A Comparative Analysis of *Solanum tuberosum* and *Ipomea batatas* on Physiochemical properties

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***Abstract*- Potatoes and sweet potatoes are two widely consumed and versatile tubers with distinct physiochemical properties. This study aims to provide a comparative analysis of these two tubers based on their physiochemical characteristics. Various parameters such as moisture content, pH, swelling power, gelatinization capacity, starch content, and sugar content and fat content, were investigated to evaluate the nutritional value and potential health benefits of potatoes and sweet potatoes. The results revealed that both potatoes and sweet potatoes have high moisture content, with potatoes containing slightly higher levels that is 8.2% for potato and 6.5% for sweet potato. Swelling power(g/g) and gelatinization (%) capacity also differed with potato (28.6 g/g) (38.6%) and sweet potato (8.6g/g) (87.03%) respectively, understanding such properties help in their industrial use. sweet potatoes (4.3%) contain a higher proportion of sugars, especially sucrose than potato (1.16%). This difference in starch composition contributes to differences in taste, texture, and cooking properties between the two tubers.**

***Keywords*: Starch Content, Nutritional Value, Cooking Properties, Gelatinization Property, Potato and Sweet Potato.**

1. INTRODUCTION

Potatoes (Solanum tuberosum) and sweet potatoes (Ipomoea batatas) are two widely consumed and versatile tuber crops that have been an integral part of human diets for centuries. Despite their similar names, they belong to different botanical families and exhibit distinct physiochemical properties, nutritional compositions, and potential health benefits. (Barrett, D. M et al.,2010). In recent years, sweet potatoes have gained increased attention for their nutritional value and potential health benefits. They are known for their vibrant orange flesh, indicative of their high beta-carotene content, a precursor to vitamin A. Sweet potatoes is also a good source of dietary fibre, vitamins C and E, and minerals like potassium and manganese (Rautenbach et al., 2021).

The presence of bioactive compounds, such as anthocyanins and phenolic acids, in sweet potatoes has been linked to antioxidant and anti-inflammatory activities, suggesting potential protective effects against chronic diseases (Rautenbach et al., 2021; Xie et al., 2020). To better understand the similarities and differences between potatoes and sweet potatoes, numerous studies have been conducted to explore their physiochemical properties, nutritional compositions, and health implications. For instance, a recent study by (Nwokocha et al.2021) compared the antioxidant activities and phenolic contents of different potato varieties and sweet potatoes. Their findings indicated variations in the antioxidant potential and phenolic composition, suggesting that different cultivars within each crop may have unique health-promoting properties. Furthermore, a study by (Rautenbach et al. 2021) conducted a comprehensive nutritional profiling of orange- and yellow-fleshed sweet potato cultivars in South Africa. The analysis revealed variations in nutritional composition, including differences in levels of carotenoids, dietary fibre, and minerals, emphasizing the importance of selecting specific sweet potato varieties to maximize nutritional benefits.

2. MATERIALS AND METHODS

2.1 SAMPLE COLLECTION AND PREPARATION

Brown potato and sweet potato were collected from local market, Hyderabad, India. freshly-produced samples of each potato variety were taken and the Samples were gently washed with tap water immediately after collection to remove sand and other extraneous material before being washed with distilled water and then air dried. The samples were then cut into small pieces, placed in an auto seal bag and kept in a desiccator to inhibit moisture gain or loss. They were then ready for the determination of their proximate composition. (Alam M et al 2016).

