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CONTENTS

Physico-functional and sensory qualities of instant custard powder incorporated with resistant starch from Grand Naine banana

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ABSTRACT: Banana is one of the most imperative fruit crop grown in India and serve as an essential staple food due to its availability throughout the year. The Grand Naine banana, is a high yielding cultivar and is one of the most popular banana varieties commonly grown in India. Green banana are a rich source of starch, which is a type of resistant starch. They act as a prebiotic and provide potential benefits to the gut.Therefore, the present study was conducted to develop an instant custard powder by using resistant starch obtained from Grand Naine banana. The fresh mature banana was peeled, sliced, dried at 50^{0}C and powdered. Starch was isolated from the banana flour by a modified water-alkaline extraction process. The isolated starch was modified by autoclaving at 121°C for 30 minutes with a 10% moisture content.Custard powder was formulated by incorporating varying concentrations of resistant starch with corn flour and other ingredients across different treatments (T_0- T_6). Custard was prepared using these treatments were subjected to organoleptic evaluation. The best treatment was selected through organoleptic evaluation using a score card with a nine point hedonic scale. Custard (T_4) prepared by blending resistant starch (20 %), corn flour (15 %) and other ingredients (65 %) attained a maximum score for all organoleptic attributes (8.25). The physico-functional properties of custard powder showed moisture (6.25%) swelling power (1.67%), solubility (1.12%), bulk density (0.76g/ml)dispersibility (74.23%) and water absorption capacity (35.56%) and the addition of banana resistant starch to custard powder has successfully improved its functional properties without compromising its organoleptic qualities. Grand naine banana resistant starch has good functional properties and it is a great option for producing composite instant custard flour samples on a larger scale for health-conscious consumers.

Key words: Banana starch, custard powder, Grand Naine banana, organoleptic, physico-functional qualities, resistant starch

Banana is one of the most important fruit crops grown in India. It is a herbaceous plant belonging to the Musaceae family. It is called Kalpatharu, meaning herb with imaginable uses, and it is the oldest fruit known as the 'Apple of Paradise'. Grand Naine banana is a cultivar of the well-known Cavendish banana. It is a high-yielding cultivar and is one of the most popular banana varieties commonly grown in India. Its medium height and large fruit yield make it ideal for commercial agriculture. During peak season, large volumes of fruits are available and due to the perishable nature of the commodity, the producers faced post-harvest problems.

Banana starch, extracted from green banana, represents a unique form of resistant starch known for its ability to bypass digestion in the small intestine and transit to the large intestine intact. This characteristic of banana starch significantly contributes to its role as a valuable prebiotic, as it fosters the growth and activity of beneficial gut microbiota. The resistant starch content in green banana, coupled with its high amylose content, imparts a range of health benefits, including enhanced colonic health and improved glycemic control. Regular incorporation of green banana flour, which is rich in this resistant starch, into the diet has been shown to offer various physiological advantages, such as improved insulin sensitivity and increased satliety. Consequently, green banana starch has garnered attention as a functional food ingredient, offering potential applications in both therapeutic and dietary contexts due to its nutritional and functional properties.

Starch based custard flour is commonly used to create a smooth and creamy gruel or paste by mixing it with water and boiling it. This type of custard is a popular choice for breakfast in many regions worldwide. The gelling capability and consistency of custard are attributed to the corn starch, traditionally used as the main ingredient. To enhance the sensory appeal and nutritional value of the gruel, additional ingredients such as salt, flavours, colourants and protein sources are often added. However, corn starch is a high energy food with a high glycemic index, making it less suitable for health-conscious individuals. Therefore, there is a pressing need to improve the functionality of custard to make it a more ideal option for these individuals. One potential approach is to partially replace corn starch with health enhancing ingredients like green banana resistant starch in the formulation of custard.

MATERIALS AND METHODS

Collection of raw ingredients

Fully mature Cavendish variety (AAA) (Grand Naine) was collected from the Banana Research Station, Kannara of Kerala Agricultural University. All other ingredients required for the study were purchased from the local market.

Preparation of banana flour

The fresh banana varieties were washed and peeled. It will be then sliced to an average thickness of 1 cm. The slices were dried at 50°C, for 8 hr in a hot air oven. The dried chips were ground and sieved to get a uniform flour.

