Nutritional Values of the Rhizome of Arrowroot

Maranta arundinacea L. (Adalut)

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Abstract

Arrowroot is chiefly valuable as an easily digested starch. Arrowroot is a starch rich underground creeping rhizome. Its powder is one of nature's finest carbohydrates. The rhizomes of arrowroot are widely used in herbal remedies and healthy foods. Arrowroot is a very nutritious diet for people suffering from certain chronic diseases. So that the rhizome of arrowroot was chosen for chemical analysis. Firstly, it was checked for qualitative tests of sugar, carbohydrate and starch contents. In addition, quantitative tests for carbohydrate, fat, ash, moisture, protein and crude fibre in rhizome of arrowroot were determined. Finally, the mineral contents were determined by using EDXRF spectroscopy.

Introduction

The arrowroot plant is native to the tropics of South America. It has a long history of cultivation by native peoples, who developed an extensive treatment process for extracting the usable powder from the rhizomes.

Arrowroot is a starch rich underground creeping rhizome belonging to Marantaceae family plants. It is widely cultivated in the philippines, caribbean islands, and South America for its tubers, which yield fine, easily digestible edible starch. Its powder is one of nature's finest carbohydrates.

Arrowroot was also used medicinally, with some Indians believing that it should be placed on wounds of poisoned arrows to draw out the toxins. The Europeans may have begun calling it arrowroot because of the preceived medicinal properties.

Arrowroot contains very good levels of B complex group of vitamins such as niacin, thiamin, pyridoxine, pantothenic acid and riboflavin. Arrowroot flour is used in confectionaries as thickening agent to

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make cakes, gels, mousse; and in kitchens to prepare soups, sauce, dressings, gravy etc.

In this research paper, rhizome of arrowroot was selected for chemical analysis. Carbohydrate, reducing sugar, sugar, glucose and starch could be done by the qualitative test. Chemical constituents of carbohydrate, fat, ash, moisture, protein and crude fibre were investigated by the quantitative test. In addition, chemical constituents of mineral contents were determined by EDXRF spectroscopy.

Aim and Objectives

Aim

The aim of this research to study the nutritional values of the rhizome of arrowroot.

Objectives

- To prepare arrowroot powder
- To determine the qualitative test of arrowroot
- To determine the starch contents in arrowroot
- To determine the mineral contents in arrowroot
- To determine the fat content in arrowroot
- To determine the ash content in arrowroot
- To determine the moisture content in arrowroot
- To determine the crude fibre content in arrowroot
- To determine the protein content in arrowroot
- To determine the carbohydrate content in arrowroot

Botanical Description

Fig. 1. Rhizome of Arrowroot Plant

Common name	-	Arrowroot
Botanical name	-	*Maranta arundinacea* (Linn.)
Family name	-	Marantaceae
Myanmar name	-	Adalut
Genus	-	Maranta
Species	-	*M. arundinacea*

Description

A perennial plant about two feet high, arrowroot has small white flowers and fruits about the size and form of currants. The rootstocks are dug when the plant is a year old, and often exceed 1 foot (30 cm) in length and 0.75 inches (19 mm) in diameter. They are yellowish white, jointed and covered with loose scales. The plant is a small size perennial herb, growing to the length of 3 to 5 feet with turmeric-like broad, flat, ovate leaves. Small, white flowers in pairs all along the long pedicle appear about 90 days after planting.

The root is actually an underground small, cylindrical shaped cream-white/light red tuber covered with thin scales that leave ring like impression on the root. The tubers are ready for harvest after 10-12 months from

planting. Each root weighs about 30 to 50 g. It will only grow as a stove plant, with tanners bark. The plant is an herbaceous perennial, with a creeping rhizome with upward-curving, fleshy, cylindrical tubers covered with large, thin scales that leave rings of scars. The flowering stem reaches a height of 6 feet, and bears creamy flowers at the ends of the slender branches that terminate the long peduncles. They grow in pairs. The numerous, ovate, glabrous leaves are from 2 to 10 inches in length, with long sheaths often enveloping the stem.

