Environment and Ecology 39 (4A) : 1410—1416, October—December 2021
ISSN 0970-0420

Study on Physico-chemical and Sensory Quality of Chilli Sauce with Native and Modified Jackfruit Seed Starch

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Received 26 August 2021, Accepted 10 October 2021, Published on 2 November 2021

ABSTRACT

North eastern region of India is very rich with potential source of native starch i.e., sweet potato, discoscorea, jackfruit seed and tapioca. So, it is important to utilize these neglected crops for their use in many food and non-food applications. Non-conventional starches and their value addition have increasingly been gaining importance in recent years because of their potential application as functional ingredients in the development of new products. Non-conventional starches extracted from jackfruit seed have very good market potential. The starches were modified viz., heat moisture treatment and hydroxypropylation crosslinking. Study on physico-chemical, pasting, analysis showed heat moisture treatment modified starch have good scope. The modified starch was used in chilli sauce and study on various quality and sensory parameters were evaluated. High sensory score and low serum separation was observed in chilli sauce with heat moisture treatment modified starch.

Keywords Jackfruit seed starch, Heat moisture treated modified starch, Hydroxypropylation crosslinking, Modified starch, Chilli sauce.

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INTRODUCTION

Today's fast-track families are looking for tasty meals with limited preparation time. Simple to use systems from dry mix gravies, sauces and entrees in box to gourmet desserts rely on thickeners with no cook or minimal hydration temperature requirements. Starch as major ingredients or as an additive is used to optimize processing efficiency, product quality or shelf life, imparts body and mouth feel to the product, improve the nutritional and sensory quality of food. Native starches have limitations that reduce their use at the industrial level. These are insolubility in cold water, loss of viscosity and thickening power after cooking, low shear resistance, thermal resistance, thermal decomposition and fair stability to retrogradation with soft texture (Zhang and Jackson 1992).

They become thick for a short time, and then begin to break down. They do not stand up well to processing and produce a low quality final product. Due to the sub-optical behavior of native starch, modification of starch is the efficient way to improve on desirable functional properties to meet the needs for specific uses. The modifications alter the properties of starch, including solution viscosity, association behavior and shelf life stability in final products. It changes thermal, rheological and stability properties of starches (Sarkar and Jindal 2015, Sarkar 2016).

Starch modification, involves the alteration of the physico-chemical characteristics of the native starch to improve its functional characteristics, can be used to tailor starch to specific food applications (Hermansson and Svegmark 1996).

The jackfruit (*Artocarpus heterophyllus*) highly seasonal fruit widely available in tropical countries of the world however due to its abundance in peak season it is underutilized (Akter *et al.* 2018). At present, India is the largest producer with a production of 1.4 million tons per annum (Sawe 2017). The fruit can reach up to 36 kg in weight and it comprises of approximately 100 to 500 seeds which make up 8–15% of the whole fruit (Tran *et al*. 2015). The seeds are reported to powerhouse of nutrients, containing approximately 14% protein and 80% carbohydrate (Chen *et al.* 2016).The seeds also contain an abundance of starch, approximately 60–70% of its dry weight. However, the seeds are often discarded as they are not usually consumed (Dutta *et al*. 2011).

Chilli sauce is delicacy relished in many dishes. However they have tendency for phase sepaeration and additives are used. So in this light jackfruit is abundantly available so in the present study jackfruit seed starch is explored for application in chilli sauce to improve its quality.

MATERIALS AND METHODS

Starch isolation and modification

Starch from jackfruit seed cotyledons was isolated as per Mukprasirt and Sajjaanantakul (2004). To alter the properties of native starches two types of modifications heat moisture treatment (Collado and Corke 1999) and hydroxypropylation crosslinking (Raina *et al.*2006) were performed. Jackfruit seeds were purchased from local market. All chemicals used for the study were of analytical grade.

Physico-chemical properties of native and modified starches

Moisture content and ash of native and modified starches were determined according to AOAC (2005), Official methods, respectively. Sediment volume was determined as described by Tessler (1978). Water binding capacity of the jackfruit seed tarches was determined using the method described by Medcalf and Gilles (1965). Starch swelling power and solubility was determined by method described by Subramanian *et al.* (1994). The color of the starches was measured by a chroma meter (CR-300, MIN LTA, Japan) as L, a and b values. Pasting properties of native and modified starches were determined by Rapid Visco-Analyzer (RVA) (model 3D, RVA; Newport Scientific Pvt. Ltd., Warriewood, Australia.

Chilli sauce preparation

The steps for preparing chilli sauce at laboratory-scale were as follows: The chilliwere washed with tap water. The chilli and pickling garlic were steamed for 30 min in boiling water. After the chilli seeds were removed, the fusion was blended with vinegar for homogeneity and sieved to remove any skin. Sugar, salt and starch (1 g/100 g) was added at 50 °C. Pasteurization at 100 °C for 10 min, hot filling and cooling at room temperature. The chilli sauce was divided into two lots for properties analysis. The first lot was not subjected to storage test, whereas the second lot was storage at 37 °C for 4 weeks.