Isolation of starch from banana flour

Starch was isolated from the banana flour by a modified water-alkaline extraction process suggested by Vasanthan (2001). The powdered bananas are then blended with water to form a paste. Additional water, in a ratio of 1:10, was added to the paste after grinding. A small amount of Sodium metabisulphite, precisely 0.01%, was incorporated into the mixture. This mixture is then allowed to settle for 5-8 hours. Following the settling period, the mixture is filtered through a double layer of cheesecloth. The filtered mixture is then washed multiple times with water. Finally, the resulting slurry was dried in a hot air oven at 60^0C for 12 hours.

Processing of isolated starch

Isolated starch was modified by autoclaving at 121^0C for 30 minutes with a moisture content of 10 per cent. The mixture was cooled to room temperature and stored at 4^0C for 24 h. After three repetitions of the autoclaving and cooling cycles, the sample was dried and ground into fine particles.

Standardisation of custard powder

Instant custard mix powder was standardised by incorporating corn flour, milk powder, modified banana resistant starch (BRS) and other suitable ingredients such as milk powder (15 %), sugar (40 %), cashew nuts (4 %), salt (1%), desiccated coconut (4%) and vanilla essence and permitted yellow orange food colour (1 %). The treatments adopted for standardisation are given below. Custard was prepared using banana RS custard powder, adopting the standard procedure by Shabina (2011).

Organoleptic evaluation

The sensory evaluation was carried out for the prepared banana RS custard, using a nine point hedonic scale with a panel of 20 judges considering the 6 sensory parameters such as appearance, colour, flavour, texture, taste and overall acceptability. Based on organoleptic qualities best treatment was selected for further studies along with control.

Physico-functional properties of custard mix

The physico-functional properties like moisture,

Table 1: Treatments for the formulation of banana resistant starch incorporated custard powder

Sl. No	Treatments	Combinations
1	T_0	35 % CF + 65 % OI
2	T_1	35 % BRS +65 % OI
3	T_2	30 % BRS + 5 % CF + 65 %OI
4	T_3	25 % BRS + 10 % CF + 65 %OI
5	T_4	20 % BRS + 15 % CF + 65 %OI
6	T_5	15 % BRS + 20% CF + 65 %OI
7	T_6	10% BRS + 25 % CF + 65 %OI

BRS – Banana resistant starch, CF-Corn flour, OI-Other ingredients swelling power, solubility, water absorption capacity, dispersibility, bulk density and gelatinization temperature of best selected banana resistant starch custard powder were determined along with control.

Moisture

Moisture content of starch samples was estimated by the method of A.O.A.C (1980). To determine the moisture content of the products, five gram of sample was taken in a petridish and dried at 60^0C to 70^0C in a hot air oven, cooled in a desiccator and weighed. The process of heating and cooling was repeated till constant weight was achieved. The moisture content of the sample was calculated from the loss in weight during drying. Moisture content of the chips stored in polyethylene bags and laminated pouches were analysed at 10 days interval for one month.

$$\text{Moisture content (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Swelling power and solubility

Swelling power and solubility were determined by method described by Onwuka (2005). One percent (1%) solution of starch slurry was prepared and heated in a water bath maintained at 90^0C for 30 minutes with constant stirring and cooled. The suspension was centrifuged with Benchtop centrifuge at 3200 rpm and the supernatant was collected in a preweighed aluminium dish which was dried at 110^0C for 24 hours. The weight of the wet sediment in the centrifuge and that of the dried aluminium dish were recorded. The solubility and swelling power were thus calculated:

% Solubility = Weight of dried supernatant × 100 / Sample weight

% Swelling power = Weight of wet sediment × 100 / Sample weight × (100 - % solubility).

Water absorption capacity

The water absorption capacity (WAC) was determined using the method described by (Ranganna, 1995). A sample (1 g) each was mixed with 10 ml of distilled water and blended for 30 s. It was then allowed to stand for 30 min and centrifuged at 3500 rpm for 30 min at room temperature. The supernatant was decanted and weight of water absorbed by the flour was calculated and expressed as WAC.

