ISSN: 3068-7527

Open Access Journal of Medicine and Healthcare

Research Article

Volume 2 | Issue 3

Exploring the Nutritional and Phytochemical Profile of American Tomatoes and Their Functional Potential

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Citation: Hajare R. (2026). Exploring the Nutritional and Phytochemical Profile of American Tomatoes and Their Functional Potential. Open Access J. Med. Healthc, 2(3): 1-7.

Received: 13-08-2026 **Accepted:** 19-08-2026 **Published:** 27-08-2026

10.5283/OG.OAJMH.17083717

Absract

Persimmons are good sources of heart health. The purpose of this study was to assess the starch extract from defatted persimmon seeds in terms of its physicochemical, function, and morphological properties. The process involved washing, hand-shelling, oven-drying, and milling persimmon seeds. After extracting the defatted persimmon flour with n-hexane, it was steeped in distilled water. The starch's morphological, functional, and physiochemical characteristics were all examined. The starch's physicochemical analysis revealed that it contains 7.26 percent carbohydrates, 12.10 percent moisture, 4.46 percent protein, 1.99% fat, 1.20 percent fiber, and 2.99% ash. It also contains calcium (194.17 mg/g), copper (0.05 mg/g), manganese (0.42 mg/g), magnesium (4.26 mg/g), iron (0.34 mg/g), zinc (1.59 mg/g), phosphorus (26.1 mg/g), sodium (23.20 mg/g), potassium (37.13 mg/g), Na/K (0.62), and Ca/P (7.44) and the functional analysis revealed the following: swelling index (246.67%), gelation capacity (12.00m/v), amylose (20.5%), amylopectin (79.5%), in-vitro digestibility (63.68%), foaming capacity (12.69%), foaming stability (3.26%), emulsion capacity (45.48%), emulsion stability (50.00%), and starch bulk density (0.42g/ml).This finding demonstrated that the defatted persimmon starch is particularly rich in nutrients and can therefore be used as a meal supplement.

Keywords: Persimmon, Defatted, Potassium, Sodium, Phosphorus

Introduction

A big aspect of American history and culture is traditional cuisine. The persimmon (Diospiros virginiana), a climber belonging to the Ebenaceae family, is found in the chilly regions of the United States, particularly in California. After being sown, the seeds are typically boiled before eating. The legume seed persimmon has a high calorie and amino acid content. It can be added to some foods that are lacking in nutrients and are rich in protein and healthy fats, which can help those who are malnourished greatly. It has also been reported that of all plant or legume species, persimmon seed has the highest antioxidant activity [1,2]. In addition to having phytochemicals including luteolin, flavonoids, and phenolic compounds, persimmon seeds are also considered to be an excellent of minerals. Its increased consumption is thought to be beneficial to human health. Starch is a naturally occurring insoluble, non-structural carbohydrate that is created and stored in the tissues of green plants, such as persimmon seed. It is a typical carbohydrate found in human diets and is utilized by industry as a renewable raw resource. Two polysaccharide polymers, amylose and amylopectin, are present in starch granules [3,4]. Functional characteristics of starches produced from various plants vary, including the paste's final viscosity, stickiness, and intended applications. The way starch metabolized in the human intestine is also influenced by its structure. Reduced digestibility starches, such as amylose starches, are highly prized for their health-promoting properties

3, which can help ward against diseases like diabetes and colon cancer [5]. It is crucial to comprehend the physico-chemical, functional, and morphological structures of the starches that are extracted from various starchy crops because this is a necessary step towards improving starch crops specifically. Therefore, the physico-chemical, functional, and morphological properties of the starch that was isolated from the defatted Diospiros virginiana persimmon seed were examined in this work.

Materials and Method

Acquisition of Materials

Persimmon seeds were obtained from the California, America by Courier.

Sample Preparation

Production of Persimmon Flour

The persimmon seeds were washed thoroughly and shelled manually to remove the kernel from the seeds. The removed seeds were washed and sliced (2-3mm) for easy drying. The shredded persimmon seeds were oven dried at 70ºC for 24hours and milled into flour according to the method of Barber and Obinna-Echem (2016).

