Research Paper Chemistry

Physicochemical Charaterization of Starch Extracted from Sorghum Sorghum Bicolor Moench

Abubakar Ahmed Hamidu Department of Chemistry Adamawa State University,Mubi,Nigeria.

Tumba Philip Gambo Department of Chemistry, Adamawa State University,Mubi,Nigeria.

ABSTRACT

Starch was extracted from sorghum by steeping in distilled water, wet grinding and centrifuging or sedimentation. The isolated starch was characterized for total starch content of starch content and the physiochemical properties of Amylose/ Amylopectin ratio, moisture content, ash content, PH , Phosphorus content, water absorption capacity, water solubility content index and swelling power. Result from the analysis showed a total starch content of 68.51% and a value of 18.70% and 81.30% amylase/ amylopectin content. The values of 9.20% and 0.65% and 0.11 %(110.10mg/kg) were obtained for moisture, ash content and phosphorus or lipid content respectively. The PH of the extracted starch was found to be 5.80.From the results, there were indications of some degree of resilience and a high degree of swelling due to the high amylopectin content which may contribute to high degree of swelling power and swelling index. The low moisture content could be an indications of improves shelf life presence of some minerals for increased applications. The functional properties of water absorption capacity, swelling power and index increased with increase in temperature. These properties show convincingly that the quality of starch obtained can be utilized industrially with the food industries and drug related industries as potential beneficiaries.

KEYWORDS

INTRODUCTION

The need for seeking complimentary sources of raw materials that could replace or complement the existing once has scaled up researches to explore new and better alternative. Natural endowments include botanical resource which are abundant rich in most of the raw materials and are usually left untapped.

Among these botanical resources is starch, which is a polysaccharide produced by all green plants as an energy store (1).It is a carbohydrate which comprises of a large number of glucose units joined together by glycosidic bonds (2).These bonds are covalent bonds that join one carbohydrate sugar molecule to another group, which may or may not be carbohydrate groups.

Starch has been traditionally been extracted from the botanical sources from the staple foods of potatoes, wheat, maize (corn), rice and cassava to mention but a few. These are made up of basically two components: amylase (10-25%) and amylopectin (75-90%).

The Amylose consist of 250-300 D-glucopyronoside units connected by α 1, 4- linkages in a linear form. It is not soluble in water but soluble in hot water and gives a blue colour with iodine solution. The Amylopectin, is composed of more than 1000 α 1, 4- linkages with 1, 6 branching points (3).Starch has numerous applications in both food and non-food industries. It's uses in the food industry include food additive, custards, noodles,pestles,salad dressing and a lot more (4) .It is also used in the pharmaceutical industry more especially as a matrices in drug delivery systems and encapsulations (5).Other uses of starch include; in adsorbent, in the production of bioplastic and in the production of biodegradable materials (6,7,8).

Despite the above mentioned application, researchers have continued to develop numerous products that have greatly expanded starch use and utility. This has ultimately led to the high cost of the staple sources of yam, cassava, and potatoes to mention but a few, hence the need for newer sources to be researched upon.

In line with this, many research works have been carried out on the alternative sources of M.indica and C. aibidun which are usually discarded(8,9).Another common cereal crop used in mostly in the manufacture of local beer which bears some social ills. Therefore, this research is aimed at extracting and characterization in terms of both functional and physicochemical properties of starch from Sorghum (***Sorghum bicolor moench***), in order to ascertain its usefulness as an alternative source of cheap starch for Industrial applications.

MATERIALS AND METHODS

3.0 Materials

The seeds of Sorghum bicolor L. Moench were collected from waste sites around Mubi North local Government Area of Adamawa State. This was identified by the experts in Botany of the Department of Biology, Adamawa State University, and Mubi.The seeds were thoroughly washed with distilled water, dried and stored in an air tight container before extraction of the starch. All chemicals used for this analysis were of analytical grade.

3.2 Methods

3.2.1 Extraction of Starch

The extraction process was carried out according to the methods described by (10) with slight modifications. This involved the steeping 100g of the grounded starch in 200ml NaOH (0.25% W/V) at 5^0C for 24h.This was washed and blended with an equal volume of water filtered, centrifuged repeatedly until a top white layer was seen. The total starch content was determined out of 100g of the sample used.

3.3 Physicochemical Characterizations

3.3.1 Amylose/Amylopectin Content.

This was carried out in accordance with the methods described by (11) as modified by (8).This involved the suspension of a weight 2g in 50ml beaker containing distilled water. At the ratio of 1: 9 butanol : water. This mixture was continuous-

ly and gradually added to the boiling mixture. Another mixture of water to alcohol at the ratio of 1:1 was also added and allowed to cool over a water bath. The supernatant mixture was filtered and the microcrystalline precipitate formed as a result of the cooling process was washed repeatedly with butanol saturated with water dried in an air oven and weighed. This procedure was repeated twice and the mean values were taken as the percentage amylase content. The supernatant was also repeatedly washed with methanol and the precipitate dried in an air oven. This was also weighed to determine the amylopectin content.

