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Physicochemical properties of starch extracted from sorghum grains

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ABSTRACT

A wide-going farming advancement of starch has fixated on monetarily significant cassava, potato, maize and rice. Starch fundamentally adds to the finished properties of certain customer products and is every now and again utilized as a thickener, colloid stabilizer, solidified operator, building specialist and water holding specialist, in food and modern applications. The investigation centers around the characterization of the starch extracted from sorghum, an inadequately-used crop and that may substitute or upgrade the current supplies. The rate yield of sorghum starch was seen as 69.25% which was over the top than different sources. The amylose:amylopectin proportion was determined as 12.8:87.2 in this manner adding to a serious extent of swelling. The low estimation of moisture content could be a sign of improve timeframe of realistic usability and existence of certain minerals for expanded applications. The assessment of the physicochemical properties further helped in the utility of the extracted starch. The utilitarian properties of swelling power and water solubility index (WSI) expanded with increment in temperature. These properties show convincingly that the nature of starch got can be modernly used as potential beneficiaries by the food industry and drug industry.

Key words: Sorghum starch, rate yield, physicochemical properties, swelling power, water solubility index (WSI), food industry

In order to identify different and improved potential sources of compatible raw materials that may supplement, augment or enhance current supplies, the purpose of research has been extended. Natural resources provide botanical products high in certain raw resources, but are commonly left unused.

Starch being one of these botanical commodities is nowadays of immense value and importance to mankind. Starch had become a vital aspect of human nutrition and it is included in certain basic necessities such as cereals(e.g. rice, wheat, barley, sorghum, corn, oats); legume (e.g. lentil, bean, pea) and tuber (e.g. potato, sweet potato, yam, cassava, taro). Pure starch is a white, bland and inodorous powder which exists as water-insoluble granules with particular morphology in various plants; ranging from round, oval, ogival or lengthened to level, lenticular or polyhedral, and sizes ranging from 0.1- 200μm in width (*Hoover*, 2001; *Singh et al.*, 2003).

Sugar molecules composed of two forms of amylose and amylopectin α-D-glucan chains are known as starch. Different structures and compositions of the starch molecules formed for burgeoning vegetation types can differ considerably with protein and fat in storage systems. Therefore, starch differs depending on the source. This inherent functional diversity due to the different biological sources enlarges its

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range of industrial uses (*Santana et al.*, 2014). The utility of starch in many food items is currently increasingly prominent. Starch significantly adds to the textured properties of certain consumer items and is frequently employed as a thickener, colloid stabilizer, frozen agent, bulking agent and water retaining agent, in food and industrial applications (*Moo et al.*, 2015; *Syahariza et al.*, 2017; *Zhou et al.*, 2018). While starch is present in many plant tissues, it is primarily extracted from cereal grains and tubers commercially (*Daudt et al.*, 2014).

A wide-ranging agricultural development of starch has centered on economically important cassava, potato, maize and rice.Nevertheless, a significant proportion of starch is similarly used as a source of staple foods from these crops. Sorghum has become a source of substitute starch in underutilized crops, and may be used as a substituting source of cereal grains. Sorghum is a subtle source of starch (Olayinka *et al.*, 2013). *Sorghum bicolor* is the fifth most significant grain crop after wheat, rice, maize, and grain regarding creation (*Beta et al.*, 2004; *Waniska et al.*, 2004). It is an imperative food crop for many individuals in parts of Africa, Asia and Latin America (Beta *et al.*, 2004; Dicko *et al.*, 2006).India grows the world's biggest acre of sorghum led by Nigeria and Sudan and the second highest tonnage behind the United States of America. This is grown as both rainy and post-rainy season crops in most regions of India (FAO, 2009; Nadia *et al.*, 2009).It continues the lives of the least fortunate provincial individuals and frequently alluded to as "coarse grain" or "needy individual's crop." However, with expanding total populace what's more, diminishing water supplies, it is anticipated as a significant future yield. Despite the fact that sorghum is major cereal crop and looks like maize when all is said in done organization, it is viewed as substandard compared to corn for food, feed what's more, modern use. Sorghum based food items possess a low situation in an eating regimen because of poor grain quality characteristics. The dim shading, high fiber content, articulated flavor, coarseness of flour and trouble to cook into the delicate items like bread, roll, pastries, cakes, baked goods, are a portion of the detriments (*Shinde et al.*, 2004).Unutilized stockpile sorghum could be used for the development of starch and starch-based sugars. The procedure is prone to be practical as sorghum is accessible on huge scope with minimal effort. Sorghum grain comprises 68-75% starch, based on cultivar, region and climatic conditions(Shinde, 2005; Singh *et al.*, 2009)..

