}{\text{Weight of the ssample}} \times 100$$

Determination of non-reducing sugar or sucrose

Sucrose content was determined by the following formula:

Percent of Sucrose or non-reducing sugar = (% Total sugar - % Reducing sugar) × 0.95.

Determination of starch content of Sweet potato

The starch contents of the sweet potato were determined by the Anthrone method as described in Laboratory Manual in Biochemistry.

Reagents

a) Anthrone reagent (0.2% anthrone in conc. H_2SO_4),
b) Standard glucose solution (10 mg/100 ml)
c) 1M HCl

Procedure

About 5 g of the tuberous root of sweet potato were cut into small pieces and homogenized well with 20 ml of water. The homogenate was then filtered through a double layer of muslin cloth. To the filtrate, twice the volume of ethanol was added to precipitate the polysaccharide, mainly starch. Then it was kept overnight in cold; the precipitate was collected by centrifugation at 3,000 rpm for 15 minutes. The precipitate was then dried over a steam bath. Then 40 ml of 1M HCl acid was added to the dried precipitate and heated to about 70°C. It was transferred to a volumetric flask and diluted to 100 ml with 1M HCl. Then 2 ml of the diluted solution was taken in another 100 ml volumetric flask and made up to the mark with 1M HCl. An aliquot of 1 ml of the extract was pipetted into test tubes and 4 ml of anthrone reagent were added to the solution of each tube and mixed well. Glass marbles were placed on top of each tube to prevent loss of water by evaporation. The tubes were placed in a boiling water bath for 10 minutes, then removed and cooled. A reagent blank was prepared by taking 1 ml of anthrone reagent in a test tube and treated as before. The absorbance of the blue-green solution was measured at 680 nm in a colorimeter. The amounts of starch present in the sweet potato were calculated from the standard curve of glucose (figure- 2.2).

Calculation

The percent of starch (g per 100g of sweet potato) $= \frac{\text{Weight of starch obtained}}{\text{Weight of the sample}} \times 100$

Determination of minerals[19]

Preparation of plant samples for analysis

Drying

Two clean containers (dish or beaker) were placed in an oven at 105°C overnight and allowed the container to cool in desiccators and weighed. The samples were put into the container and weight was taken. Then the containers were placed in the oven at 105°C for 24 hours and allowed the container to cool in a desiccator and the weight was taken again. Drying, cooling, and weighting were repeated until the weight becomes constant. The dried samples were stored in an airtight container. The moisture contents in the sample were calculated.

Grinding

If necessary, the dried plant materials were cut into small pieces with a knife or scissors. The samples were ground in a plant grinder fitted with a suitable screen. If the grinding takes a long time, the sample will absorb moisture and it is necessary to dry the sample again in the oven at 105°C overnight.

Determination of Fe, Mn, Ca, K, Zn, Pb, As Reagents

a) Iron accelerator
b) Copper accelerator
c) Concentrated sulphuric acid
d) Catalyst mixture
e) 33% Sodium hydroxide
f) 0.05 M Sodium hydroxide
g) 0.05 M Hydrochloric acid
h) Methyl red- methyl blue indicator solution
i) 68% Nitric acid
j) 1: 20 diluted HNO_3
k) 1:100 diluted HNO_3
l) 5 M HNO_3
m) $CaCl_2$- solution
n) Acetate buffer solution
o) Azomethine-H reagent
p) Perchloric acid
q) Hydrochloric acid 1:1
r) 0.5 M Barium chloride solution
s) Silver nitrate solution
t) Used two stock solutions and one standard solution of each mineral at different concentrations.

Digestion

0.5 g of dried plant material was weighed into each of 38 nitrogen digestion tubes. The two remaining tubes were blanks. 5 ml of 68% nitric acid was added to each of all

40 tubes. The content in each tube was mixed and left overnight. The tubes in the digester were placed and covered the tubes with the exhaust manifold. The temperature was set to 125°C. The digester was turned on and continued the digestion for 4 hours after boiling has started. The precaution was taken so that no tubes became dry. After cooling, the digestion mixture was transferred with distilled water to a 100 ml volumetric flask. The flask was made up to volume with water and mixed and filtered on a dry filter into a dry bottle, which was closed with a screw cap. The filtrate was kept in a closed bottle. Ca, K, and Fe, contents in the filtrates were determined.