3.3.1.1 pH
This was done in accordance with the methods describe by (12). This involved the shaking of 5g of the starch sample in 20mls of distilled water for 5minutes.This was continuously stirred with a magnetic stirrer and left for 10minutes to settle. The pH of the supernatant was determined using a pH meter model 827 initially calibrated using standard buffers of pH of between 4 and 7.

3.3.1.2 Water Absorption Capacity
This was done according to methods described by (13).This involved the dispersion of a weighed (W_i) starch sample in distilled water for 2 hours. The beaker was then weighed after 2 hours and the weight recorded as W_f .The water absorption capacity of the starch sample was determined by the mathematical equation below;

Water absorption capacity= (W_f- W_i)

Where:

$W_{f=}$ the final weight after dispersion

W_i = the initial weight before dispersion.

3.3.1.3 Moisture Content
This was also determined in accordance with the methods described by Mweta, 2009(13).This involved the drying of the starch samples in at 1050°C for least 24 hours until the weight became constant. The moisture content was determined using the mathematical relationship below:

Moisture Content = 100-(100× ($W_2 – W_0$)/ ($W_1 – W_0$)

Where;

W_0 = weight of empty porcelain dish

W_1 = Weight of porcelain dish + sample

W_2 = Dry Weight of porcelain + sample

3.3.1.4 Ash Content
This was determined according to the methods described by (15).This was one by first heating the crucibles in a furnace for 3hours at 575°C .This was then cooled at room temperature in desiccators for 1hour and weighed. The crucible with the sample was heated at to 300°C and cooled for 1 hour in a desiccator, removed and immediately weighed. The ash content was determined from the mathematical equation below;

Ash Content = 100× ($W_2 – W_0$)/ ($W_1 – W_0$)

Where;

$W_{0=}$ Weight of empty dish

W_1 = Weight of dish + sample before aching

W_2 = Weight of dish + ash

3.3.1.5 Phosphorus Content
This was also determined according to the methods described by (12).This involved the aching of 2g of the starch sample into a 150ml ceramic beaker at 550°C for 5hours.This cooled in a desiccators, mixed with 100mls of1M HCL followed by the addition of 1ML of 1M HNO_3.The resulting mixture was boiled, cooled an transferred to a 100ml volumetric flask and the volumes made up to the mark with distilled water. Aliquots (1ml) in triplicates were transferred into test tubes and mixed with 9ml of Murphy-Riley solution. The absorbance of these mixtures was taken against the blank.

3.3.1.6 Swelling Power and Solubility Index
The methods described by (14) were adopted for the following analysis. This involved the weighing accurately 0.4g of starch (dry basis) in a centrifuge tube before adding 4mls of distilled water. The slurry was heated at 0,50,60 70 and 80°C in a water bath for 30minutes.After cooling the samples to room temperature, the solutions were centrifuged at 3000rpm for 15minutes.The supernatant was carefully removed, and the swollen sediment was weighed. The aliquot of the supernatant was evaporated overnight at 110°C and the swelling power and the solubility were calculated as follows;

Swelling Power (g/g) = Weight of the wet sediment (g)/weight of the dry starch (g)

Solubility (%) = Weight of dry supernatant (g)/ weight of dry starch (g) × 100

RESULTS AND DISCUSSIONS
Table 1: Physicochemical Properties of S.bicolor moench Starch

Parameter	Composition
Starch Yield (%) in H_2O	68.5
pH	5.80
Moisture Content (%)	9.20
Ash Content (%)	0.65
Phosphorus Content(mg/kg)	110.10
Amylose content (%)	18.70
Amylopectin Content (%)	81.30

Table 1 shows the result of physicochemical analysis of the starch under the investigation. From the table, the percentage yield of starch was extracted using water or soaking method was 68.5% .This value is greater than value of 39.2 % on obtained from the seeds of Faidherboa Albida, 22 to 31% for horse gram starch and 42.2% for rye starch but less than for sago, potato, and corn starch, with the values of 93.6%, 93.4% and 86.5% respectively as reported in the studies of(15).

Starch pH
From the table, the results of the starch pH with the value of 5.80 fall short of the standard of the world health organization of the limits (6.8-7.2).

Proximate Analysis
The result of the proximate composition analysis carriedout on Sorghum starch showed that starch had a value of 9.20% moisture content is in agreement with the values for tubers, cereals and root crops of between (8- 16.5%) and within the acceptable British standard limit of not more than 15%.The low moisture content may suggest that the starch will not undergo deterioration very quickly and therefore resulting in an improved self life .

The ash content value recorded for sorghum was a low value of 0.65% which suggests the presence of some minute quantities of metal with little interference on the physical and chemical properties of the starch. This may have resulted in the high starch yield.