Production of Defatted Persimmon Flour

Defatted persimmon flour was obtained by solvent extraction method to extract oil from the **persimmon** flour using soxhlet extraction method and starch was extracted by method of Muazu (2007).

Proximate Composition of Defatted Persimmon Starch

Proximate composition was evaluated in terms of moisture content, crude protein, fat, ash content, crude fiber and carbohydrate content according to the standard methods A.O.A.C. (2012).

Determination of Mineral Composition of Defatted Persimmon Starch

The mineral composition of the defatted persimmon starch was carried-out by ashing (dry ashing). The atomic absorption spectrophotometer (Buck Scientific, 2004) was used in the determination of the concentration of the minerals (A.O.A.C., 2012).

Determination of the Functional Properties of Defatted Persimmon Starch

Bulk Density

The Bulk density was conducted according to the method describe by Asoegwuet al., (2006).

Water absorption capacity (WAC)

The water absorption capacity was carried-out with the procedure of Sathe et al., (1982) as modified by Adebowale et al., (2005).

Oil absorption capacity (OAC)

Oil absorption capacity is an index of the amount of oil retained within a protein matrix under certain conditions. The oil absorption capacity of persimmon starch was determined using the method of Sathe and Salunkhe (1981) as modified by Adebowale et al.,(2005).

Swelling index determination

The swelling index of the starch was carried-out by the method of Ukpabi and Ndimele (1990).

Foaming Capacity and Stability

The method of Coffman and Garcia, 1977 was used with slight modification in the determination of foaming capacity and stability of the starch.

Emulsion Stability

The emulsion capacity and stability of persimmonstarch was carried-out according to the procedure described by Beuchat (1977).

Gelation Capacity (GC)

The gelation properties of the starch was carried-out by the method used by Adebowale et al. (2005b)

Swelling power and Solubility

The swelling power and solubility of the starch was conducted at temperature 30, 50, 70 and 90 ºC respectively using the method of Walizewskiet al. (2003)**.**

Freeze-Thaw Stability

The freeze-thaw stability of the starch was conducted according to the procedure described by Simi and Abraham (2008).

Pasting Property

The pasting property of the defatted persimmon starch was assessed using the RVA (Rapid Visco Analyzer).

The Amylose and Amylopectin of Defatted Persimmon Starch

The amylose and amylopectin of the defatted persimmon starch was assessed using the method described by Zhuet al., (2011).

In-Vitro Starch Digestibility

The in-vitro starch digestibility of persimmonstarch was conducted by themethod used by Singh et al. (1982).

Color Attributes of Defatted Persimmon Starch

Colour was determined using a colour meter PCE-CSM 2 (Deutschland GmbH) connected to a CQCS3 software (PCE Instruments UK Ltd, United Kingdom). Whiteness Index (WI) was calculated as follows**:**

$WI = [(100-L^{*})^{2} + a^{*2} + b^{*2})^{1/2}]$

Where,

WI = Whiteness index,

L = Lightness

a = Green to red

b = Blue to yellow

Scanning Electron Microscopy (SEM) of Defatted PersimmonStarch

The granular morphology of persimmonstarch was characterized by using SEM (JEOL JSM-6390, Tokyo, Japan). The starch was first coated with platinum before imaging at a voltage of 3.0kV and X1200 magnification.

Statistical analysis

Statistical analysis was done using IBM SPSS Statistics software version 21. Analysis of variance (ANOVA) was used to compare the mean values of the flour blend at $p<0.05$.

