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Partial Characterization of Custard Powder Prepared from Native and Modified Non-conventional Starches

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ABSTRACT

Background: Non-conventional sources of starch like sweet potato, jackfruit seeds, dioscorea are under-utilized as compared to conventional sources. So, it is necessary to utilize these underutilized crops for enhancing their application in food. Custard powder prepared from modified starches (heat moisture treatment and hydroxypropylation crosslinking) were evaluated in the present study.

Methods: Custard powder was prepared from native and modified (heat moisture treatment and hydroxypropylation crosslinking) starches of sweet potato, jackfruit seeds and dioscorea. The properties of custard powder and custard were analyzed for hygroscopicity, bulk density, total soluble solids, textual, viscosity, colour and sensory parameters.

Result: Bulk density was higher for custard powder prepared from hydroxypropylated crosslinked starch. Viscosity and textural properties of custard prepared from hydroxypropylated crosslinked starch were good. On sensory score custard with hydroxypropylated crosslinked sweet potato starch was preferred by consumers.

Key words: Custard powder, Heat moisture treatment starch, Hydroxypropylated crosslinked starch, Non-conventional starch.

INTRODUCTION

Starch contributes greatly to the textural properties of many foods and is widely used in food and industrial applications as a thickener in milk-based sweets and jellies; soups; sauces; custards and dessert (Basim *et al.,* 2004). Non-conventional sources such as sweet potato, jackfruit seeds, dioscorea are good source of starch and has been less utilized as compared to conventional sources. So, it is necessary to utilize these underutilized crops for their use in many foods and non-food applications (Sarkar, 2016; Sarkar and Jindal, 2015). 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 (Goni *et al.,* 2008). Root and tuber crops are mostly consumed fresh or used as animal feed However, in recent years in many countries, there has been an increasing scientific awareness of the importance of increasing root crop production (Hahn *et al.,* 1989). Modification of starch improves their functional properties and broaden their application.

Sweet potato (*Ipomea batatas*) is dicotyledonous plan from Convolvulaceae family an important crop in many developing countries and some parts of the world sweet potato is the staple crop (Radley, 1976; Collins and Walter, 1982). Sweet potato contains approximately 20% starch and most of the sweet potatoes are consumed as simple food products (*e.g.* fresh, steamed, or roasted snacks) or used as an animal feed. Until now, starch is the main industrial product from sweet potatoes but its use is still limited (Jangchud *et al.,* 2003). The jackfruit (*Artocarpus heterophyllus*) a 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.,* 2016). The seeds are reported to be powerhouse of nutrients, containing approximately 14% protein, 80% carbohydrate and also contain an abundance of starch, approximately 60-70% of its dry weight (Chen *et al.,* 2016). However, the seeds are often discarded as they are not usually consumed (Dutta *et al.*, 2011). Yam belongs to family Dioscoreacea and is a monocotyledous tuber bearing plant, from the genus Dioscorea (Ayensu, 1972). Yam is mostly consumed locally or retained for planting owing to poor shelf life of the tubers profound amount is lost during storage (Wheatley, 2000). Post harvest utilization of tuber will improve earnings from this crop. The high starch content of the tuber have huge market potential for the exploitations.

As custard prepared from custard powder serves as a great boon to seriously ill patients as it is an instant energy source and also to patients having dysphagia (Barczi *et al.,* 2000). Dysphagia patients need thickened fluids which may be either pre-packaged ready-to-use or freshly-

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prepared from powder thickeners dissolved in water, cordial, fruit juices and milk. Corn starch is preferred for preparation of custard powder, however in India, corn has become the third important food grain after wheat and rice. The demand for corn is growing up in India with the setting up of food processing units involved in production of breakfast cereals and snacks. The alternative non conventional sources which are underutilized and available in abundance can be used in the production and modification of starch. Shaikh *et al.,* 2017 reported custards were prepared using modified pearl millet had improved cold storage stability, pasting, textural and sensory properties overall quality of custard. Very few literatures are available on utilization of modifies starches from non- conventional sources in custard powder. So, the present study focuses on optimization of process parameters for the development of custard powder using modified starches and its quality evaluation.