Determination of Minerals

Using a pipette, transfer 20 ml of filtrate was transferred to a 100 ml volumetric flask. The flask was made up to volume with distilled water and was mixed well.

1. Estimation of Ca

20 ml of diluted filtrate was transferred into a 50 ml volumetric flask and the flask was made up to volume with distilled water and mixed. The content of Ca was measured by an atomic absorption spectrometer (AAS). If the reading is higher than the reading of the highest standard solution, then it needs to larger dilution, e.g. 10 ml filtrate into a 50 ml volumetric flask. In this case, 1:100 diluted HNO_3 must be added to the volumetric flask to make the total volume of 1:100 diluted HNO_3 and filtrate equal to 20 ml.

2. Estimation of K and Fe

10 ml of diluted filtrate was transferred into a 50 ml volumetric flask using a pipette. The flask was made up to volume with water and mixed. The content of K was measured by a flame photometer. A larger dilution is needed if the reading is higher than the reading of the highest standard solution, e.g. 5 ml volumetric flask. In this case, diluted HNO_3 must be added to the volumetric flask to make the total volume of 1:100 diluted HNO_3 and filtrate equal to 20 ml. The content of these elements was measured by an atomic absorption spectrometer (AAS) directly in the undiluted filtrate.

Calculations

Ca, K,

$$\text{mg per kg plant material} = \frac{a \times 25000}{b \times c}$$

Where,

a = mg/l Ca, K, measured on atomic absorption spectrometer, flame photometer or spectrophotometer, flame photometer or spectrophotometer,

b = ml diluted filtrate transferred into the 50 ml volumetric flask for determination of Ca, K,

c = Amount of plant material (g) weighted into the digestion tube.

If an additional dilution is made before the transfer to the 50 ml volumetric flask, the result is multiplied by the dilution factor.

Fe,

$$\text{mg per kg plant material} = \frac{d \times 100}{c}$$

Where,

d = mg/l Fe measured on an atomic absorption spectrometer or spectrophotometer,

c = plant material weighted into the digestion tube in g

RESULT AND DISCUSSION

Moisture plays an important role in the growth activities of trees. Water is indispensable for the absorption and transport of food, carrying out photosynthesis, metabolizing materials, and regulating moisture in plants, as in all other living systems. It contributes as much to the essential properties of life as do the other constituents like carbohydrates, and protein. Moisture is also essential for most of the physiological reactions in the plant tissues and its absence lives do not exist. In the present study moisture contents in tubers of red and white color sweet potatoes were determined. As shown in Table 2.1, the moisture contents were found 60±0.08%, 67.40±0.06% respectively. Data on changes in dry matter content of sweet

potatoes derived from a percentage of moisture content are shown in Table 2.1. The increase in dry matter content shows a good correlation with the decrease in moisture content.