Results

Table 1 displays the approximate components of defatted persimmon starch. Defatted persimmon starch yields a moisture percentage of 12.10%. The outcome is better found when they looked at the nutritional value of tiger nut starch. The stability of a product's storage is greatly influenced by moisture. Results in milled food products with moisture levels less than 13% are thought to be stable from moisture deterioration. Defatted persimmon starch was discovered to have a protein level of 4.46%, amino acids are the building blocks of protein, the value gained is more than the protein derived from cassava starch. Table 1 indicates that the defatted persimmon starch contains 1.99% crude fat. Food's shelf life is determined by its fat content. Food deterioration may occur more quickly if there is a higher fat content since rancidity can lead to the development of bad tastes and smells. Additionally, eating a diet high in fat puts people a risk for developing heart disease and obesity as indicated in Table 1, the study's ash content, which was derived from the defatted persimmon starch, was 2.99%.This study's percentage of ash and ash is the inorganic residue that remains after water and organic materials have been removed by heating in the presence of an oxidizing agent, hence the amount of ash present in a food material could be used as a measure of the percentage mineral constituent of the food. In defatted persimmon starch, the crude fiber value (1.20%) was more than the 0.5.00% reported. A diet's inherent crude fiber content increases the volume of stool produced and shortens the amount of time waste products remain in the digestive tract. The obtained defatted persimmon starch has a carbohydrate content of 77.26%. Comparing the obtained carbohydrate content to the sample reported by standard, it was greater.

Table 1: Proximate Composition of Defatted Persimmon Starch

Variables	% Amount
Moisture (%)	12.10±0.19
Protein (%)	4.46±0.07
Fat(%)	1.99±0.01
Fibre (%)	1.20±0.18
Ash (%)	2.99±0.05
Carbohydrate (%)	77.26±0.50

Values are expressed as mean ± standard deviation of triplicate readings.

Means with different letters in the same column are significantly different in the same column at the $p \leq 0.05$ level.

Table 2 displays the mineral contents of defatted persimmon starch. Defatted persimmon starch was found to have the following: phosphorus (26.10 mg/g), sodium (23.2 mg/g), potassium (37.13 mg/g), calcium (194.17 mg/g), magnesium (4.26 mg/g), copper (0.05 mg/g), manganese (0.42 mg/g), iron (0.34 mg/g), zinc (1.54 mg/g), and manganese (0.05 mg/g). According to studies, calcium, magnesium, and zinc are essential for the metabolism of glucose. As co-factors for glucose metabolism-related enzymes, they can boost the action of insulin by stimulating the insulin receptor. Mineral elements have a critical role in many metabolic processes, including maintaining osmotic pressure, controlling muscle contractions, sending impulses, maintaining acid-base balance, absorbing glucose, forming bone, and more. According to literature, potassium is essential for the production of properties of proteins and amino acids. Given that the defatted persimmon starch's molar ratio of Na/K is within the advised range of (< 1.0), persons with high blood pressure may benefit from using it. The calculated Ca/P molar ratio of defatted persimmon starch is 7.44, indicating that it falls within the recommended range of 1.0 by the FAO. Consequently, persimmon starch can act as a calcium enhancer to shield adults from osteoporosis and children from rickets. Food is categorized as "good" if the Ca/P ratio is greater than one and as "poor" if it is less than 0.5. A Ca/P ratio greater than two aids in improving the small intestine's ability to absorb calcium.

Table 2: Mineral Composition of Defatted Persimmon Starch

Mineral	Amount (mg/g)
Calcium	194.17±0.29
Copper	0.05±0.01
Manganese	0.42±0.02
Magnesium	4.26±0.01
Iron	0.34±0.02
Zinc	1.59±0.01
Phosphorus	26.10±0.01
Sodium	23.20±0.26
Potassium	37.13±0.32
Na/K	0.62±0.00
Ca/P	7.44±0.00

Values are expressed as mean ± standard deviation of triplicate readings.

Means with different letters in the same column are significantly different in the same column at the $p \leq 0.05$ level.

Table 3 displays the functional characteristic of defatted persimmon starch. Defatted persimmon starch has a bulk density of 0.42 g/ml. The study's outcome pales in comparison to the findings of foods with low bulk density can be utilized as complimentary foods. For kids with developing digestive tracts, it improves easy digestion.513.33% of the defatted persimmon starch that was obtained could absorb water. The quantity of water content that food can absorb and hold on to is indicated by its water absorption capacity. Additionally, it improves the digestion of meals. Food deterioration and eventualrottating can becaused by an excess of water. According to literature, the oil absorption capacity of defatted persimmon starch, as seen in Table 3, is 347.00%, greater than that of plantain and banana starch. When employed in food preparation, a high oil absorption capacity enhances flavor and mouthfeel.This study's foaming capacity value is 12.69%.