2.2. PHYSICAL ANALYSIS

2.2.1. Moisture content

Preheat the oven to 105-110°C.Weigh a clean and dry aluminium or glass dish and record its weight. Cut the potato sample into small pieces and blend it in a blender or food processor to form a homogeneous mixture. Weigh approximately 10 grams of the potato sample into the pre-weighed dish and record its weight. Place the dish with the potato sample in the preheated oven and dry it for 3-4 hours until the sample is completely dry. Remove the dish from the oven and allow it to cool in a desiccator. Weigh the dish with the dried potato sample and record its weight. Calculate the moisture content of the potato using the following formula:
Moisture content (%) = ((Initial weight of dish + wet sample) - (Final weight of dish + dry sample)) / (Initial weight of dish + wet sample) x 100. (AOAC 2021)

2.2.2. pH

To analyse the pH of potatoes, you can follow these steps: Wash and peel a potato to remove any surface dirt or debris. Cut the potato into small pieces and blend them with distilled water to form a slurry. Filter the slurry using filter paper or a cheesecloth to remove any solid particles. If using pH indicator paper, dip a strip of the paper into the slurry and compare the colour of the paper with the colour chart provided by the manufacturer to determine the pH value (AOAC 2000)

2.2.3. Swelling power

The swelling power of potato starch can be analysed using the following steps: Weigh a sample of potato starch (typically 1 gram) and place it in a test tube. Add a known volume of distilled water to the test tube. The ratio of water to starch should be determined based on the desired consistency of the paste or gel. Mix the starch and water thoroughly to ensure that all the starch is wetted. Heat the mixture in a water bath at a controlled temperature (usually 90-95°C) for a specified time (usually 30 minutes). The temperature and time of heating can be adjusted based on the desired experimental conditions. After heating, cool the mixture to room temperature and determine the weight of the resulting gel. Calculate the swelling power of the starch using the following formula:
Swelling power (g/g) = (weight of gel - weight of dry starch) / weight of dry starch. (AOAC 2000)

2.2.4. Gelatinization property

Gelatinization analysis of potato starch can be performed using the following steps: Weigh approximately 1 gram of potato starch and add it to a test tube. Add 10 ml of distilled water to the test tube and mix well to form a suspension. Place the test tube in a water bath and heat it gradually while stirring continuously. Record the temperature at which the starch suspension begins to thicken and become opaque. This is known as the gelatinization temperature. Continue to heat the suspension until it reaches its maximum viscosity. Record the temperature at which the maximum viscosity occurs. Allow the suspension to cool to room temperature and record its viscosity at this temperature. (AOAC 2007)

2.3. CHEMICAL ANALYSIS:

2.3.1. Starch Content of Potato Analysis Through Iodine Sol

Starch content of potatoes can be analysed through the iodine sol method steps: Prepare a sample of potato by washing and peeling it. Cut it into small pieces and grind it into a fine paste using a blender or mortar and pestle. Weigh 1 gram of the potato paste and place it in a test tube. Add 10 ml of distilled water to the test tube and mix it thoroughly to dissolve the potato paste. Add a few drops of iodine solution to the potato solution. The iodine solution will react with the starch in the potato and form a blue-black colour. Titrate the solution with a standardized sodium thiosulfate solution until the blue-black colour disappears, indicating that all the starch has reacted with the iodine. Note the volume of sodium thiosulfate solution used for titration. Repeat the above steps for at least two more trials to obtain an average value.

Calculate the starch content of the potato using the following formula:
Starch content (mg/g) = (volume of sodium thiosulfate solution used x concentration of sodium thiosulfate solution x 1000) / weight of potato sample. (AOAC 2000).