This work is therefore intended at extracting and assessing starch from Sorghum grains in aspects of its functional characteristics to assess their usage in the industrial sector as a potential cheap source of starch.

MATERIALS AND METHODS

The experiment was carried out at Laboratory of Department of Food & Nutrition. The experiment was conducted over a period of six months. The Sorghum grains were purchased from the local general store of south city, Lucknow, India. All chemicals and equipments used for the extraction and analysis were of analytical grade.

Extraction of Starch:

The method used for extraction of starch was described by Shinde *et al.*, 2004, with certain modifications elaborated by Udachan *et al.*, 2012. Sorghum grains (250 g) was weighed and cleaned thoroughly in distilled water to remove the dirt and extraneous matter. The washed grains were soaked at the room temperature for 24 hours in 500ml of distilled water (1:2w/v) with another 2 ml of benzene. In addition a very low concentration (0.001M) mercuric chloride was added into the steeping water. The steeped grains were further washed and pulverized using a mixer grinder and the slurry was further steeped in 500 ml of NaOH (0.25% w/v).The steeped slurry was stirred for 2 hours using magnetic stirrer and then kept at 5°C for 24 hours. The slurry was filtered using muslin cloth completely while rinsing the residue with water. The filtrate obtained was allowed to stand for a couple of days in the refrigerator for comprehensive sedimentation of the crude starch. The upper supernatant was siphoned off and the crude starch was obtained. The crude starch was filtered by suspending in distilled water (1:5 w/v) and NaCl was added to accomplish the last fixation to 0.1M. Further toluene was added to the suspending medium in the ratio of 3:1(v/v). The medium was continued shaking for 1-2 hours and then centrifuged at 4000rpm for 10minutes. The toluene layer with the protein part was discarded. Then the starch was refluxed with 80% aqueous methanol for 12 hours. It was washed with acetone and afterwards ether. The starch was washed with distilled water a few times and continued towards drying at 45°C for 4 hours in a dehydrator. The dried pure starch was stored in plastic zipper pouches until further use.

Physico-chemical Characterization of extracted starch:

Bulk density

A known weight of the starch was poured in a 10 ml graduated cylinder and the volume was noted. The bulk density was calculated as,

$$\text{Bulk density (g/ml)} = \frac{\text{weight of the starch (g)}}{\text{volume of the starch (ml)}}$$

True density

True density was determined by adding 5 g of starch powder in 25 ml toluene in 100 ml measuring cylinder. The final volume was noted and true volume of starch powder sample was determined from as,

$$\text{True density (g/ml)} = \frac{\text{weight of the starch (g)}}{\text{true volume(ml)}}$$

Porosity

Porosity is the level of air between the particles contrasted with a unit volume of particles.

Porosity of the extracted starch was estimated by,

$$\text{Porosity(\%)} = \frac{\text{True Denisty- Bulk Density}}{\text{True Density}} \times 100$$

Moisture Content

Using moisture analyser, the moisture contents were determined. 5 g of the sample is placed at 180°C in the moisture analyser. The process persisted until all moisture was dissipated.

pH

The 5g of the starch sample was weighed and blended appropriately with 15ml distilled water. The blend was poured into boiling distilled water to makeup 100ml of slurry.The slurry was permitted to cool. Utilizing a digital pH meter, the pH of the slurry was estimated.

Amylose:Amylopectin ratio

The method described by Muazu *et al.,* 2011was used to measure the amylose:amylopectin ratio.2g of the extract was suspended in 50ml distilled water. A 1:9 butanol:water mixture was added with continuous stirring and heating to boiling. Butyl and amyl alcohol (1:1) was added to the boiling suspension which was then allowed to cool in a cold water bath. The supernatant liquor was decanted and the microcrystalline precipitate formed was washed repeatedly with butanol saturated with water, dried in oven and weighed. The supernatant was precipitated with excess methanol and the precipitated was dried in an oven and weighed to determine the ratio of amylopectin.

Swelling Power & Water Solubility Index (WSI)

The estimation of swelling power and water solubility index was determined by Claver *et al.*, 2010. In a water bath, a suspension of 0.10 g of starch and 6 ml of distilled water was heated was acceptance of the food from consumer's standpoint. heated in the range of 30°C-80°C for 30 minutes. The suspension was quickly refreshed and centrifuged at room temperature at 8,000rpm for 20 minutes. The ratio of dry mater supernatant to dry starch was reported as WSI, whereas the proportion of swelling of starch granules from sediment to dry starch was reported as SP.

Oil Absorption Capacity (OAC)

Method of Sindhu and Khatkar 2016 was used for determining the oil absorption capacity.3ml refined groundnut oil was added to 0.5g of sample and mixed for 1 minute. Following 30 minutes at room temperature the cylinders were centrifuged at 3200 rpm for 25 minutes. The volume of unabsorbed oil was resolved.