According to recent findings, there was a significant difference in the foaming capability of persimmon starch and open sun-dried cassava starch (14.363%) and solar-dried cassava starch (11.417%), respectively. Since the surface activity of proteins affect foaming capacity, all starches can be rated as having a low foam capacity because they do not contain a significant amount of proteins and observed that the foaming stability of defatted persimmon starch was 3.26 percent, which is lower than the 60.193% obtained for oven-dried cassava starch. The amount of oil, water, non-polar amino acid residue left on the surface of proteins, and other ingredients in the diet are all connected to emulsion capacity (EC).Compared to other foods, the defatted persimmon starch has a lower emulsion capacity percentage of 45.48%. This could be the case due to the fact that starches are polysaccharide that primarily increse the viscosity of the aqueous phase in emulsions, acting as a stabilizers. 50.00% is the emulsion stability value derived from defatted persimmon starch.The steadiness of the protein-based emulsion is gauged by its emulsion stability.Because proteins are made up of charged, non-charged, polar, and non-polar amino acids, they can interact with both water and oil components in food systems, making them potential emulsifiers and surfactants with both hydrophilic and hydrophobic qualities.The defatted persimmon starch has a percentage swelling index of 246.67%. The swelling index displays the extent to which water activity has exposed the starch granules' interior structure.It is a gauge of one's ability to hydrate. Persimmon starch yielded a gelation capability of 12.00%.Gelation capability is the ability of a food system including biopolymers, like protein, starch, etc., to form gel. The type of protein and other non-protein ingredients in a meal sample affect the gelation properties.

Table 3: Functional Properties of Defatted Persimmon Starch

Component	Amount (%)
Bulky density	0.42±0.02
Water absorption capacity	513.33±11.54
Oil Absorption capacity	347±10.75
Foaming capacity	12.69±0.01
Foaming Stability	3.26±0.08
emulsion capacity	45.48±0.03
emulsion stability	50.00±0.00
swelling index	246.67±11.55
Gelation capacity	12.00±0.00

Values are expressed as mean ± standard deviation of triplicate readings.

Means with different letters in the same column are significantly different in the same column at the $p \leq 0.05$ level.

The pasting charactertics of the defatted persimmons starch are displayed in Table 4. The transformation that occurs in food when heat is applied in the presence of water is known as the pasting property of food material.There could be an impact on the food product's final use, digestion, and texture. The highest viscosity of the flour made from persimmon starch was 14.0 RVU, which is less than the native tiger nut starch's 270.5 RVU. The highest viscosity attained shortly after or during cooking is known as peak viscosity. It is a sign of the starch's ability to bind water. The strength of the paste created by gelatinization during food processing is indicated by peak viscosity. Strong peak viscosity is correlated with strong starch thickening capacity. This study's finding for persimmon starch's peak viscosity points to a limited thickening capacity.Table 4's persimmon starch setback value is 4.00 RVU.This number is much less than the 85.3 RVU for tiger nut native starch and found that the rate of synresis and crying decreased with increasing setback value.

This study's low setback value for persimmon starch suggests a high retro gradation value. The temperature at which viscosity starts to increase is known as the pasting temperature. The fact that the persimmon starch obtained for this study had a pasting temperature of zero (0) suggests that the starch was not viscous. During processing, low pasting temperatures guarantee swelling, gelatinization, and gel formation. The defatted persimmon starch used in this investigation had a breakdown viscosity of 2.00 RVU. The constancy of peak viscosity during processing is reflected in breakdown viscosity. A lower breakdown viscosity of starch makes it more resistant to shearing and heating during cooking. Peak time is also known as the cooking time measurement. It is the amount of time needed for the starch to reach its maximum viscosity. The persimmon starch peak time was 5.67 minutes. The persimmon starch obtained had a final viscosity of 16 RVU.A measure of starch's capacity to create a viscous paste is its final viscosity. The ultimate viscosity of native water yam starch was raised by modification employing acetylation and oxidation and a high ultimate viscosity of starch means that the paste is more resilient to mechanical shear and may readily form a more rigid gel; however, the value found for persimmon starch in this work is the opposite of what is expected. Food product including soup, sauces, and dressing need to have a high final viscosity. In this investigation, the trough viscosity a measure of a paste's capacity to degrade with standing and cooling was low (12.00 RVU). This suggests that when cooled, persimmon starch flour will dissolve easily.