2.3.2. Sugar content

Sample Preparation: Start by obtaining a representative sample of potatoes. Peel the potatoes and remove any visible blemishes. Cut the potatoes into small pieces and homogenize them using a blender or food processor to obtain a uniform consistency. Extraction of Reducing Sugars: Extract the reducing sugars from the potato sample using a suitable solvent, such as distilled water or a buffered solution. Add the solvent to the homogenized potato sample and mix well. Allow the mixture to sit for a specific period to allow the sugars to dissolve. Filtration: Filter the extract using a filtration system or centrifuge the mixture to remove any solid particles or debris. The filtered extract can be used for further analysis. Fehling’s Solution: Prepare Fehling's solution by mixing equal volumes of Fehling's A and Fehling's B solutions. Fehling's A contains copper sulphate, while Fehling's B contains alkaline tartrate and sodium hydroxide. Titration Setup: Set up a titration apparatus with a burette containing the Fehling's solution. Place a measured volume of the potato extract into a flask or beaker. Add a few drops of phenolphthalein indicator to the extract. Titration Process: Slowly add the Fehling's solution from the burette to the potato extract while stirring the mixture. The Fehling's solution will react with the reducing sugars in the extract, causing a colour change from blue to reddish-brown. Endpoint Determination: Continue adding the Fehling's solution drop by drop until the reddish-brown colour persists for a specific duration, indicating the endpoint of the reaction. Titration Calculation: Record the volume of Fehling's solution used for the titration. The volume represents the amount of reducing sugars in the potato sample data Analysis: Calculate the concentration of reducing sugars in the potato sample based on the volume of Fehling's solution used and the known concentration of Fehling's solution. (AACC 2000).

2.3.3. Fat content

Select several potatoes of similar size and shape, and weigh each one to determine its initial weight. Peel the potatoes and cut them into small pieces. Place the potato pieces into a blender and blend them until they form a smooth puree. Weigh out 10 grams of the potato puree and transfer it to a test tube or other small container. Add 10 mL of a fat extraction solvent, such as diethyl ether or hexane, to the test tube and mix thoroughly. Allow the mixture to sit for several minutes to allow the fat to separate from the potato puree. Carefully decant the fat extraction solvent into a pre-weighed container. Repeat steps 5-7 two more times with fresh portions of the potato puree to ensure complete extraction of the fat. Evaporate the solvent from the collected fat using a rotary evaporator or other appropriate method. Weigh the remaining fat to determine its mass. Calculate the percentage of fat in the potato by dividing the mass of the extracted fat by the initial weight of the potato and multiplying by 100 (AOAC 2000).

2.4. SENSORY ANALYSIS

Potato chips were made of both the potato and sweet potato for sensory analysis of potato vs sweet potato, descriptive analysis of the potato chips is done using hedonic scale of ranking 1to 5. For that a trained panel of assessors who are familiar with the sensory characteristics of food products are involved. The potato chips of both the potatoes that is potato and sweet potato are prepared in same quantity, with same method of preparation using same ingredients. A sensory evaluation form with a list of attributes is evaluated, such as, colour, aroma, texture and taste.

2.5. STATISTICAL ANALYSIS

The experiments were performed with three replicates for each sample of both the potatoes. Descriptive statistics were performed for all variables. Paired t-Test was performed to test the differences among varieties for their proximate, all analyses were performed with R software Version 3.2.2. The 5% level of least significance was used to determine any differences in the mean values between different potato and sweet potato. Differences at $p < 0.05$ were considered to be statistically significant. Experimental results were expressed as the mean ± standard deviation (SD) (Alam M et al 2016).

3. RESULT AND DISCUSSION

3.1 PHYSIOCHEMICAL ANALYSIS

The moisture content found in the collected samples: potato and sweet potato is obtained as 8.2% for potato and 6.5% for sweet potato. The standard moisture content was compared with 9.5% for potato (Tong et al,2023) and 6.3% for sweet potato (C.D. De Paula et al,2021). p value obtained for the moisture content of potato and sweet potato was 0.04 which is less than p=0.05(alpha). One of the advantages of knowing moisture contents can pave ways to different types of developments in storing purposes, without or minimal changes in nutrition value (Hossain M.M et al,2022).