Water holding capacity = Weight of the sediment – Weight of the raw sample

Dispersibility

The dispersibility of the samples was determined by the method describe by Kulkarni *et al.* (1991). Samples were weighed (10 g each) into 100 ml measuring cylinder and distilled water added to reach a volume of 100 ml. The set up was stirred vigorously and allowed to settle for 3 h. The volume of settled particles was recorded and subtracted from 100. The difference was then reported as percentage dispersibility.

Bulk density

The method described by Okaka and Potter (1977) was used for the determination of the bulk density. The custard sample was weighed (20g) into a 50 ml graduated measuring cylinder. The cylinder was tapped gently against the palm of the hand until a constant volume was obtained. Bulk density was calculated as;

Weight of sample/ Volume of sample after tapping

Cost of production of selected banana resistant starch custard mix

The cost of production of the most acceptable combination of BRS custard mix was computed based on the market price of procured ingredients used for preparation of products along with labour charge, fuel charge, electricity charge and packaging cost. The cost was calculated for 100 g of the product and compared with similar products available in the market.

Statistical analysis

The data was analysed using suitable statistical techniques. The best treatments were selected by applying Kendall's coefficient of concordance and nutritional parameters carried out independent sample t test.

RESULTS AND DISCUSSION

Organoleptic evaluation of custard

Organoleptic evaluation of custard was carried out using score card by a panel of twenty judges. The organoleptic scores are presented in Table 2.

The study on organoleptic evaluation of different treatments of banana resistant starch custard found that treatment T_4, which used 20% banana resistant starch, received the highest scores in all parameters, such as appearance, colour, flavour, texture, taste, and overall acceptability. The quality of Banana RS custard is highly dependent on the physical properties of the starch used as the base material, with texture being the most important factor followed by taste and flavour. Treatment T_4 received the highest total mean score of 8.25, followed by T_5 (8.08) and T_6 (8.01). The judges also showed significant agreement in their evaluation of the different quality attributes of banana RS custard based on Kendall's value (w). Based on organoleptic evaluation the treatment T_4 was selected for physico-functional evaluation.

Simi *et al*. (2016) standardised ready to use custard powder using canna starch and corn flour in different combinations. Canna starch powder is exceptional for its pure white colour and fine texture and is extremely suited for preparing ready to use custard powder. The overall acceptability of custard prepared exclusively with rhizome starch (35%) was found to be 8.69 and was selected as the best combination. Elias (2018) reported that custard powder prepared with 60 per cent corn flour and 40 % Tannia starch flour has the highest mean score of 8.5. Shabina (2011) noticed that the highest mean score of colour, texture, and taste in custard prepared with 10 % pumpkin powder and 25 % corn flour.

Physico-functional properties of BRS custard powder

The banana RS custard powder (T_4) was selected as best in the organoleptic evaluation and is subjected to physico-functional properties analysis along with control (Table 3).

The moisture content of selected banana resistant starch custard powder was observed to be 6.25 per cent and for control it was 5.60 per cent. Moisture content of banana RS included custard was slightly higher due to linear chain produced in autoclaving which exhibit increasing water holding properties (Nimsung *et al*., 2007).

The swelling powder of selected starch custard powder was observed to be 1.67, and for control, it was 1.90. Alimi *et al.* (2017) prepared custard powder with corn starch and banana starch and they analysed the swelling power of the custard samples.

The incorporation of banana starch led to a significant reduction of the swelling power of custard

Table 3:Physico-functional properties of BRS Custard powder

Parameters	Control	T_4	t value
Moisture (%)	5.60	6.25	5.58*
Swelling power (%)	1.90	1.67	4.28**
Solubility (%)	1.48	1.12	8.31**
Bulk density(g/ml)	0.68	0.76	5.06^{NS}
Dispersibility (%)	75.46	74.23	6.2*
Water absorption capacity (%)	36.72	35.56	7.10^{NS}

*Significant at 5% per cent level, NS- non significant (T_4 – 20 % banana resistant starch, 15 % corn flour, 65 % other ingredients)

Table 2. Mean score for organoleptic evaluation of Grand Naine banana RS incorporated custard

