# Effect of Taro Starch-Hydrocolloids Mixture as a Functional Ingredient on the Quality of Milk Dessert

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**Abstract:** The study was carried out to investigate the effect of taro starch-hydrocolloids mixture on the physical and sensory properties of milk dessert. Four different hydrocolloid i.e. arabic, Carboxymethyl cellulose (CMC), guar and xanthan gums were mixed with taro starch in different concentration and their potential use in milk dessert as functional ingredients were evaluated. Physical and sensory characteristics were found to be considerably improved in different aspects by adding these functional ingredients. Taro starch-arabic gum blend was observed to be an effective additive to produce creamy texture of milk dessert. Syneresis from dessert was noted to be diminished and sensory characteristics were also found to be improved by adding taro starch-guar gum blend. Similarly, taro starch-xanthan gum blend has effectively been stabilized the texture and sensory properties of milk dessert.

**Keywords:** Taro starch, Hydrocolloids, Milk Dessert, Syneresis, Sensory Properties.

## INTRODUCTION

Starch has been found widespread application in food processing industries. Studies on new sources of starches are essential for their use and also to increase the exploitation and utilization of starchy crops. There are various starch sources such as wheat, corn, rice, potato, tapioca and sago by which starches are commercially produced and utilized in many ways. There is another important source of starch called Taro (*Colocasia esculenta*) which is grown in humid and swampy agricultural field of tropical and subtropical regions including Pakistan [1, 2]. It has been reported that taro starch has some distinct properties such as high peak viscosity, high gel strength and high swelling power and hard coating layer [3-5]. However it is somewhat neglected and did not receive significant commercial importance. Besides its advantageous properties, raw taro starch exhibits certain undesirable characteristics, for example unstable texture, poor solubility, instability at high pH and shear during processing, poor heating and cooling stabilities [6]. Nevertheless, various modification treatments can be applied to improve and modify its intrinsic properties and impart new desirable properties.

Addition of hydrocolloids with starch is often use as an alternative modification treatment to control the functional properties of native starches. Hydrocolloids serve as emulsion stabilizer, suspending agents, gelling agents, thickeners, fiber sources, mouth feel improvers, fat replacers and processing aids. The functional and rheological properties of starch and hydrocolloid mixtures have been extensively reported in literatures [7-13]. It is well known fact that the addition of hydrocolloids increases the viscosity of starch dispersion and influences the retrogradation rate. Many investigations have been reported so far to clarify the role and potential usefulness of hydrocolloids in controlling rheology and modifying texture of starch based food products [9, 10, 14-16]. Currently, there has been received an immense importance in evaluating the properties of complex polysaccharides system having various hydrocolloids and raw starches and resultant mixtures are considered to be potential additives for many food products. In this connection, the present study was aimed to evaluate the effect of taro starch-hydrocolloid mixtures as functional ingredients on the quality of milk dessert.

## MATERIALS AND METHODS

Taro was purchased from local market of Karachi and starch was extracted by freeze-thaw method [17]. Four different hydrocolloids such as gum arabic, CMC, guar and xanthan gums were of food grade, chemicals were of analytical grade and purchased from Sigma Co. St. Louis, MO., USA.

### Ingredient and Formulation

Milk dessert was prepared by using 3 % (w/w) taro starch, tested hydrocolloids (0.2, 0.4 and 0.6 %, w/w), 8 % sucrose and 12 % skimmed milk powder (SMP).

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SMP was dispersed in distilled water and stored overnight in a refrigerator to hydrate the milk proteins. Taro starch, selected hydrocolloids and sucrose were added to the cold milk and stirred gently for 10 min at magnetic stirrer to achieve homogenized mixture. The flask mixture was then heated at 95 $^{o}$C using shaking water bath for 20 min. The evaporated water was replaced gravimetrically, after heating process. The sample was cooled to 40 $^{o}$C using tap water and then vanilla flavor (0.1 %) was added. The sample was homogenized, transferred to a capped small plastic cup and stored in refrigerator at 4 $^{o}$C for 48 hrs. Milk dessert without any hydrocolloid was considered as control sample.