Materials and Methods

Sample Collection

Rhizomes of arrowroot were collected from Pyin Oo Lwin Township, Mandalay Region.

They were cut into small pieces and dried in air. And then they were crushed in a motor and stored in well-stoppered bottles which were used throughout the experiment.

Extraction of Sugar and Carbohydrate from the Rhizome of Arrowroot

Sugars can be extracted from arrowroot powder (5 g) by boiling with 95 % ethanol (100 mL) on a water bath. The mixture was filtered and evaporated to reduce the alcohol. Then, the filtrate was centrifuged. The decantate was used for the many qualitative test of sugar.

Table 1. Qualitative Test for Carbohydrates and Sugar in Rhizome of Arrowroot

Experiment	Observation	Inference
Molisch's Test 2 drops of Molisch's reagent was added to about 2 mL of the test solution. The solution was mixed properly and poured concentrated sulphuric acid along the side of the tube.	The colour changed at the junction of the two liquids.	The color (purple or pink) develops due to the formation of furfural derivative by the action of the acid on the carbohydrates.
Fehling's Test Equal amount of Fehling's (A) and (B) were taken in a test tube (1 mL each) and mixed well. A few drops of the mixture test solution was added and was boiled for a few minutes.	Brick red precipitate was formed.	Cupric hydroxide present in Fehling's solution is reduced to curprous oxide (Yellow brick coloured ppt) by the reducing sugar.
Benedict's Test 5 drops of the test solution was added to 2 mL of Benedict's reagent and boiled for five minutes in a water bath. The solution is cooled.	Reddish precipitate was formed.	As in Fehling's Test, cupric hydroxide in alkaline solution is reduced to cuprous oxide by sugar.
Moor's Test Volume of 2 % sodium hydroxide solution was added to the test solution in the test tube and boiled.	Solution was turned yellow in the beginning and reddish brown later.	The test solution contains glucose. The brown colour is due to the formation of caramel condensation product of glucose.

Determination of Starch Contents in Rhizome of Arrowroot

10 gm of arrowroot powder was taken out with about 50 mL distilled water in a beaker and boiled for a few minutes. The extractor was filtered through a fine cloth after cooling and the following tests were performed to the filtrate.

Table 2. Qualitative Test for Iodine in Rhizome of Arrowroot

Experiment	Observation	Inference
1. Iodine test: (i) 2 ml of the test solution and 1 or 2 drops of iodine solution were taken	(i) Blue colour appeared.	The test solution contains starch. The colour is due to the adsorption of iodine molecules by the α-amylose.
(ii) The above solution was heated	(ii) The colour gradually disappeared	This solution contains starch.
(iii) The above solution was cooled	(iii) Blue colour reappeared.	This solution contains starch.
(iv) A few drops of strong sodium hydroxide was added to the above solution	(iv) Blue colour of iodine disappeared	(Sodium hydroxide removed free iodine which is necessary for the appearance of blue colouration). This solution contains starch.
2. Tanic acid test: An excess of tanic acid was added to a starch solution. Then the mixture was heated.	Formation of white precipitate which was dissolved on heating.	The test solution contains starch.

Determination of Fat Content in Rhizome of Arrowroot

Accurately weighed arrowroot powder (20 g) was introduced into the weighed extraction thimble. The open end of the thimble was closed with a plug of cotton wool. Thimble was closed and the extractor was attached. Sufficient petroleum ether (b.p 60°C-80°C) was poured into extractor so as to start the siphon. Then the extractor was attached to the condenser and the flask was heated on a water bath for 10 hours. When the extraction completed the petroleum ether was removed by vaccum distillation. The last trace of the solvent was then removed by vaccum distillation and then removed by placing the content in an oven at about 100°C until constant weight was obtained. After extraction, the thimble contained in the meal cake was placed in an oven until no odour of ether remains.

Calculation

$$\% \text{ of fat content} = \frac{\text{Fat wt(g)} \times 100}{\text{sample wt(g)}}$$

The fat content of the arrowroot powder was found to be 1.43 % as shown in Table (4).