Table 4: Pasting Properties of Defatted Persimmon Starch

Pasting Properties	(RVU)
Peak Viscosity	14.00
Trough Viscosity	12.00
BreakdownViscosity	2.00
Final Viscosity	16.00
Set-back Viscosity	4.00
Peak Time (Min)	5.67
Pasting Temperature (°C)	err

Figure 1 shows the amount of amylose and amylopectin in defatted persimmon starch flour. About 30% of starch is made up of amylose, an essential component, and the remaining 70% is made up of amylopectin. The flour made from defatted persimmon starch included 20.50% amylose and 79.50% amylopectin, respectively. Food starch digestibility is determined by the amount of amylose it contains. Because starches with lower amylose and amylopectin contents are more easily digested than those with higher amylose and amylopectin contents, amylose content is important for starch digestion. Bases on this investigation, it was found that the amylose concentration of defatted persimmon starch matched that of native starches (15-30 %), sweet potatoes (10.1-20.2%) and cassava (17.9-23.6%). Compared to cocoyam and yam (26.7%), the amylose content found in this study was lower. Foods high in amylose digest more slowly than foods low in amylose, and they also have a lower tendency to raise blood sugar levels. Figure 1 shows the defatted persimmon starch flour's in vitro starch digestibility. This study found a moderately high starch digestibility of 63.68%, which may have resulted from the high amount of amylose and amylopectin and low fiber content. This outcome is similar to that of miracle berry seed starch flour. According to a survey, the kind and quantity of crude fiber in diet can affect how easily starch is absorbed. By trapping starch granules inside the viscous protein-fiber-starch network, high crude fiber content in diet may slow down the rate of starch digestion. Therefore, the starch found in the defatted persimmon used in this study might not be appropriate for use in the creation of functional foods intended to aid in weight loss and the management of diabetes.

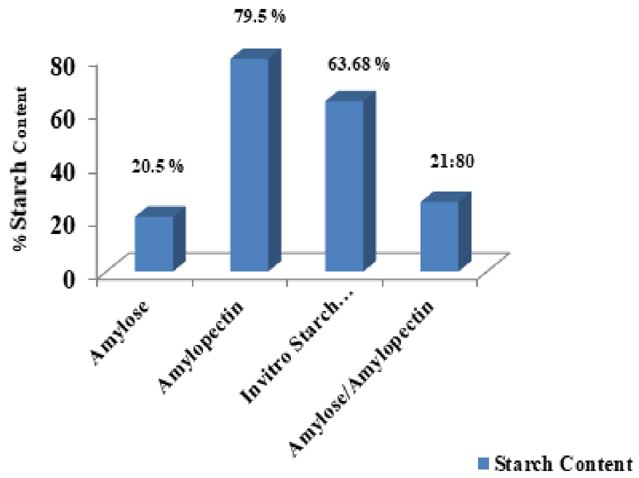
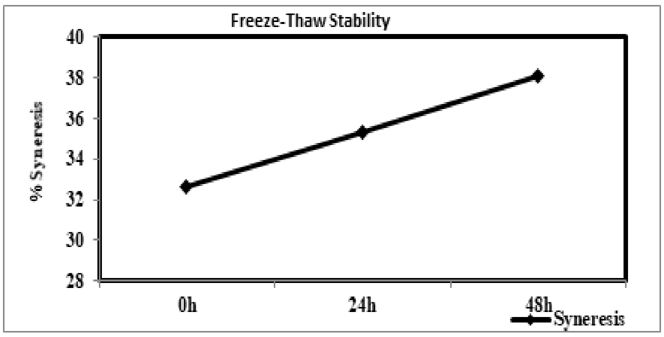