## Syneresis

Percent syneresis of dessert was measured by a centrifugation test. Dessert mix at 40 $^{o}$C was filled in plastic centrifuge tubes and stored in a refrigerator for 7 days. All the tubes were then kept at room temperature for 4 hrs and centrifuged at 8000 x g for 10 min. The water released by the dessert gel was separated and weighed and expressed as percentage syneresis.

## Gel Strength

The textural firmness of dessert containing Taro starch and different hydrocolloids was investigated by using Universal Testing machine (Zwick GmbH & Co., Germany). The prepared dessert was poured into plastic cylindrical cups of dimension 20 mm x 30 mm and stored in a refrigerator at 4 $^{o}$C for 4 hrs. The resistance to penetration of the dessert gel was determined by the method of Hoover and Senanayake (1996) [18].

## Sensory Evaluation

The sensory evaluation of milk dessert (both control and starch-hydrocolloid mixtures) was carried out by 10 trained judges using 5 points hedonic scale. Five sensory attributes were selected namely, visual appearance, aroma, taste, mouth feeling and texture. Overall acceptability of dessert was evaluated by taking weighted arithmetic mean, given the following weightage to each attribute: Visual appearance 15 %, Aroma 15 %, Taste 25 %, Mouth feeling 20 % and Texture 25 %.

## Statistical Analysis

A one-way analysis of variance (ANOVA) was applied to find the significance of differences between the mean values at $P < 0.05$ level of confidence. The statistical analyses were performed using SPSS version 17.01 for window program (SPSS Inc., Chicago, IL, USA).

# RESULTS

## Syneresis

The results of different dessert samples with and without taro starch-hydrocolloid blends are presented in Figure **1**. It was noted that TSG (taro starch-guar gum mixture) and TSX (taro starch-xanthan gum mixture) effectively reduced the syneresis at all gum concentrations. Although, TSC1 (taro starch-0.2 %

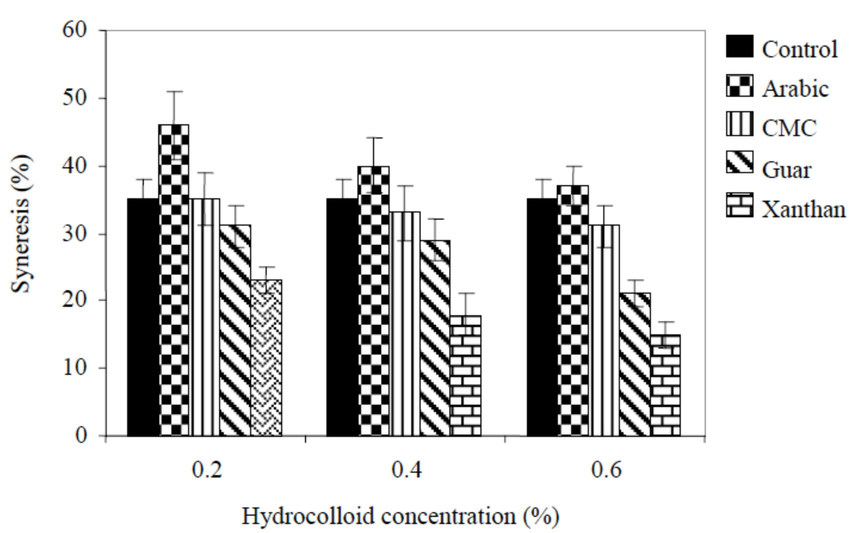


**Figure 1:** Effect of hydrocolloids and taro starch (3 %) on syneresis of milk dessert.
Error bars represent standard deviation of triplicate, n = 3.

CMC) did not exerted any effect on gel syneresis, however syneresis was found to be reduced by incorporation of TSC2 (taro starch-0.4 % CMC) and TSC3 (taro starch- 0.6 % CMC). TSA (taro starch-arabic gum) was found to be ineffective on dessert gel.