Determination of Ash Content

The porcelain crucible and its cover were heated, cooled and weighed at room temperature. About 5 g of sample powder was added in crucible. The covered crucible containing sample was heated on open flame. After evolving vapours and gases had stopped, the crucible was heated in muffle furnace. Heating was stopped until the incombustible residue was completely free from carbon and the ash became absolutely white. The crucible was cooled in desicator and weighed. Ash content can be calculated from difference between the mass of crucible with the ash and that of empty crucible.

Calculation

$$\text{Ash } \% = \frac{\text{wt of residue (g)} \times 100}{\text{wt of sample (g)}}$$

The ash content of the arrowroot powder was found to be 3.60 % as shown in Table (4).

Determination of Moisture

Accurately weighed (5 g) of defatted arrowroot powder was added into a petridish previously dried and cooled in a desicator. The dish containing the sample was placed in an oven and dried for 30 minutes at 101° ± 1°C. The dish then removed from the oven and cooled in a desicator at room temperature and weighed. The procedure was repeated until the loss in weight did not exceed 0.05 % per minute during the drying period.

Calculation

$$\% \text{ of Moisture} = \frac{\text{loss in wt(g)} \times 100}{\text{wt of sample (g)}}$$

The moisture content of the arrowroot powder was found to be 7.06 % as shown in Table (4).

Determination of Crude Fibre

"Crude fibre" is the organic residues, consisting largely of cellulose, that is left after the carbohydrates and proteins have been removed by successive treatment with boiling acid and alkali.

Reagent

(1) Sulphuric acid solution 1.25 % [w/v]

(2) Sodium hydroxide solution 1.25 % [w/v]

Procedure

About (2 g) of the defatted arrowroot powder was accurately and introduced into a 500 mL flask. Then 200 mL of 1.25 % sulphuric acid solution was added, the flask was connected with a reflux condenser and refluxed for about 30 minutes. The flask was rotated with hand at every 5 minutes in order to mix thoroughly. After 30 minutes the insoluble material was filtered through linen in a funnel. The residues were washed with hot water and the washing was continued until the washing was no longer acidic. The residues were then washed down into the flask with 200 mL of sodium hydroxide solution. The flask was boiled gently for exactly 30 minutes. At the end of period, it was filtered through the same linen. The residues was washed thoroughly with hot water until free from alkali and

then with about 15 mL of 95 % ethanol. The residues were introduced into a crucible and dried to a constant weight. The weight was recorded and residues were incinerated at a full red heat for about 20 minutes until the carbonaceous matter had been removed.

The contents of the crucible were cooled and weighed. Heating, cooling and weighing were repeated until a constant weight was obtained. The loss in weight was taken as crude fibre.

Calculation

$$\text{Fibre \%} = \frac{\text{wt of fibre (g)} \times 100}{\text{wt of sample (g)}}$$

The crude fibre content of the arrowroot powder was found to be 3.96 % as shown in Table (4).

Determination of Carbohydrate

The carbohydrate content was determined by phenolsulphuric acid colourimetric method in terms of glucose.

Preparation of Sample Solution

(0.1 g) of sample powder was dissolved in (100 mL) of hot water and shaken for ten minutes. (1 mL) of this solution was then diluted to (10 mL) with distilled water and this solution was taken as the sample extract.

Preparation of Standard Sugar Solutions

100 mg (0.1 g) of hydrated glucose was exactly weighed and dissolved in (100 mL) of distilled water 1, 2, 4, 6, 8 and 10 mL of these solutions were drawn out and put in each (100 mL) volumetric flask and diluted to the mark with distilled water.