Data Analysis:

All the above mentioned procedures for characterization of the extracted starch sample were done in triplicate and their mean value was calculated as the final value.

RESULTS AND DISCUSSION

Starch Yield:

The individual weights of the isolated starch and the sorghum grains used were measured to assess the extracted starch yield.The assurance was done in triplicate and the mean value was considered. The percentage yield of sorghum starch was found to be 69.25%. It was observed that the starch yield of sorghum was significantly higher than the starch yield of the millet, wheat and rice varieties isolated by Verma *et al.* 2018.The yield percentage was compared to the percentage yield of potato (14.49%), cassava (29.41%) and maize (45.85%) starches found in the study conducted by Kundu *et al.*, 2011.

Physicochemical Properties:

Appropriates of production process, product design and development management, product formation, food quality assurance and food process mapping are essential to understand the characteristics of food. The physicochemical characteristics of a consumer commodity or an element decide the end-use. This explains the appearance, taste and feeling of ingredients during processing and cooking of the end products. The characterization of the utilitarian properties is fundamental to theoretical and applied investigations in Food Science and Technology. This is often the basis for establishing the nutritional value and overall The physicochemical properties of the extracted sorghum starch are compiled in table 1.

Table 1 Physicochemical Properties of Extracted Sorghum Starch

Parameter	Value
Bulk Density (g/ml)	0.78
True Density (g/ml)	1.63
Porosity %	31.96
Moisture Content %	8.40
Ph	6.3
Amylose: Amylopectin Ratio	12.8:87.2
Water Solubility Index(WSI) %	17.5
Swelling Power (g/g)	19.1
Oil Absorption Capacity(OAC) %	14.8

All the physico-chemical properties play a major role to swelling, pasting properties, viscosity and gelatinization temperature of the starch thereby describing its utility. The true and bulk density has an impact on the texture and mouthfeel of the food. Higher porosity brings about more noteworthy contact with climatic oxygen, along these lines higher pace of auto oxidation. In the current investigation the amylose and the amylopectin content of the separated sorghum starch was ascertains as 12.8% and 87.2% individually. This outcome was in conjuction with the outcomes determined by Udachan *et al.*, 2012 for starch separated from local assortments of sorghum(CSH-9, CSH-5, Dadar and Parbhani) produced in India. The moisture content and pH of the derived starch is close to those of the previous analysis. Among the two experiments was noticed a substantial connection.

It has been found that the swelling power has a temperature feature between 40°C-80°C and the graph is shown in Figure 1.The intensity and nature of the micellar network within the starch granule is the swelling power of the starch. With the rise in temperature, the starch granules were more profoundly jiggled, violating intermolar connections and allowing hydrogen linking sites to moleculate more water. A pattern similar to that of swelling power was also observed in the water solubility index(Figure2).