Parameters	T_0	T_1	T_2	T_3	T_4	T_5	T_6	W
Appearance	8.73(6.55)	7.77(2.50)	7.78(2.55)	8.05(3.23)	8.28(4.63)	8.20(4.33)	8.18(4.23)	0.474**
Colour	8.78(6.50)	7.42(2.00)	7.70(2.95)	7.72(3.00)	8.18(4.73)	8.00(4.50)	7.98(4.33)	0.533**
Flavour	8.63(6.25)	7.51(2.30)	7.77(3.48)	7.81(3.30)	8.10(4.40)	8.07(4.38)	7.95(3.90)	0.368**
Texture	8.68(6.45)	7.45(1.88)	7.75(2.93)	7.80(2.85)	8.47(5.80)	8.12(4.23)	8.00(3.88)	0.623**
Taste	8.68(6.38)	7.87(2.88)	7.88(2.88)	7.91(3.08)	8.25(4.83)	8.12(4.00)	8.10(3.98)	0.381**
Overall acceptability	8.63(6.60)	7.52(2.23)	7.62(2.60)	7.65(2.78)	8.22(5.33)	8.02(4.50)	7.90(3.98)	0.608**
Total mean rank score	8.68	7.59	7.74	7.82	8.25	8.08	8.01	

Figures in parenthesis indicate mean rank scores, ** significant at 1 % level, flour from 1.85 (corn starch) to 1.16 (banana starch). The presence of banana starch in the matrix altered the symmetry by causing significant variations in granule sizes and shapes, ultimately weakening the interactive forces within the network. This can be attributed to the fact that swelling power is influenced by the interactive forces present within starch molecules (Adebowale *et al*., 2009). Solubility also varied from 1.12 (T_4) to 1.48 (Control).

Bulk density is the ratio of the mass of the particle to the volume of the particle. It affects the flowability of the green banana flour; therefore, it can affect the conveying and storage properties. The bulk density of the prepared grand naine banana custard powder was 0.76 which was slightly higher than the control (0.68). The bulk density of custard powder made from heat moisture treated starch samples was found to be higher compared to custard powders made from native starches, attributed to the hydrophilic nature of the heat moisture treated starch samples (Singh *et al.,* 2009). Additionally, custard powders made from hydroxypropylated crosslinked starch exhibited lower hygroscopicity compared to those made from native and heat moisture treated starch (Sarkar, 2022).

The dispersibility of the selected custard was found to be 74.23 which was slightly lower than the control (75.46). Dispersibility is an index that measures how well flour or flour blends can be rehydrated with water (Kulkarni *et al.,* 1991). All the flour blends have relatively high dispersibility signifying that they will reconstitute easily to fine consistent dough or pudding during mixing (Adebowale *et al.,* 2008). Water absorption capacity (WAC) indicates the level of compactness of the molecular structure of starch in flour as it relates to the amount of water a food product could retain following the application of mild pressure.The water absorption capacity of banana resistant starch custard powder was 35.56 which was slightly lower than the control (36.72). Alimi *et al.* (2017) standardised banana- corn starch-based custard powder which was contain 36-37 per cent water absorption capacity. The knowledge of WAC of the custard samples is a useful guide for the quantity of water to be added to ensure uniform consistency. Generally, the low WAC of all the samples shows their desirability for making thinner gruels (Oduro-Yeboah *et al.,*2014).

The cost of production

The production cost of control custard mix was Rs.42.61/100g, which was lower than the cost of instant BRS custard mix (Rs.47.21/100g). Additionally, the cost of the prepared custard mix was lower than the market price (Rs.50/100g). The incorporation of banana resistant starch for the development of instant mixes increases the nutritive value and reduces the cost. Elias (2018) standardised Tania corn starch instant custard mixes and calculated the cost of products, and it was observed as 65/100g.

CONCLUSION

Hence, the study found that incorporating 20 per cent banana starch into custard significantly enhanced its overall acceptability compared to other formulations, except for the control group. However, adding more than 20 per cent banana starch due to color fading, diminished appearance intensity, and adverse effects on texture. The study analysed the physico-functional composition of various treatments, including a control group, and found that banana resistant starch based custard powder can achieve the desired consistency without additional thickeners. Modified banana starch emerged as a promising new starch source for developing value added products, with both native and hydrothermally treated banana starch improving flow consistency of custard pastes and increasing the fraction of slowly digestible starch. Starches with higher resistant starch content showed excellent resistance to enzyme digestion, making them ideal for functional dietary food products, while those with the highest gelatinization peak viscosity were suitable as thickeners. Custard paste samples with hydrothermally modified banana starch had higher levels of resistant starch, potentially benefiting individuals managing diseases like diabetes. These findings highlight the potential health benefits of corn-banana starch paste and its role in meeting dietary needs, with improved functional properties in custard flour samples suggesting potential for commercial-scale production, particularly for health-conscious consumers.