Procedure

1 mL of solution and six standard sugar solutions containing, 10, 20, 40, 60, 80 and 100 μg of glucose per mL were put in each test tube and mixed. (1 mL) of blank of 5 % phenol solution was also added to each test tube and mixed. A blank also prepared with 1 mL of distilled water instead of sugar solution (5 mL) of 96 % sulphuric acid was again added to each tube so that the stream hit the liquid surface directly to produce good mixing. Each test tube was agitated during the addition of acid. After 10

minutes, the tube was reshaken and placed in water bath at 25°-30°C for twenty minutes. The yellow orange was stable for several hours. Absorbances were determined by using UV Vis spectrophotometer (Model 1601), measured at Department of Chemistry, Yadanabon University.

The amount of carbohydrate present in the sample solution was calculated by using standard curve. The result obtained was tabulation Table (6).

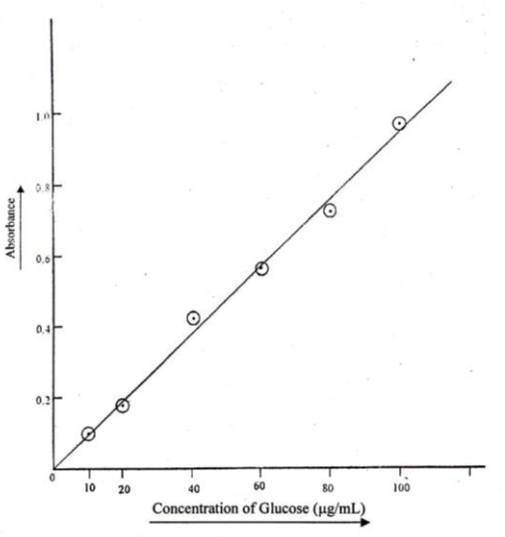

Fig 2. Standard Calibration Curve for Glucose

Determination of Protein Content by Kjeldahl's Method

Accurately weighed defatted powder (2 g) was placed in the Kjeldahl's digestion flask, a round bottom flask with a long narrow neck. Analar potassium sulphate (10 g) anhydrous copper sulphate (0.5 g) and pure sulphuric acid (10 mL) were added to the Kjeldahl's digesting flask in such a way as to wash down any solid adhering to the neck. Then, it was shaken until the content were well mixed and heated gently and cautiously in small flame. When foaming ceased, heating was increased gently until mixture boiled brickly and became colourless. The digestion was continued for half an hour to make sure that all the nitrogen in the sample was converted into ammonium sulphate. It was allowed to cool and distilled water (100 mL) was carefully added into the flask with frequent shaking. The Kjeldahl's distillation apparatus was set up, taking care that the tip of

the condenser extended well below the surface of the standard sulphuric acid solution (50 mL) in the receiver. The digested solution was poured into the distillation flask and then 100 mL of 40 % sodium hydroxide solution was added into it through the dropping funnel to make the mixture strongly alkaline. The evolved ammonia was distilled off and passed into a receiver containing sulphuric acid and the distillate with respect to excess sulphuric acid was titrated with standard N, sodium hydroxide solution using methyl orange as an indicator. A blank determination was carried out exactly as above, but instead of arrowroot powder sample, (20 mL) of distilled water was used.

Calculation

$$\text{Protein \%} = \frac{0.014 \times 100 \times (X - V) N_A \, 6.25}{W}$$

The protein content of the arrowroot powder was found to be 3.75 % as shown in Table (4).

Where,

X = Volume (mL) of sulphuric acid solution used in blank

V = Volume (mL) of sulphuric acid solution used in test

N_A = Normality of sulphuric acid solution

W = Weight (g) of sample

Determination of Mineral Contents in Rhizome of Arrowroot

The mineral contents of arrowroot powder were determined by Energy Dispersive X-rays Fluorescence Spectrometry, measured at Department of Physics, University of Mandalay. These results are shown in Table (5).

Results and Discussion

In this research, arrowroot sample was obtained from Pyin Oo Lwin Township, Mandalay Region.

The qualitative test of arrowroot powder gives positive results for reducing sugar, glucose, sugar, carbohydrate and starch respectively. These results are shown in Table (3).