Figure 1: Defatted Persimmon Starch Content

The ability of starch to tolerate certain physical changes that happen during freezing and thawing is known as the ‘‘ freeze thaw stability’’ phenomenon. Products that need to be stored at low temperatures are especially affected. Figure 2 displays the freeze-thaw stability of the defatted Persimmon starch gel at 40 °C for 24 and 48 hours in this investigation. According to the results, which varied from 32.63% to 38.06%, syneresis rose as freezing days increased. Its low setback value (4.00 RVU) could be the cause of the rise in water released from defatted Persimmon starch gel during the freezing and thawing procedure, which lasted for 48 hours and found that the rate of syneresis and weeping decreased with increasing setback values. Based on the results, defatted Persimmon starch gel has a tendency to retrograde faster because syneresis is related to the tendency of starch to retrograde and found a higher value of syneresis for yellow (65%) and black (68%) maize. The results of this study were closer but higher than the 22.3% for starch syneresis of the fedearroz rice variety. Reported on samples produced with native corn starch, suggesting their susceptibility to syneresis.

Figure 2: Freeze-Thaw Stability of Defatted Persimmon Starch



Defatted persimmon starch has a swelling power ranging from 3.15 to 4.72%. From 30 to 90 degrees Celsius, swelling power increased as the temperature rose. This study showed that defatted persimmon starch has a lower swelling power than cassava flour (9.233–12.513%).The micellar network inside the starch granules, which is the main component influencing the swelling behavior of starch, may be the reason for the poor swelling power of defatted persimmon starch. Experimental worked reports that a strongly linked starch that has a micellar network structure that is substantially strong-bonded is easily resistant to swelling. This suggest that the strength and character of the starch's micellar network were diminished by the temperature increase. The swelling strength decreases as the amylose content increases. The swelling power of starch is dependent on amylose's capacity to solubilize in water and let starch granules to absorb water. According to the swelling power value, a rise in temperature may have weakened the starch granules by facilitating interactions between the bulk amorphous regions' amylose (a water-soluble fraction) molecules and the crystalline regions' branched amylopectin (a water-insoluble fraction) segment. The protein and starch compositions of flour samples are mostly responsible for their swelling power. According findings flour with greater protein content may have starch granule trapped in a rigid protein matrix, limiting starch's access to water and preventing swelling. Defatted persimmon starch ranged in solubility from 1.98 to 3.17%.When temperatures increased from 30° C to 70°C, solubility showed a modest increase (1.98–1.9%), and at 90° C, solubility increased to 3.17%, with a margin of 1.18%.These values for cassava starch are significantly less than the 7.57% and 10.46%.Since the solubilized amylose molecules leach from the swollen starch granules of flour, the low solubility found in this study may have been caused by the amylose concentration.

Figure 3: Swelling Power & Solubility Curve of Defatted Persimmon Starch

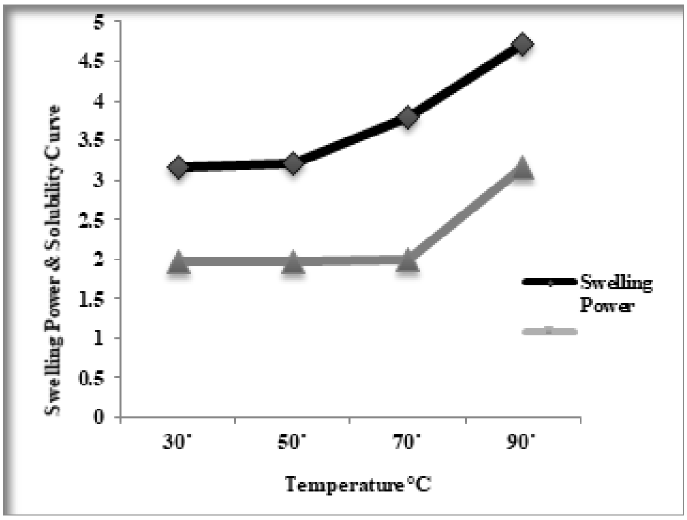


Figure 4 displays the color characteristics of defatted persimmon starch. The results show that the values for hue (h*), chroma (c*), yellow-blue (b*), red-green (a*), and lightness (L*) are 8.11, 20.45, and 22.00, respectively.