Characterization of chilli sauce

pH value and total soluble solid were measured with a pH meter and Hand refractometer, respectively. All measurements were done in duplicate.

Serum separation

For measurement of serum separation, the chilli sauce samples (100 ml) were filled in 100 ml cylinders, sealed with parafilm and stored at 37 °C for 4 weeks. Every week the distance of serum separation (cm) on each cylinder was measured (Robinson *et al.* 1956). All measurements were done in triplicate.

Sensory evaluation

Sensory evaluation was based on taste, mouth feel, color, homogeneity (smoothness and good blend) and overall quality. Every attribute was assigned a suitable quantity by students and staff from College of Home science, Tura on 9-point hedonic scale.

Statistical analysis

Analysis of variance (ANOVA) with Tukey's standardized range test was performed to examine the effect of modification on various physico-chemical and rheological properties of starches. Samples were analyzed at a significance level of $p \leq 0.05$.

RESULTS AND DISCUSSION

Physico chemical properties

The physico-chemical properties and functional characteristics of starchsystems and their uniquenessin various food products vary with starch biological origin. The water binding capacity in commercial starches is important to the quality and texture of some food products because it stabilize them against effects such as syneresis, which sometime occurs during retorting or freezing . Among all native starches native jackfruit seed starch showed higher water binding capacity about 94.52%. Oil binding capacities for native starches was found to be, 92.68, 99.63, 88.48 for native starches. Heat moisture treatment and hydroxypropylated crosslinked starches of jackfruit seed, Oil binding capacities of starches is mentioned in Table 1 increased in heat moisture modified starch and hydroxypropylation crosslinking showed decreasing effect of oil binding capacity on starches. Food eating quality is often connected with the retention of water and oil in swollen starch granules.

Sediment volume

The sediment volume was found to be decreased after heat moisture as well as hydroxypropylation crosslinking modification. The heat moisture treatment lowered the sediment volume of starches to 13.5, which is lower than their native counterpart this may be due to the heat moisture treatment may make the granules resistant to deformation by strengthening the intragranular binding force, and it was speculated that in the annealed starch, swollen gelatinized granules were more rigid, contributing significantly reducing sediment volume. Hydroxypropylated starches also showed decreased sediment volume after modification and the values are mentioned in Table 1. The decrease may be attributed as cross-linking inhibits swelling and thereby reduces the sediment volume.

Swelling power and solubility

Swelling power indicates the water-holding capacity of starch and has generally been used to demonstrate differences between various types of starches and to examine the effects of starch modification. Heat moisture treatment showed profound effect on starch swelling properties and starch swelling properties decreased in all the starches after heat moisture treatment. Hydroxypropylation crosslinking showed decreased swelling power which decreased from

Table 1. Physico-chemical characteristics of native and modified starch (Heat moisture treated starch- HMT, Hydroxypropylated cross-linked starch- H & C. HMT-heat moist treated, H & C- Hydroxypropylated cross-linked starches *average of three values.

Jackfruit starch	Sediment volume (ml)	Solubility (%)	Swelling power (%)	Water binding capacity (% g/g)	Oil binding capacity (% g/g)
Native	17 ± 0.47	12.36 ± 0.22	24.55 ± 0.22	94.52 ± 0.64	92.68 ± 0.28
HMT	13.5 ± 0.17	11.02 ± 0.16	22.1 ± 0.54	99.74 ± 0.42	99.63 ± 0.32
H & C	14 ± 0.22	9.65 ± 0.04	23.86 ± 0.42	89.7 ± 0.53	88.48 ± 0.79