The pH values obtained for potato is 6 and for sweet potato is 5.2. Standard ph value of potato is from 6.2 (Kizonas M A, 2010) and 5.5 for sweet potato (Baidoa O.A ,2023). P value obtained for ph of potato and sweet potato was 0.2 which is more than p=0.5(alpha). The swelling power obtained for potato flour was 28.6(g/g) at 90º C and for sweet potato flour was 8.6(g/g) at 90º C. The standard value for swelling power was compared with 33.5 (g/g) at 90°C for potato (Neeraj et al., 2021) and 8.6(g/g) at 90º C for sweet potato (Reddy et al., 2015). P value obtained for swelling power of potato and sweet potato was 0.01 which is less than significant p =0.05(alpha).

The swelling power of potato flour is more than the swelling power of sweet potato flour. Swelling power indicates the water holding capacity, which can also be one of the reasons for higher moisture content in potatoes than sweet potato. This property can be used in different processing method in making varied products from various potatoes species (Ulfa G M et al., 2019).

The gelatinizing power obtained for potato was 38.6 % at temperature 60º C at this temperature the gelatinization was at peak, for sweet potato flour the maximum gelatinization was observed at 70ºC with gelatinization power of 8.8%. Standard temperature for gelatinization for potato was compared with 65.5ºC (Schirmer et al., 2013) and 69ºC for sweet potato flour (Dos Santos, T. P. R., 2019), P value obtained for gelatinization powers for both potato and sweet potato was 0.001 which is less than the value p=0.05(alpha). This is observed due to larger starch granules in sweet potato compared to potato. Gelatinization power also differ with change in the other components such as protein, temperature, season (dos Santos, T.P.R et al 2023).

Table 1: Physical analysis result for potato vs sweet potato

Sample	Moisture content %	pH value	Swelling power (g/g)	Gelatinization capacity %
Potato(A)	8.2±0.7A	5.9±0.1A	28.6±1.52A	38.6±0.5B
Sweet potato(B)	6.5±0.5B	5.2±0.A	8.6±0.43B	87.03±0.5A

Values in each column are presented as mean ± SD (i.e., n = 3). Means in the same column in each parameter with a different superscript (A, B, C) are significantly different ($p < 0.05$).

The starch content in potato flour was obtained around 70% and for sweet potato flour 40% which was compared with standard starch content that is 60-80% in potato flour (Robertson T.M.,2018) and 43.5 % in sweet potato flour (Zhang M., 2019). P value obtained for the starch content comparison between potato flour and sweet potato flour is 0.009 which is less than the value p=0.05(alpha). The starch content of potato comprises of amylopectin and amylose composition which differs in structure and size in both the potato and sweet potato. Therefore, varied results is seen in both of their starch content as Potato has more starch content in its dry state due large molecular particle size when compared to sweet potato in dry state (Iheagwara M.C.,2019).

The sugar content in potato was obtained as 1.16% and in sweet potato the sugar content was obtained as 4.3% which was compared with the standard values of sugar content in potato as 0.15–1.5% (Rady A.M.,2015) and sweet potato sugar content 4.5% (Lai Y.C et al., 2011). P value of sugar contents in both the potato and sweet potato obtained was 0.01 which is less than the value p=0.05(alpha). The sugars in potato comprises of glucose and fructose that are also known as reducing sugars and sucrose which is non reducing sugar, the difference in sugar content is seen in both the potatoes due to the difference in sucrose content. Sweet potato has more of sucrose than potato which gives it a sweeter taste (Ju He H et al., 2022).

The fat content obtained for potato was 0.16% and for sweet potato was 0.08% which was compared with standard values 0.2% for potato is 0.10–0.73% (ZHOU L et al., 2019) and sweet potato fat content is 0.1% (USDA 2019). P value of fat contents of both the potato and sweet potato obtained was 0.05 which is equal to the value p= 0.05(alpha). The fat content in both the potatoes is less, therefore the significant difference between both the potato and sweet potato is of less magnitude. Though the fat content changes with temperatures and way of cooking that is the fat content of potato increases on boiling and increases even more on roasting (Beals K A.,2019).