## Gel Strength of Milk Dessert

The results of textural firmness of dessert containing taro starch-hydrocolloid blends are presented in Figures **2a-2c**. The addition of both TSX1 (taro starch-0.2% xanthan gum) and TSG1 (taro starch-

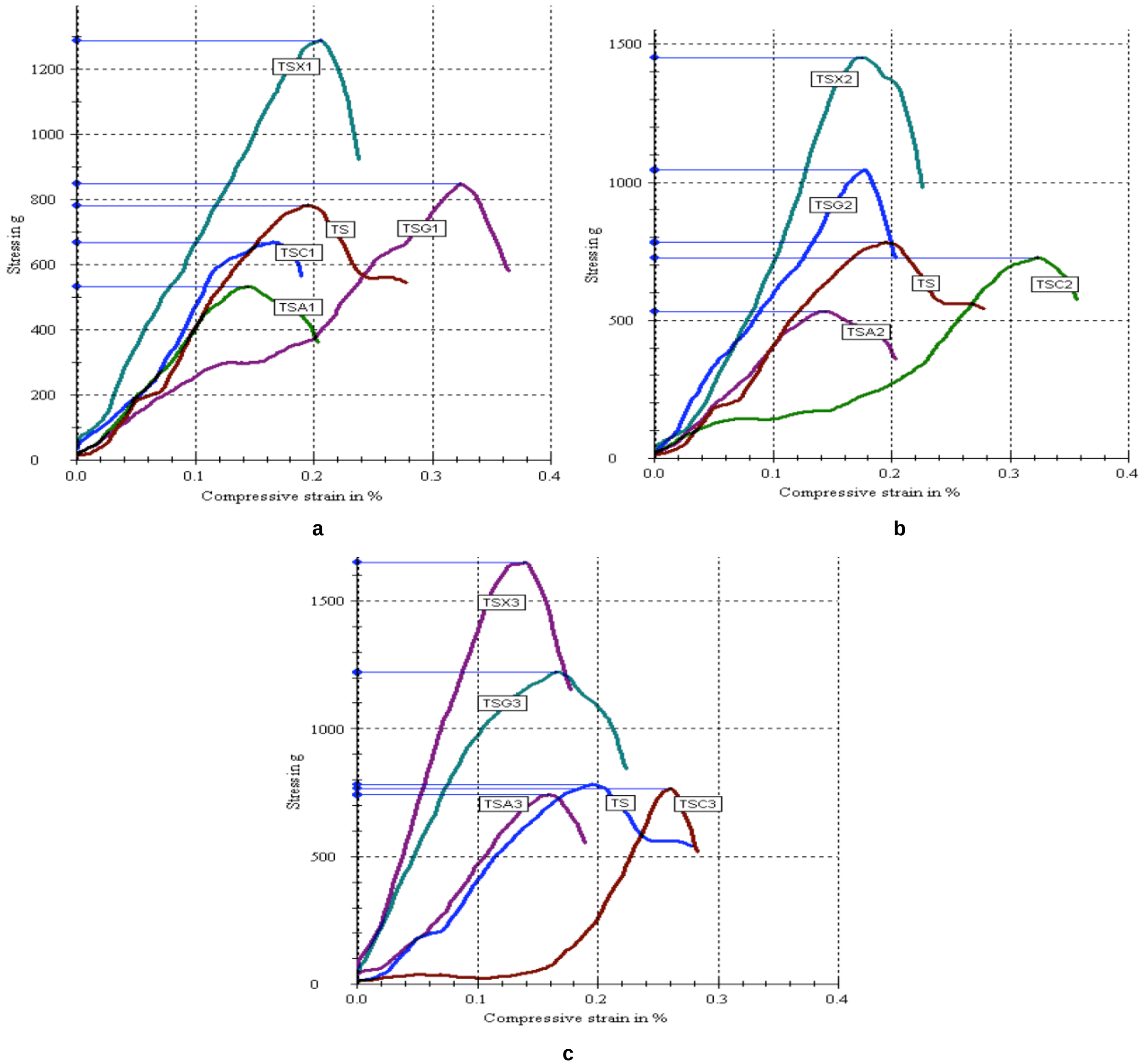


**Figure 2: a**: Effect of hydrocolloid (0.2 %) and taro starch (3 %) on gel strength of milk dessert obtained by UTM. TS = Taro Starch, TSA1 = Taro starch with 0.2 % gum arabic, TSC1 = Taro starch with 0.2 & CMC.

TSG1 = Taro starch with 0.2 % guar gum, TSX1 = Taro starch with 0.2 % Xanthan gum.