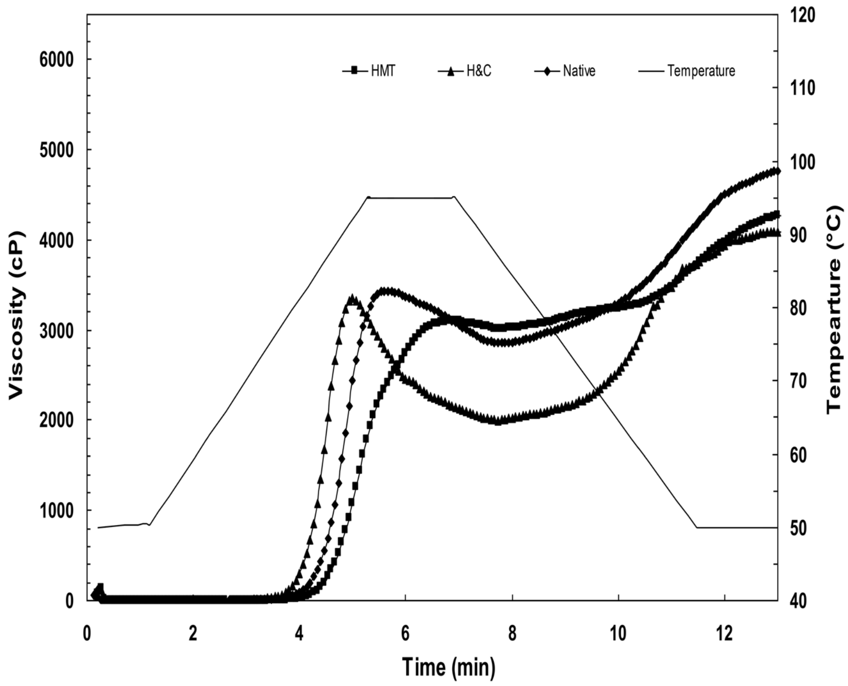

Fig 1. RVA of native and modified starches Jackfruit seed starch (HMT-heat moisture treated starch, H & C- Hydroxypropylated cross-linked starch).

24.55%, in native starches to 23.86% (Table 1), this decrease may be due to increase in hydrogen binding, thereby increase in the temperature required for hydration (Raina *et al*. 2006).

Color

The L, a, b value range for native sweet potato starch was 98.102, -0.0382, 0.517 respectively. Values of L, a, b for other starches are given in Table 2. With modification there is an increase in darkness due to decrease in Lvalues but having other advantages of modified starches, these can be easily used in food formulations without affecting the color quality.

RVA analysis of native and modified jackfruit seed starch

In case of jackfruit seed starch, pasting profile of native starch showed high peak viscosity viz. 3437cP which decreased to 3096 cP in heat moisture treated jackfruit seed. Fig.1. shows the pasting profile of jackfruit seed starch. There was no considerable difference in hot paste viscosities of native as well as heat moisture treated jackfruit seed. Breakdown viscosity was found to be 538 cP in case of native jackfruit seed starch while its value decreased to 238 cP in case of heat moisture treated jackfruit seed. The most important property of heat moisture treatment was its low breakdown viscosity. It showed that the granules were quite strong and resisted to breakdown under shear and heat. The high peak viscosity with low breakdown is a desirable property of the starches because its paste has non-cohesive texture suitable for many food and industrial applications (Singh *et al*. 2006).

Similar pattern of decreasing viscosities was found in case of final and setback viscosities of both native and heat moisture treated starches (Table 3) The decrease in setback viscosity may be attributed to the Newtonian behavior of its starch gel and due to the insufficient time for the starch molecule to align themselves during this measurement (Doungjai and Sanguansri 2005).

Table 2. Effect of treatments on color values of native and modified starches* HMT-heat moist treated, H & C- Hydroxypropylated cross-linked starches *average of three values. Values in the same column with different letters are significantly different (p< 0.05).

Starch source	Mode	*L*	*a*	*b*	*ΔE*
Jackfruit seed	Native	93.942^{b}	0.922^{d}	2.061^{d}	93.97^{c}
	HMT	93.216^{b}	1.305^{e}	2.748^{e}	93.27^{c}
	H & C	93.767^{b}	1.276^{e}	3.051^{f}	93.82^{c}

Table 3. Pasting properties of native and modified starches PV, peak viscosity; TV, trough viscosity; BV, breakdown viscosity; FV, final viscosity; SV, setback viscosity; PTemp, pasting temperature. HMT-heat moisture treated starch, H & C- Hydroxypropylated cross-linked starch Average of triplicate measurements, n=3 Values in the same column with different letters are significantly different (p< 0.05).

Jackfruit starch	PV (cP)	TV (cP)	BV (cP)	FV (cP)	SV (cP)	Peak time (min)	Pasting temp
Native	3437^{d}	2854^{e}	538^{c}	4768^{e}	1914^{d}	5.67^{c}	86.25^{e}
HMT	3096^{c}	2858^{e}	238^{b}	4271^{d}	1412^{c}	6.73^{d}	88.75^{e}
H & C	3350^{d}	1997^{ab}	1353^{d}	4093^{cd}	2096^{e}	4.93^{bc}	82.3^{cd}

In heat moisture treatment, pasting temperature slightly increased due to moisture treatment to 88.75^{0}C from 86.25^{0}C as that of native jackfruit seed. This may be due to strengthening of intragranule-bonded forces between the starch molecules occur after heat moisture treatment which allow the starch to require more heat before structural disintegration and paste formation. Eliasson (1981) reported similar findings for wheat starch. After hydroxypropylation crosslinking peak viscosity of jackfruit seed starch was decreased from 3437cP in native to 3350cP. Decrease in peak viscosity in other starches after modification may be due to pronounced effect of crosslinking. Hot paste viscosity was found to be decreased from 2854cP in native to 1997cP in hydroxypropylated crosslinked starch. Final viscosity found to be decreased in jackfruit seed starch after hydroxypropylation crosslinking. Final viscosity decreased from 4768cP to 4093cP. Breakdown and set back viscosity increased in hydroxypropylated-crosslinked jackfruit seed starch (Table 3). The breakdown in visco-amylography is a measure of the structural disintegration of starch during cooking and similar results were observed by Raina *et al* (2006).