Phosphorus in starch exists naturally in two forms, phosphate esters or phosphate lipids. Root and tuber starch contain phosphorus in the forms of mono phosphate lipids covalently bonded to the starch while phosphate lipids are predominantly present in cereals. The quantity varies with species determined by environmental disposition (8).

In line with this, the phosphorus content of the starch been investigated was 110.10mg/kg or (0.0063 to 0.013%) significantly varying by (p≥ 0.0001) with the sources. The value of phosphorus content obtained for sorghum starch in this investigation is within the range of 63.35 to128.75mg/kg for the world health organization (16).

Amylose Content

The amylase content of the starch was 18.70% which was lower than the values of 26.7% and 25.2% obtained for starches of ***Faidheria albida and*** Oat respectively but higher than corn starches with the values of 16.90%.Also, the amylase content falls within the limits of values within the range of (11.6 to 88%)().The crystalline nature of starch is determined by its amylase content and thus affects its solubility(), and this plays an important role in determination its applications(17).

Figure 1 shows the water absorption capacity of sorghum been investigated. This is to advance an understanding of the water holding capacity of the starch which will ultimately contributes the applications of the starch.

From the table, it was observed that, the percentage water holding capacity increased with increasing temperature.

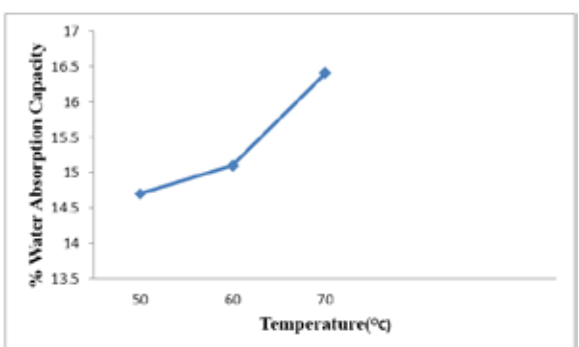

Figure 1: Effects of Temperature on Water Absorption Capacity.

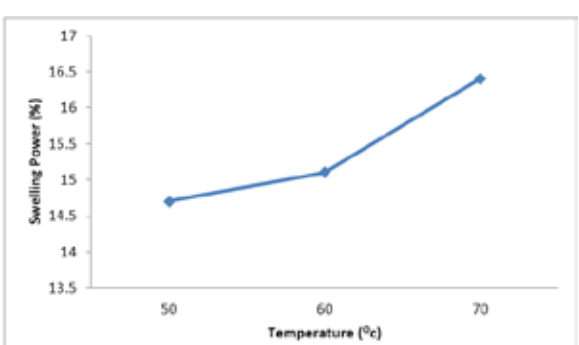

Figure 2: Effects of Temperature on Swelling Power.

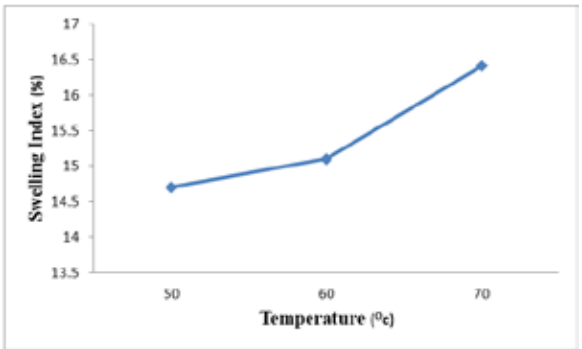

Figure 3: Effects of Temperature on the Swelling Index.

Figure 2 and Figure 3 show the swelling power and the swelling or solubility index of the starch been investigated. From the figures, it can be seen that, the swelling power and solubility index was steady at the lower temperatures of 50 to 60°C but rose steadily as the temperature increased to 70°C. There was however, no considerable increase in swelling as the temperature rises from 50 to 90 °C.

This observation was not unconnected with the fact that the swelling property of starch is attributed to the strength and character of the miceller network in the starch granule. As the temperature is increased, the starch granules vibrate vigorously. This results in breaking the intermolecular bonds and allowing the hydrogen bonding sites to engage more water molecules (18).

Studying the swelling power and solubility index provide evidence of the level and magnitude of the interactions between the amorphous and the crystalline regions in the starch chains (19), (17) and (13).The extend of interaction is however boosted by the ration of amylase and amylopectin content, molecular weight distribution, degree of branching, length of branching and conformation of molecules (20).

CONCLUSION

From the analyses of the starch obtained fron Sorghun bicolor moench, the following conclusions could be made:

(i) The physicochemical properties of the starch obtained were comparable to the values in the literature, a few of the properties still show variations from values obtained for other sources of starches for instance potato, sago, and corn to mention but a few.
(ii) The yield of starch as reported in this study is an indications that sorghum could be exploited maximally as sources of starch for food, drugs and polymer related industry.
(iii) The starch obtained may require some form of modification for use in as a raw material for use in the industry
(iv) The high value of amylopectin may indicate its usefulness as a potential source of material for the production of matrices for sustainable drug delivery systems and hydrogel systems.

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