Table 3. Results of Qualitative Test for Rhizome of Arrowroot

No.	Experimental	Solution	Observation	Remark
1.	Reducing sugar	Fehling	Yellow or brick red ppt	+
2.	Glucose	Moor	Yellow in beginning and reddish brown later	+
3.	Sugar	Benedict	Yellow orange or reddish ppt	+
4.	Carbohydrate	Molisch	The colour change of the junction of the two liquids	+
5.	Starch	Iodine test	Blue colour was appeared	+

Chemical constituents of arrowroot powder such as carbohydrate, fat, ash, moisture, protein and crude fibre are shown in Table (4).

Table 4. The Chemical Constituents of Rhizome of Arrowroot

No.	Parameters	Results (%)
1.	Carbohydrate	80.77
2.	Moisture	7.06
3.	Crude fibre	3.96
4.	Protein	3.75
5.	Ash	3.60
6.	Fat	1.43

Carbohydrate % of arrowroot is 80.77. Arrowroot is a carbohydrate rich food. Carbohydrates are important constituents of all living organisms and major source of metabolic energy. Fibre is present in arrowroot 3.96 %. Fibre can control blood pressure.

Table 5. Determination of Mineral Content in Rhizome of Arrowroot

Sr No.	Parameter	Measuring value ppm	Method/Instrument
1.	Potassium (K)	14320	EDXRF
2.	Chlorine (Cl)	5189	
3.	Calcium (Ca)	449.7	
4.	Iron (Fe)	167.9	
5.	Manganese (Mn)	49.0	
6.	Copper (Cu)	4.8	

In addition, mineral contents of this sample were determined by applying EDXRF technique.

The rhizome of arrowroot consists of potassium (14320 ppm), chlorine (5189 ppm), calcium (449.7 ppm), iron (167.9 ppm), manganese (49.0 ppm) and copper (4.8 ppm) respectively. Arrowroot is rich in potassium, which can prevent hypertension. In addition, it contains (167.9 ppm) iron. For the formation of iron in the blood, the arrowroot is the best source. Therefore, arrowroot may be used in preventing diseases and providing more energy.

Arrowroot performed absorbance of standard glucose solution curve by using 1 mL of solution and six standard sugar solution. The results were shown in Table (6).

Table 6. Absorbance of Standard Glucose Solution

No.	Concentration of glucose (μg/mL)	Absorbance of 490 nm
1.	10	0.1052
2.	20	0.2070
3.	40	0.4100
4.	60	0.6100
5.	80	0.8593
6.	100	1.0870

The amount of carbohydrate present in the sample solution was calculated by using standard curve. The result obtained was tabulation Table (7).

Table 7. The Results Given by the UV Spectrophotometer and Standard Curve

No.	Volume of sample (mL)	Absorbance	Concentration of carbohydrate %
1.	1	0.795	80.77

Conclusion

In this research, the rhizome of arrowroot was selected for qualitative and quantitative determination of chemical constituents. The rhizome of arrowroot contains carbohydrate (80.77 %), moisture (7.06 %), fibre (3.96 %), ash (3.60 %), fat (1.43 %) and protein (3.75 %) respectively. The rhizome of arrowroot is a carbohydrate rich food. Carbohydrates are important constituents of all living organisms and major source of metabolic energy. Fibre decreases intracolonic pressure and thus play a beneficial role in diverticular disease. In addition, they play a role in reducing the risk of colon cancer. As described in Table (5), K, Cl, Ca, Fe, Mn and Cu minerals contains in rhizome of arrowroot. The highest potassium value was observed in these results. Potassium is an important component of cell and body fluids that help regulate heart rate and blood pressure. Therefore, the rhizome of arrowroot may be a good source of dietary energy, some micronutrients and medicinal uses.

Acknowledgements

I would like to express my gratitude to the Rector Dr Aye Kyaw and the Pro-rectors, Yadanabon University for providing necessary resources. I owe a great deal of gratitude to Dr Hlaing Hlaing Myat, Professor and Head, Department of Chemistry, Yadanabon University for her invaluable advice, guidance and encouragement throughout this research.

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