MATERIALS AND METHODS

Starch isolation and modification

Sweet potato starch was isolated as described by Singh *et al.*, (2005). Starch from jackfruit seed cotyledons were isolated as per Mukprasirt and Sajjaanantakul (2004). Starch from dioscorea was extracted as per method described by Riley *et al.,* (2006). 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. Sweet potato, jackfruit seeds and dioscorea were purchased from local market. All chemicals used for the study were of analytical grade. The work was carried during period of 2015-2-16 in College of Community Science, Central Agricultural University, (I), Meghalaya, India.

Preparation of custard powder

The custard powder was prepared as per the following formulation *i.e*. starch (98%), sunset yellow colour (1%), vanilla flavor (0.9%) and salt (0.1%).

Characteristics of custard powder

Moisture content of the custard powder prepared by sweet potato, diascora and jackfruit seed starches (native and modified) was measured by A.O.A.C., 2005. Bulk density and hygroscopicity was measured as per Goula *et al.,* 2004; Cai and Corke 2000. The color of the starches was measured by a chroma meter (CR-300, MIN LTA, Japan) as L, a and b values.

Preparation of the model custard system was performed according to the recipe and protocol of COST Action 921 (Santonicoa *et al.,* 2008).

Quality evaluation of custard

Viscosity was measured by digital brookfield viscometer; spindle no.6 at 100 rpm, at constant temperature (10-15°C) for 5 min. Soluble solids content of prepared custard was determined with a hand refractometer (Gonzalez *et al.,*2009). Custard texture measurements were carried out with the TA.XT2i Texture Analyser (Stable Micro Systems Ltd, Surrey, UK) with a 5 kg load cell. Back extrusion cell (A/BE) with 35mm diameter compression disc was used.

Sensory evaluation was conducted on the custard samples after one-day storage at 4°C temperature.

Sensory characteristics

appearance, color, aroma, texture (mouth-feel), taste, after-feel and overall acceptability were evaluated by semi trained panel members on 9-point hedonic scale.

Statistical analysis

Analysis of variance (ANOVA) with Tukey's standardized range test was performed and samples were analyzed, at a significance level of $p \leq 0.05$.

RESULTS AND DISCUSSION

Characteristics of custard powder

Moisture content and hygroscopicity

Moisture contents of all the custard powders was found to be higher than commercial custard powder (Table1).The bulk density was higher for custard powder prepared from hydroxypropylated crosslinked dioscorea starch was found to be lower for custard powder prepared from hydroxypropylated crosslinked jackfruit seed starch (Table 1).

Hygroscopicity of custard prepared from jackfruit seed starch was found to be higher *viz*. 3.930% than the custard powders prepared from other native starches which could

Table 1: Characteristics of custard powder.

Starch source	Custard sample	Moisture content (% wb)	Bulk density (g/ml)	Hygroscopicity (%)
	CS	9.64±0.04a	0.662±0.01a	2.32±0.07a
Sweet potato	Native (control)	11.82±0.05b	0.58±0.03b	2.030±0.05b
	HMT	9.88±0.12c	0.571±0.05b	2.162±0.04c
	H and C	10.04±0.03d	0.667±0.02a	1.528±0.01d
Jackfruit seed starch	Native (control)	11.22±0.01e	0.501±0.05c	2.13±0.10e
	HMT	10.43±0.04f	0.572±0.07b	2.36±0.05a
	H and C	11.16±0.11g	0.521±0.01d	2.33±0.06a
Dioscorea	Native (control)	12.14±0.07h	0.669±0.01a	2.39±0.05e
	HMT	9.72±0.06i	0.520±0.03d	2.49±0.07f
	H and C	11.20±0.02e	0.667±0.02a	2.37±0.08ae

Average of triplicate measurements, n=3, Values in the same column with different letters are significantly different (P<0.05).
CS: Commercial custard powder; HMT: Heat moisture treated starch; H and C- Hydroxypropylated cross-linked starch.

be attributed to the higher water binding capacity of jackfruit seed starch (Table 1). The custard powder prepared from heat moisture treated starch samples showed higher bulk density than custard powders prepared from native starches which was due to hydrophilic tendency of heat moisture treated starch samples (Singh *et al.* 2009). Custard powders prepared from hydroxypropylated crosslinked starch showed lower hygroscopicity than other custard powder prepared from native as well as heat moisture treated starch.