Table 2: Chemical analysis of potato and sweet potato

Chemical Analysis	Potato(A)	Sweet potato (B)
Starch content%	70.3±5.6	40.3±1.52
Sugar content%	1.16±0.30	4.33±0.15
Fat content%	0.16±0.05	0.08±0.01

Values in each column are presented as mean ± SD (i.e., n = 3). Means in the same column in each parameter with a different superscript (A, B, C) are significantly different ($p < 0.05$).

Statistical analysis was done using paired t-Test for physiochemical properties of two samples that is potato as sample (a) and sweet potato as sample (b). The results were discussed with p value taken as p=0.05. The p value obtained for physical analysis for moisture content was (p=0.04); for pH value (p=0.2); for swelling power (p=0.01); for gelatinization capacity (p=0.001); for chemical analysis that are: starch content (p=0.009); for sugar content (p=0.01); for fat content (p=0.05); for both the a and b samples. These values are represented in table (3) along with other t-Test value.

The values obtained above (α 0.05) that is ph value shows that there is no significant difference and it failed to reject null hypothesis, which indicates ph value of both samples a and b are similar. Whereas, for the rest of the other physiochemical analysis shows values less than and equal to (α 0.05), which rejects null hypothesis and favours alternative hypothesis. This indicates significant difference occurs in physiochemical properties of both the samples a and b (Baig et al ,2022).

Table 3: Statistical analysis of Physiochemical Properties of Potato (a) and Sweet Potato (b)

Parameter	Mean ranges	SD ranges	T- Statistics	Degree of freedom (df)	P value
Moisture (%)	8.55-6.5	0.7-0.5	13.66	1	0.04
pH	5.9-5.3	0.1-0.2	2	1	0.2
Swelling Power (g/g)	29.5-8.85	1.5-0.4	37.54	1	0.01
Gelatinization Capacity (%)	38.85-86.8	0.5-0.056	319.66	1	0.001
Starch Content (%)	73.5-41	5.6-1.5	65	1	0.009
Sugar Content (%)	1.3-4.35	0.3-0.1	-61	1	0.01
Fat Content (%)	0.19-0.07	0.05-0.01	12	1	0.05

P-value<0.05; significant and P-value>0.05; non-significant

SENSORY ANALYSIS

Sensory analysis was done by making product (potato chips) from each of the variant potatoes using descriptive sensory analysis, which was done with 20 participants, score for each descriptive sensory analysis that is aroma, texture, colour and taste were evaluated using a hedonic scale of rating 1 to 5. Shown in Table (4) below:

TABLE (4): Sensory analysis of potato chips and sweet potato chips

ATTRIBUTES	Potato chips (A)	Sweet potato chips (B)
Colour	3.2±1.05	2.7±0.8
Aroma	3.7±0.73	3.15±0.74
Texture	3.05±0.75	4.05±0.82
Taste	3.95±0.82	3.85±0.74

Values in each column are presented as mean ± SD (i.e., n = 20). Means in the same column in each parameter with a different superscript (A, B) are significantly different ($p < 0.05$)

On sensory analysis of potato chips and sweet potato chips, colour, aroma, and taste of potato chips were liked more than sweet potato chips. In texture sweet potato chips were more liked than potato chips.

CONCLUSION

The comparative analysis of potatoes and sweet potatoes based on their physiochemical properties provides valuable insights into these two widely consumed tubers. The latest articles on the physiochemical properties of potatoes and sweet potatoes have shed new light on these crops. The study done on comparing different varieties of tubers that is potato and sweet potato have highlighted variations in moisture content, swelling power, gelatinization power, starch, sugar and fat contents. such comparative analysis of potatoes and sweet potatoes demonstrates their distinct characteristics and highlights the importance of considering specific varieties within each crop. These findings contribute to our understanding of these tuber crops and their potential impact on human nutrition and health. Incorporating potatoes and sweet potatoes into our diets can provide valuable nutrients and contribute to a balanced and healthy lifestyle.

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