The ash content of sweet potato is shown in Table 2.1 most of the inorganic constituents or minerals are present in ash. The ash content in tubers of red and white color sweet potatoes was observed 1.03±0.01%, 0.92±0.03 % respectively. Protein plays an important role in all biological processes. The protein constituents of fruits and vegetables, although occurring in low concentration, are of primary importance not only as components of nuclear and cytoplasmic structures but also including, as they must the full complement of enzymes involved in metabolism during the growth, development, maturation of fruit and vegetables[8,9]. Water soluble protein content was determined by the Lowry method as described in the materials and methods. As shown in table 2.1 soluble protein contents in tubers of red and white color sweet potatoes were 2.02±0.02%, 1.95±0.02% of the sample respectively. The total soluble sugar content of sweet potato was analyzed and the result is summarized in table 2.1. The amounts of total soluble sugar were estimated to be 14.76±0.04%, 12.08±0.04% respectively. In Table 2.1 shows the reducing sugar content of the sweet potato. It was found that it contained a low amount of reducing sugar and the contents of reducing sugar was estimated to be 11.74±0.03%; 9.73±0.03% respectively. In the case of sweet potatoes, the reducing sugar content is affected by several factors including variety, growing conditions, maturity, and the storage environment. Table 2.1 shows the Non-reducing sugar or sucrose content of the sweet potato. Sucrose contents in tubers of red and white color Sweet potato were found 2.86±0.02%, 2.23±0.02% respectively. Starch is the most important source of carbohydrates in the human diet. As presented in table 2.1 tubers of red and white color Sweet potato were found to contain a significant amount of starch 16.77±0.02 %, 15.10±0.02% respectively. Minerals are inorganic elements that exist in the body and food as an organic and inorganic combination. In foods, mineral elements are present as a salt. They are combined with organic compounds, e.g. iron in hemoglobin. Minerals are required for teeth and bone formation. A minute amounts of mineral elements are constituents of various regulatory compounds such as vitamins, enzymes, and hormones. The calcium contents of red and white color of sweet potatoes were 3.36±0.01ppm, 1.52±0.02 ppm respectively shown in table 2.2. The mineral contents of Sweet potato were 4.41±0.01ppm, 4.83±0.01ppm respectively. As shown in table 2.2. The manganese contents of Sweet potato were 0.22±0.02 ppm, 0.24±0.02ppm respectively. As shown in table 2.2. The zinc contents of Sweet potato were 0.02±0.001ppm, 0.01±0.001 ppm respectively. As shown in table 2.2. The iron contents of Sweet potato were 0.28±0.02ppm, 0.31±0.03ppm respectively. As shown in Table 2.2. Lead and Arsenic content of Sweet potato*es* were also determined. The results are summarized in Table 2.2.

Table 2.1: Nutrient content of Sweet potato

Parameters	Amount	
	Tuber(Red sweet potato)	**Tuber(White sweet potato)**
Moisture (%)	60.00±0.08	67.40±0.06
Dry matter (%)	40.00±0.08	32.60±0.03
Ash (%)	1.03±0.01	0.92±0.03
Water soluble protein (%)	2.02±0.02	1.95±0.02
Total sugar (%)	14.76±0.04	12.08±0.04
Reducing sugar (%)	11.74±0.03	9.73±0.03
Non-reducing sugar or Sucrose (%)	2.86±0.02	2.23±0.02
Starch (%)	16.77±0.02	15.10±0.02

Table2.2: Mineral contents of sweet potato

Parameters	Amount (Red sweet potato)	Amount (White sweet potato)
Calcium(ppm)	3.36±0.01	1.52±0.02
Potassium(ppm)	4.41±0.01	4.83±0.01
Led(ppm)	0.08±0.004	0.07±0.004
Manganese(ppm)	0.22±0.02	0.24±0.02
Zinc(ppm)	0.017±0.001	0.01±0.001
Iron(ppm)	0.28±0.02	0.31±0.03
Arsenic(ppb)	1.99±0.06	1.23±0.004

DISCUSSION

Sweet potato (Ipomoea batatas) is a nutritious vegetable and is available in Bangladesh. Now many people eat these vegetables. From the nutritional analysis, it was evident that the plant sweet potato is a good source of total protein, total carbohydrates, etc. protein content of red color sweet potato was higher than that of white. In the case of starch content, red color sweet potato contained higher amounts compared with white. The carbohydrates content of red sweet potato was higher than that of white sweet potato. From the comparative study, it can be concluded that red sweet potato tubers are a good source of protein content and starch content. From the nutrient value, these plant materials could be used as a food supplement. From the investigation of the mineral content of sweet potato, it was observed that it contained some important minerals such as calcium, potassium, lead, manganese, zinc, iron, arsenic, etc. In the case of mineral content, the iron content of white sweet potato was higher than that of red sweet potato. The calcium content of red sweet potato was higher than that of white sweet potato. From the comparative study, it can be concluded that red sweet potatoes are a good source of calcium content and white are a good source of iron content. And these plant materials could be used as a food supplement for mineral content.