Color measurement

Color of custard powder prepared from sweet potato was observed to be higher than the color of other starches. Among all custard powder samples *L* value for the custard powder prepared from native sweet potato starch was higher *viz*. 98.808. While the *b* value was found to be higher for custard powder prepared from both hydroxypropylated crosslinked starches as well as heat moisture treated starches than the custard powder prepared from their native counterpart (Table 2).

Quality evaluation of custard

Viscosity measurement

The viscosity for custard prepared from hydroxypropylated crosslinked starch containing custard powder was found to be higher among all custard samples prepared from custard powder samples which were basically formulated with native as well as modified starches while viscosity was found to be lower in case custards prepared from custard powder samples containing heat moisture treated starch samples. Viscosity ranged between 950-3510cP for all the custard samples. Custard prepared from custard powder containing heat moisture treated starch samples was found to be lower *viz.* 950cP for dioscorea starch and (Table 3). The viscosities of custard prepared from custard powder containing native as well as hydroxypropylated crosslinked starches was found to be higher than the custard prepared using commercial custard powder.

Soluble solid content

Soluble solid content for all custard samples was found to be in the range of 28-29°bx which was well comparable with the commercial custard sample.

Texture analysis

Texture is a criterion by which quality is judged and an important factor when selecting or rejecting products (Rosenthal, 1999). Firmness, consistency and adhesiveness of the custard was measured using texture analyzer (Table 4). Custard prepared from all the custard powder samples had good textural properties *viz*. custard powder prepared from native starches produced good firmness, consistency as

Table 2: Color values for different custard powders.

Starch source	Custard powder sample	*L*	*a*	*b*	ΔE
	CS	94.719±0.03a	2.362±0.02a	2.377±0.05a	
Sweet potato	Native (control)	96.808±0.02b	2.355±0.04a	2.83±0.07b	23.183
	HMT	95.021±0.01c	1.927±0.06b	3.060±0.04c	23.006
	H and C	96.078±0.06d	1.44±0.07c	3.514±0.03d	22.690
Jackfruit seed starch	Native (control)	94.720±0.05a	1.503±0.05cd	2.946±0.09e	22.183
	HMT	92.755±0.03e	1.652±0.03d	3.601±0.06f	22.598
	H and C	93.141±0.01f	1.777±0.06e	3.835±0.02g	22.309
Dioscorea	Native (control)	94.214±0.09g	2.697±0.07f	4.416±0.01h	21.480
	HMT	93.461±0.06f	2.383±0.03a	4.627±0.05i	21.376
	H and C	93.172±0.03f	3.156±0.05g	5.192±0.03j	20.676

Average of triplicate measurements, n=3, Values in the same column with different letters are significantly different (P<0.05).
CS: Commercial custard powder; HMT: Heat moisture treated starch; H and C: Hydroxypropylated cross-linked starch.

Table 3: Viscosity of custard prepared from different custard powders.

Starch source	Custard sample	Viscosity (cP)	Shear rate (%)
	C S	1800±1.3a	18±0.23a
Sweet potato	Native (control)	2050±1.5b	20.5±0.73b
	HMT	1210±2.5c	12.1±0.56c
	H and C	2510±3.2d	25.1±0.47d
Jackfruit seed	Native (control)	1980±1.9e	19.8±0.55e
	HMT	1710±3.1f	17.1±1.1f
	H and C	2140±2.2g	21.4±0.44g
Dioscorea	Native (control)	1700±1.6h	17±0.78f
	HMT	950±1.9i	9.5±0.91h
	H and C	2100±3.3j	21±0.62g

Average of triplicate measurements, n=3, Values in the same column with different letters are significantly different (P<0.05).
CS: Commercial custard powder; HMT: Heat moisture treated starch; H and C: Hydroxypropylated cross-linked starch.

well as adhesiveness well comparable with the commercial custard sample. The firmness of the custard prepared from custard powder containing hydroxypropylated crosslinked sweet potato starch was found to be higher (0.715N) among all the custard samples which is much higher than commercial custard samples. Firmness was found to be lower in case of custard prepared from custard powder containing heat moisture treated starch samples when compared to their native counterparts.

Custard prepared from custard powder containing hydroxypropylated crosslinked sweet potato starch showed highest consistency (8.055Ns) while custard prepared from the custard powder containing heat moisture treated starch samples showed lowest consistency.

Sensory evaluation

Sensory evaluation plays an important role in measuring characteristics and acceptability of food products. The sensory profile data of the custard samples prepared from different custard powder are shown in Table 5.