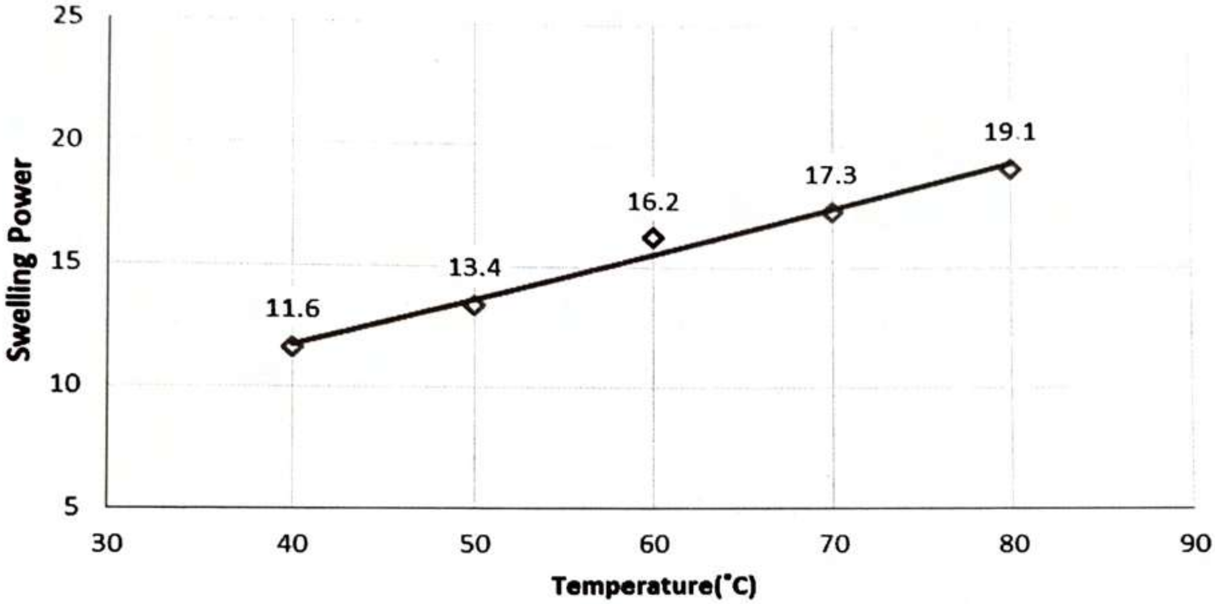

Figure 1 Effect of temperature on Swelling Power of extracted sorghum starch

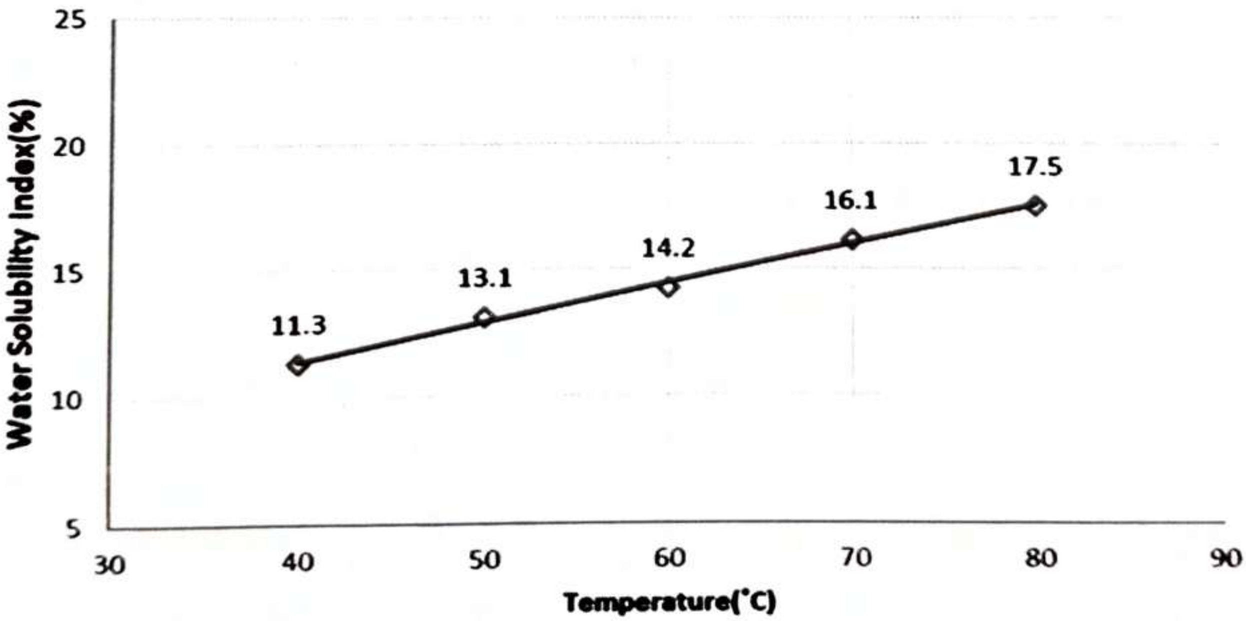

Figure 2 Effect of temperature on the water solubility index of extracted sorghum starch

A noteworthy contrast was seen between the consequences of the current examination and the discoveries of Mir *et al.*, 2017 regarding swelling power and the water solubility index. The growing intensity of corn starches differed from 10.79 to 13.55 g/g in the investigation by Mir *et al.*, 2017, though the growing intensity of the removed sorghum starch was 19.1g/g. The water solubility index for sorghum extracted starch was similarly higher than the values for maize starches determined by Mir *et al.*, 2017.

CONCLUSION

The convention followed in this investigation allowed a decent filtration just as partition of starch granules from the lattice and permitted to get an extraction yield of 69.25%. The yield of sorghum was exorbitant than the other sources of starch like potato, cassava, maize, millet rice and wheat. The yield rate finishes up sorghum as a business and practical wellspring of starch. The low amylose content recommends its compelling use in the arrangement of pie fillings and puddings. All the evaluated properties of the separated sorghum starch have significant job in deciding textural, sticking and thickening properties of starch based preparation. Furthermore adjustments during the extraction may prompt improvement in its utility. The physicochemical properties of the separated recommend that it might have expansive prospects as a fixing in food frameworks and other mechanical application. The present discoveries illuminate extraction and usage of starch from sorghum rather than corn for its business applications in different food enterprises.

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