Acknowledgement: None

Conflict of Interest: None

Source of Funding: None

REFERENCES

1. Ray RC and Ravi V. (2005). Post-harvest spoilage of sweet potato and its control measures. *Critical Review of Food Science and Nutrition*, 35: 623-644.
2. Purseglove and John Williams. (1968). Longman Scientific and Technical. New York: John Wiley and Sons. *Tropical crops: Dicotyledons*.
3. Woolfe and Jennifer A. Sweet Potato (1992). An Untapped Food Resource. *Cambridge University Press and the International Potato Center (CIP), Cambridge, UK*.
4. Loebenstein G and Thottappilly G. (2009). *The sweet potato*,391–425.
5. Scott, Best, Rosegrant, Bokanga.(2020). Roots and tubers in the global food system: A vision statement to the year. *International Potato Center, and others*.
6. Bangladesh Bureau of Statistics (BBS) 2010.
7. "Crop Production, Worldwide, 2010 data". FAOSTAT, *Food and Agriculture Organization of the United Nations*; 2011.
8. Austin and Daniel F.(1988). The taxonomy, evolution, and genetic diversity of sweet potatoes and related wild species. In: Gregory P. Exploration, Maintenance, and Utilization of Sweet Potato Genetic Resources. First Sweet Potato Planning Conference, 1987. *International Potato Center (CIP), Lima, Peru*,27–60.
9. Steingold A C. The Uber Tuber. *Hana Hou!* 2008; 11: 2.
10. Zhang D P, Ghislain M, Huaman Z, Cervantes J C, Carey E E.(1999). AFLP Assessment of Sweetpotato Genetic Diversity in Four Tropical American Regions: International Potato Center (CIP) Program report 1997-1998. *International Potato Center (CIP), Lima, Peru*.
11. Stephen K. and O' Hair.(1990). "Tropical Root and Tuber Crops". In: J. Janick and J.E. Simon (eds.), Advances in new crops. *Timber Press, Portland, OR*. p 424–8. Retrieved 26 September 2014.

12. Spence J D. Chinese Roundabout. (1993): Essays in History and Culture (illustrated, reprint, revised ed.). *W. W. Norton & Company*.p 167.
13. Takekoshi, Y. (1930) Economic Aspects of the History of the Civilization of Japan.p 352.
14. Kim J. A History of Korea. (2012).: From 'Land of the Morning Calm' to States in Conflict p 255.
15. Bazzano L A, He J, Ogden L G, Loria C M, Vupputuri S, Myers L, Whelton P K. (2002). Fruit, and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic follow-up study. American Journal of Clinical Nutrition,76(1): 93–99.
16. Lowry O H, Rosenbrough N J, Farr A L and Rendall R J(1951).Protein measurement with the Folin Phenol reagent. *J Biol Chem.*183: 265-275.
17. Jayaraman J. Laboratory Manual in Biochemistry (1st ed). (1981). *Wiley Estern Ltd. New Delhi, India*.
18. Loomis W F and Shull C A. Methods in plant physiology. (1937). *McGraw Hill, New York*.
19. Black C A. Methods of soil analysis part-I. (1965). *Argon. Managralh, ASA Madison, Wiscom., USA*.

How to cite this article: Hasi Rani Saha, Most. Lutfunnahar, Manoshi Sana et.al. Nutritional value of sweet potato (ipomoea batatas.) cultivated in the northern part of Bangladesh. *International Journal of Science & Healthcare Research.* 2022; 7(3): 258-272. DOI: *https://doi.org/10.52403/ ijshr.20220737*

Supplement

Chemicals and Equipments uses (Supplement-1)

The chemicals used in this study are mentioned below with their manufacturers:

Acetone: BDH Chemical Ltd., Poole England.
Acrylamide: Sigma Chemical Company. U.S.A.
Albumin Bovine (BSA): Sigma Chemical company. U.S.A.
Ammonium persulfate: Bio-Rad Laboratories, Richmond, U.S.A.
Ammonium sulfate: Merck, Germany
Aniline: BDH Chemicals Ltd. Poole England.
Arabinose: Sigma Chemical Company. U.S.A.
Borate (Natrium tetraborate): Sigma Chemical Company. U.S.A.
Bromophenol Blue: Bio-Rad Laboratories, Richmond, U.S.A.
Butanol: BDH Chemical Ltd., Poole England
Coomassie Brilliant Blue-250: Bio-Rad Laboratories, Richmond, U.S.A.
Copper sulfate: BDH Chemical Ltd., Poole England.
DEAE- cellulose: Pharmacia fine Chemicals Co. Ltd. Sweden
Di-sodium hydrogen orthophosphate dehydrates BDH Chemical Ltd., Poole England.
Galactose: Sigma Chemical Company. U.S.A.
Glucose: Sigma Chemical Company. U.S.A.
Glycerol: Bio-Rad Laboratories, Richmond, U.S.A.
Hydrochloric acid: BDH Chemical Ltd., Poole England.
Isopropanol: Merck, Germany
Lauryl Sulfate (SDS): Sigma Chemical Company. U.S.A.
Lysozyme: Sigma Chemical Company. U.S.A.
Mannose: Sigma Chemical Company. U.S.A.
N, N-methylene-bis-acrylamide: Sigma Chemical Company. U.S.A.
Orthophosphoric acid: BDH Chemical Ltd., Poole England.
Phenol: Sigma Chemical Company. U.S.A.
Potassium Sodium Tartrate: BDH Chemical Ltd., Poole England
Raffinose: Sigma Chemical Company. U.S.A.
Riboflavin: BDH Chemical Ltd., Poole England

Ribose: Sigma Chemical Company. U.S.A.
Rhamnose: Sigma Chemical Company. U.S.A.
Silica gel-G: Merck, Germany
Sodium dihydrogen orthophosphate: BDH Chemical Ltd., Poole England
Sodium chloride: Merck, Germany
Sodium hydroxide: Merck, Germany
Sodium azide: Sigma Chemical Company. U.S.A.
Sodium carbonate: BDH Chemical Ltd., Poole England
Sulfuric acid: BDH Chemical Ltd., Poole England
TEMED (N, N, N, N-tetramethylene diamine): Sigma Chemical Company. U.S.A.

EQUIPMENT

The important equipment used throughout this study is listed below:

1) Centrifuge (Refrigerated): Eppendorf-5430R
2) Electric balance- Mettler H18
3) Fraction collector-SF-160 (Advantec, Japan)
4) Homogenizer: NISSIN (NX-220)
5) Incubator: GALLENKAMP-Size 2 Incubator
6) Micropipette: Microlit (10-100 µl)
7) pH meter: HANNA-pH 211
8) Shimadzu Spectrophotometer: Model-1200RS
9) Stirrer
10) Slab gel electrophoresis apparatus
11) Volac pipette controller
12) Water bath
13) Cold chamber
14) Laminar air flow unit: Horizontal (Model: Equ/04-EHC)
15) Refrigerator
16) Autoclave: HIRAYAMA (Model-HA-30D)
17) Freeze dryer: TAITEC (VD-800F)

Preparation of DNS Reagent (Supplement-2)

Simultaneously 1 g of DNS is mixed with 50ml distilled water then add 30 g of Na-K tartrate and mixed. Add 20 ml 2M NaOH solution & makeup to 100 ml by adding distilled water.

Procedure

Three sets of experiments (Blank, Control, and Sample) were performed for the measurement of invertase activity. The following different solutions were taken in different test tubes.

Substances	Blank	Control	Sample
0.1 M phosphate buffer, pH 6.7	2.5	2.5	2.5
1% Sucrose solution	2.5	2.5	2.5
1% NaCl	1.0	1.0	1.0
Enzyme extract	¾	0.5	0.5

The contents in the test tubes were mixed uniformly and the test tubes were incubated in a water bath at 37°C for 10 min. Then 0.5 ml of crude enzyme extract and 0.5 ml of distilled water were added to the sample and control tubes respectively, whereas 1 ml of distilled water was added to the blank test tube. Immediately after the addition of crude enzyme extract and distilled water, 0.5 ml of 2 N NaOH was added to the control tube. The rest of the test tubes were incubated at 37°C for 15 min and the reaction was then stopped by the addition of 0.5 ml of 2 N NaOH. Then 0.5 ml of DNS reagent was mixed into all the tubes. The tubes were heated in a boiling water bath for 5 min. After cooling at room temperature the absorbance was measured at 650 nm.