Appearance

The custard prepared from custard powder containing hydroxypropylated crosslinked starch was higher next to commercial custard samples.

Color

The evaluation scores obtained for coded samples showed that color of custard prepared from commercial custard was more appealing than other custard samples.

Mouthfeel

Mouthfeel of all the custard samples was described and scored in terms of thickness, melting and creaminess by the panelists. Custard prepared from custard powder containing hydroxypropylated crosslinked sweet potato starch obtained score of 8.18 which was higher than the commercial custard sample obtained score of 8. The panelists commented that hydroxypropylated crosslinked sweet potato starch sample showed higher thickness, meltiness and creaminess when taken in mouth.

Taste

Taste of all the custard samples was acceptable by the panelists. The score obtained by commercial custard sample was 8.18. The lowest score obtained by custard prepared from jackfruit seed starches.

After-feel

Custard prepared from custard powder containing native starches as well as heat moisture treated starches showed

Table 4: Texture attributes for custards prepared from custard powders.

Starch source	Custard sample	Firmness (N)	Consistency (Ns)	Adhesiveness (Ns)
	CS	0.416c	4.590c	-1.078c
Sweet potato	Native (control)	0.560f	6.461e	-1.673b
	HMT	0.335b	3.568b	-0.622d
	H and C	0.715g	8.055f	-2.225a
Jackfruit seed	Native (control)	0.482e	5.566d	-1.461b
	HMT	0.428d	4.349c	-0.741d
	H and C	0.593f	6.677e	-1.655b
Dioscorea	Native (control)	0.535ef	5.987d	-1.224c
	HMT	0.236a	2.356a	-0.172e
	H and C	0.580f	6.220e	-1.522b

Average of triplicate measurements, n=3, Values in the same column with different letters are significantly different (P<0.05).
CS: Commercial custard powder; HMT: Heat moisture treated starch; H and C: Hydroxypropylated cross-linked starch.

Table 5: Sensory evaluation of custard samples.

Starch source	Custard sample	Appearance	Aroma	Color	Mouth feel	Taste	After feel	Overall acceptability
	CS	8.0d	7.90e	7.63c	8.18f	8.18e	8.0f	8.08f
Sweet potato	Native (control)	5.45c	6.27d	6.45b	6.18d	6.45d	6.09cd	6.10d
	HMT	6.54ab	7.09cd	6.54b	6.63b	7.27cd	6.90c	7.23c
	H and C	7.90d	7.45d	6.90d	8.0f	8.0e	8.0f	7.97ef
Jackfruit seed	Native (control)	6.54ab	6.36ab	6.27a	6.18a	6.36ab	6.54b	6.48b
	HMT	6.18a	6.18a	6.54b	6.0a	6.18a	6.18a	6.27a
	H and C	7.09b	6.54b	6.63b	6.90c	6.63b	6.36ab	6.69c
Dioscorea	Native (control)	6.18b	6.18d	6.45b	6.27d	6.36d	6cd	6.07d
	HMT	6.90b	7.27d	6.54b	6.0a	6.36ab	6.63b	6.61bc
	H and C	7.45c	7.45d	6.27a	7.36e	7.45d	7.18d	7.19de

Average of triplicate measurements, n=3, Values in the same column with different letters are significantly different (P<0.05).
CS: Commercial custard powder; HMT: Heat moisture treated starch; H and C: Hydroxypropylated cross-linked starch.

lower after-feel than that of commercial custard as well as hydroxypropylated crosslinked starch samples.

Overall acceptability

Overall acceptability of custard prepared from hydroxypropylated starch samples was higher than custard prepared from custard powder containing native and heat moisture treated starches. Custard prepared from custard powder containing hydroxypropylated crosslinked sweet potato starch was more acceptable next to commercial custard sample.

CONCLUSION

Non conventional starches could be better utilized for potential application as functional ingredients in the development of new products and they will be better alternative to conventional sources. Custard prepared from custard powder containing hydroxypropylated crosslinked starches showed higher firmness, consistency and adhesiveness than custards prepared from custard powder containing heat moisture treated starches. Thus it can be concluded that good quality custard can be prepared from non conventional sources and which can be used as a dessert, filling or sauce, added to cakes, puddings, pastries, or filled with fruit and served as fruit custard. The prepared custard will be a boon to elderly people, ill patients and for patients with dysphagia.

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