pH and total soluble solid of chilli sauce

The pH and total soluble solids of chilli sauce All chilli sauces had pH levels ranging between 3.58-3.61 (Table 4) and thus the results were not significantly different (p > 0.05).

Chilli sauce is classified as a high acid food item. For the storage study, chilli sauce was stored at 37 °C

Table 4. pH and total soluble solid of chilli sauce before and after 4 weeks of storage. Average of triplicate measurements, n=3 Values in the same column with different letters are significantly different (p< 0.05).

Samples	pH	Total soluble solids (° Brix)		
	Before	After	Before	After
Chilli sauce (without starch)	3.21±0.05a	3.17±0.05a	26.10±0.05a	25.95±0.02a
Chilli sauce (with native jackfruit starch)	3.37±0.02b	3.25±0.07b	25.78±0.01b	25.66±0.01^{B}
Chilli sauce (with heat moisture treated jackfruit starch)	3.45±0.03c	3.31±0.01c	25.55±0.08c	25.43±0.02c

Table 5. Sensory evaluation of chilli sauce. Values in the same column with different letters are significantly different (p< 0.05).

Samples	Color	Mouth feel	Homo-geneity	Taste	Overall Accep-tability
Chilli sauce (without starch)	6b	5b	6c	6b	6c
Chilli sauce (with native jackfruit starch)	6.5ab	7a	6.2b	6.8a	6.5b
Chilli sauce (with heat moisture treated jackfruit starch)	7a	7.5a	6.5a	7a	7a

for 4 weeks and the results showed a decrease in pH levels in all chilli sauce samples. The comparison of each sample before and after storage revealed that the pH values were not significantly different ($p > 0.05$). Garcia-Alonso *et al.* (2009) studied the changes in pH and titratable acidity of tomato juice and found that both pH and titratable acidity did not significantly change throughout the storage trial of 12 months. The total soluble solids of all chilli sauces determined with a refractometer (Table 4) were not significantly different ($p \geq 0.05$). The total soluble solid of chilli sauce before and after storage were also not significantly different ($p > 0.05$).

Serum separation

The serum separation (syneresis) indicated the inability of chilli sauce to hold water during storage. In this experiment revealed that addition of starch led to a decrease in the serum separation in chilli sauce. The serum separation in chilli sauce increased with the extension of storage duration of up to 4 weeks (Fig. 2). After the first week, chilli sauce with HMT modified jackfruit seed starch exhibited no serum separation while control and chilli sauce with native jackfruit seed starch showed evidence of serum separation. The level of serum separation during storage for 4 weeks was as follows: Control >chilli sauce with native jackfruit seed starch >chilli sauce with HMT modified jackfruit seed starch. The results indicated that chilli sauce with jackfruit seed starch had lower levels of serum separation than other chilli sauces.

Sensory evaluation

The sensory analysis was performed by students and staff from College of Home Science, Tura on 9-point hedonic scale. Color, homogenity (smoothness and good blend), taste and overall quality, as summarized in Table 5. Chilli sauce with HMT modified jackfruit seed starch obtained the highest preference scores in all attributes.

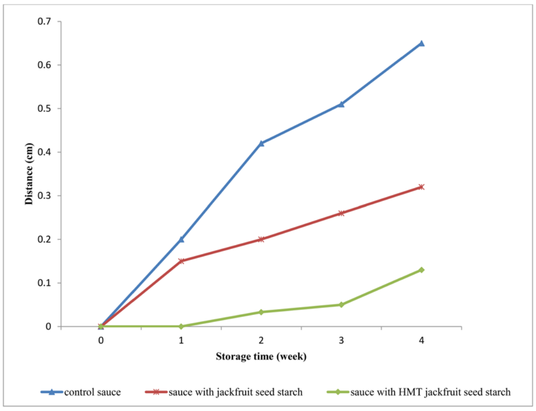

Fig. 2. serum separation of chilli sauce during storage.

CONCLUSION

Jackfruit sees starch was isolated and modified by two methods. Heat moisture treatment modifies starch was suitable for application in sauce. Heat moisture treatment modified starch incorporate sauce showed improved quality of sauce indicated by low serum separation with immense potentiality for economic exploration.

ACKNOWLEDGEMENT

Research was funded by Ministry of food processing industries, New Delhi.

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