Figure 4: Colour Properties of Defatted Persimmon Starch

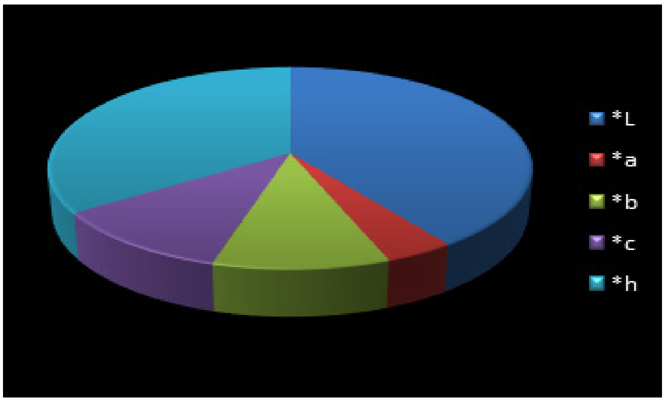
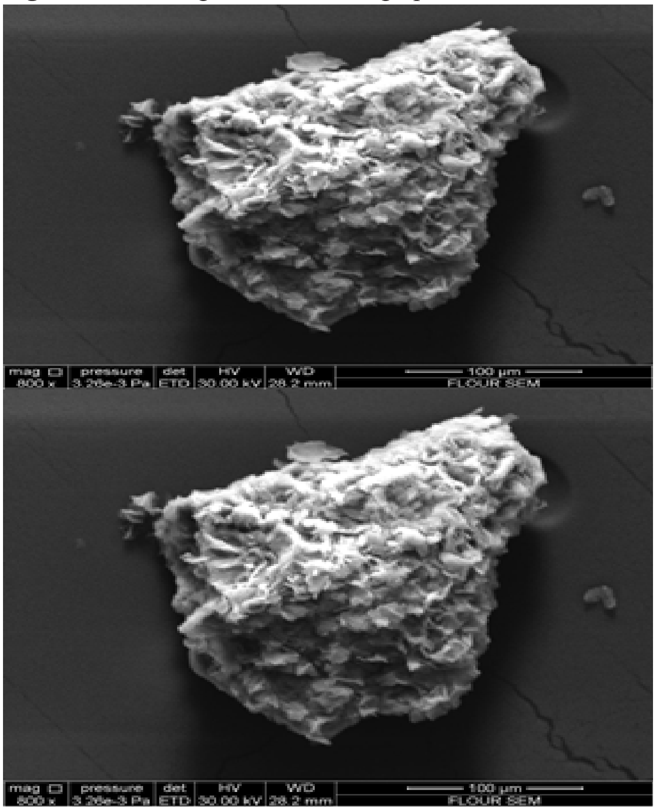


Figure 5 displays the defatted persimmon starch scanning electron micrograph. Granules of starch were present in a solitary, uneven, rough cluster with sharp points. Clusters of starch granules have been linked to residual protein and drying conditions and described an oval smooth surface granule with different diameters for native tiger nut starch. Granules with an oval and circular shape were described for native jack bean starch.

Figure 5: Scanning Electron Micrograph of Persimmon Starch



Conclusion

This investigation has proven that defatted persimmon starch is a valuable source of carbohydrates. Additionally, it has certain minerals that improve the body's metabolic processes, bone growth, acid-base balance management, and nerve impulse transmission. This shown that defatted persimmon starch is a fascinating nutritional source with possible applications in the food sector. The findings of the study indicate that defatted persimmon starch has protein content and requires dietary supplementation to fulfill the recommended intake for adults and children.

Acknowledgement

We truly acknowledge the Blue Dart courier. Internationally domestic, securely hand the box of American tomatoes and protect them from environmental and residual impurities.

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