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REFERENCES

A.O.A.C. (1980). *Official and Tentative Methods of Analysis (10th Ed)*. Association of Official Analytical Chemists, Washington, D. C., 1018p.

Adebowale, A. A., Sanni, L. O., and Ladapo, F. O. (2008). Chemical, functional and sensory properties of instant yam-breadfruit. *Nig. Food J*., 26: 2–12.

Adebowale, K.O., Henle, T., Schwarzenbolz, U., and Doert, T. (2009). Modification and properties of African yam bean (Sphenostylisstenocarpahochst. Ex a. Rich.) harms starch I: Heat moisture treatments and annealing. *Food Hydrocolloids,* 23: 1947–1957

Alimi, B. A., Workneh, T. S., and Oyeyinka, S. A. (2017). Structural, rheological and in-vitro digestibility properties of composite corn-banana starch custard paste. *Food Sci. Technol.,*79:84-91.

Elias, A. (2018). *Quality evaluation of Tannia Corm (Xanthosoma sagittifolium (L) Schott) and its suitability for product development*. M. Sc (Community Science) thesis, Kerala Agricultural University, Thrissur,119p.

Kulkarni, K. D., Kulkarni, D. N., and Ingle, W. M. (1991). Sorghum malted and soybean weaning food formulation: preparation, functional properties and nutritive value. *Food Nutr. Bull*., 13: 322–329

Nimsung, P., Thongngam, M., and Naivikul, O. (2007). Compositions, morphological and thermal properties of green banana flour and starch. *Nat.l Sci.,* 41:324-330.

Oduro-Yeboah, C., Onwulata, C., Tortoe, C. and Thomas-Gahring, A. (2014). Functional properties of plantain, cowpea flours and oat fiber in extruded products. *J. Food Process. Preserv.,* 38: 347–355.

Okaka, J. C. and Potter, N. N. (1977). Functional and storage properties of cowpea/ wheat flour blends in bread making. *J. Food Sci*., 42: 828-833.

Onwuka, G. I. (2005). *Food analysis and instrumentation: Theory and practice*. Napthali Prints, Surulere, Lagos, Nigeria, 137p.

Ranganna, S. (1995). *Hand Book of Analysis and Quality Control for Fruits and Vegetable Products*. Tata Mc Graw Hill Publishing Company Ltd, New Delhi, India, 1112p.

Sarkar, S. (2022). Partial Characterization of Custard Powder Prepared from Native and Modified Non-conventional Starches. *Asian. J. Dairy Food Res*., 41(1): 89-94.

Shabina, B. (2011). Optimisation of process variables for value added pumpkin (*Cucurbita moschata* Poir) products. M. Sc. (Home Science) thesis, Kerala Agricultural University, Thrissur, 83p.

Simi, M. C., Aneena, E. R., Panjikkaran, S. T., Sharon, C. L., and Sheela, K. B. (2016). Standardisation and quality evaluation of Queensland arrowroot (*Canna edulis* L.) based custard powder. *J. Tropical Agric.,* 54(1):35-40.

Singh, G.D., Singh, S., Bawa, A.S. and Saxena, D.C. (2009). Physicochemical, pasting, thermal and morphological characteristics of Indian water chestnut (*Trapa natans*) starch. *Starch/Starke,* 61: 35-42

Vasanthan, T. (2001). Overview of laboratory isolation of starch from plant materials. In: Wrolstad, R. E., Acree, T. E., Decker, E. A., Penner, M. H., Reid, D. S., Schwartz, S. J., Shoemaker, C. F., and Smith, D. S. P. (eds), *Current Protocols in Food Analytical Chemistry*. Wiley Publishers, New York, Pp. E2.1-6.

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