Supplement-3: Determination of Protein Concentration (Lowry Et Al., 1951)

Reagents:

a) Alkaline sodium carbonate solution (20 gm/liter Na_2CO_3 in 0.1 M NaOH solution).
b) Freshly prepared copper sulfate and sodium potassium tartrate solution (5 gm/l $CuSO_4$ 5H2O in 10 gm/liter Na-K tartrate).
c) Alkaline solution: Mixture of solution (a) and (b) in the proportion of 50:1 respectively.

d) Folin-Cicolteau's reagent (Diluted with an equal volume of H_2O just before use).
e) Standard protein (Bovine serum albumin 10 mg/100 ml in dist. H_2O) solution.

Determination of cytotoxicity of the purified enzyme by Brine-Shrimp bioassay [Supplement-4]

Brine shrimp lethality bioassay is a recently developed method for bioactive compound assessment. This bioassay indicates toxicity as well as a wide range of pharmacological activities (e.g. anticancer, antiviral, insecticidal, pesticidal, AIDS, etc.) of the compounds. Extracts and isolated compounds from plant origin can be tested for their bioactivity by this method. Here *in vivo* lethality bioassay is conducted by using the simple zoo logic organism; brine shrimp naupli (*Artemia salina*, Leach). The method has the advantages of being very simple, rapid (24 hours), and inexpensive. It easily utilizes a large number of organisms for statistical validation and requires no special equipment and a relatively small amount of sample. In the present study, TCSL was used for its cytotoxicity study using the brine shrimp lethality test.

Materials

a) *Artemia salina* leach (brine shrimp eggs)
b) Sea salt (non-ionized NaCl)
c) Small tank with a perforated dividing dam to grow shrimp, cover, and lamp to attract shrimp.
d) Pipettes
e) Micropipette (10µl- 100µl)
f) Vials, (4 ml)
g) Magnifying glass. (3X magnifying glass)

Procedure

a) Preparation of simulated seawater

38 g of sea salt (non-ionized NaCl) was weighed accurately, dissolved in one liter of sterilized distilled water, and then filtered off to get a clear solution. The pH of the seawater was maintained between 8 and 9 by using a $NaHCO_3$ solution.

b) Hatching of brine shrimp

Artemia salina leach (brine shrimp eggs) collected from the pet shop was used as the test organism. Simulated sea water was taken in the small tank and the shrimp eggs (1.5 g/l) were added to one side of the tank and this side was covered. The shrimps were allowed for one day to hatch and immature as nauplii (larvae.).The constant oxygen supply was carried out and constant temperature (around 37˚C) was maintained during the hatching time. The hatched shrimps were attracted to the lamp on the other side of the divided tank through the dam. These nauplii were taken for this bioassay.

c) Preparation of sample

The test sample contained an enzyme. This solution was used as a stock solution.

d) Application of the test sample and brine shrimp nauplii to the vials

Twelve clean vials were taken for the sample in four concentrations (Three vials for each concentration) and another three vials were also taken for control. Then the concentration of every three vials was 30, 60, 80, 100, 120, 140, 160, and 180mg/ml respectively enzyme solution containing the sample was added to every three vials gradually and finally marked up to 5 ml by seawater. With the help of a Pasteur pipette, 10 living shrimps were taken to each sample vial and control vial respectively.

e) Counting of nauplii

After 24 hours of incubation, the vials were observed using a magnifying glass and the number of survivors in each vial was counted and noted. From this, the nauplii were counted averagely of each three vials, which contained the same conc. of the sample, the percent (%) mortality was calculated for each dilution. The concentration-mortality data were analyzed by using Probit analysis.

Method

For the construction of standard curves 0.0, 0.1, 0.2, 0.4, 0.6, 0.8, and 1.0 ml of the standard protein solution (1 mg/ml) were taken in different test tubes and made up to the volume of 1 ml of distilled water. The protein solution (1 ml) was also taken in duplicate in different test tubes and 5 ml of the alkaline solution (solution-c) was added to the standard protein solution in different test tubes and mixed thoroughly. It was allowed to stand at room temperature for 10 minutes. Then 0.5 ml of diluted Folin-Cicolteau's reagent was added rapidly with immediate mixing and left for 30 minutes. The dark blue color formed was measured at 650 nm against the appropriate blank. By the same procedure described above, the absorbance of the collected fractions was measured and a graph was constructed by plotting concentration versus OD. The protein concentration was determined in the fraction from the graph.

******