**b**: Effect of hydrocolloid (0.4 %) and Taro starch (3 %) on gel strength of milk dessert obtained by UTM. TS = Taro Starch, TSA2 = Taro starch with 0.4 % gum arabic, TSC2 = Taro starch with 0.4 & CMC.

TSG2 = Taro starch with 0.4 % guar gum, TSX2 = Taro starch with 0.4 % Xanthan gum.

**c**: Effect of hydrocolloid (0.6%) and Taro starch (3 %) on gel strength of milk dessert obtained by UTM. TS = Taro Starch, TSA3 = Taro starch with 0.6 % gum arabic, TSC3 = Taro starch with 0.6 & CMC.

TSG3 = Taro starch with 0.6 % guar gum, TSX3 = Taro starch with 0.6 % Xanthan gum.

0.2% gaur gum) in dessert formulation considerably increased the firmness of the dessert. The maximum gel strength was observed in the case of xanthan which formed a very firm gel even at 0.2 %. Conversely, TSA and TSC (taro starch-CMC) reduced the strength of the dessert as compared to control. However, when the hydrocolloid level was increased from 0.2 % to 0.6 %, both TSA3 (taro starch-0.6 % arabic gum) and TSC3 has been found to produce a firm gel similar to control.

## Sensory Evaluation

The sensory data indicated that mouth feel and texture of dessert were greatly affected by all hydrocolloids particularly; TSG and TSX were found to be effective to improve the overall quality of dessert (Table **1a-1c**). At 0.4 % gum concentration, mouth feel score for TSG2 (taro starch-0.4 % guar gum) and TSX2 (taro starch-0.4 % xanthan gum) were found to be 4.55 and 4.38, respectively. Similarly, at the same gum

**Table 1a: Influence of Hydrocolloids (0.2 %) and Taro Starch (3 %) on the Sensory Characteristics of Milk Dessert**

| Sample | Visual Appearance | Aroma | Taste | Mouth feel | Texture | Overall* Acceptability |
|---|---|---|---|---|---|---|
| TS | 4.00 ± 0.1$^{a}$ | 4.02 ± 0.3$^{a}$ | 4.12 ± 0.2$^{a}$ | 4.10 ± 0.2$^{a}$ | 3.88 ± 0.2$^{a}$ | 3.98 ± 0.3$^{a}$ |
| TSA1 | 4.08 ± 0.2a | 3.90 ± 0.2$^{b}$ | 4.15 ± 0.3$^{a}$ | 4.00 ± 0.2$^{b}$ | 3.74 ± 0.1$^{b}$ | 3.84 ± 0.2$^{b}$ |
| TSC1 | 4.05 ± 0.3$^{a}$ | 4.15 ± 0.2$^{c}$ | 3.96 ± 0.2$^{b}$ | 4.07 ± 0.3$^{a}$ | 3.92 ± 0.2$^{a}$ | 4.02 ± 0.2$^{a}$ |
| TSG1 | 4.14 ± 0.1$^{b}$ | 4.10 ± 0.1$^{c}$ | 4.16 ± 0.3$^{a}$ | 4.20 ± 0.2$^{c}$ | 4.02 ± 0.3$^{c}$ | 4.15 ± 0.3$^{c}$ |
| TSX1 | 4.15 ± 0.4$^{b}$ | 4.05 ± 0.2$^{a}$ | 4.18 ± 0.2$^{a}$ | 4.20 ± 0.1$^{c}$ | 3.98 ± 0.2$^{c}$ | 4.08 ± 0.1$^{c}$ |

Five point hedonic scale ratings: 5 = like extremely and 1 = dislike extremely.
*Overall acceptability was calculated by weighted arithmetic mean, given the following weight to each attribute: Visual appearance 15%, Aroma 15%, Taste 25%, Mouth feeling 20% and Texture 25%.
Values are means ± SD of triplicates, n = 3.
Values in the same column with different superscript are significantly different ($P < 0.05$).

**Table 1b: Influence of Hydrocolloids (0.4 %) and Taro Starch (3 %) on the Sensory Characteristics of Milk Dessert**

| Sample | Visual Appearance | Aroma | Taste | Mouth feel | Texture | Overall* Acceptability |
|---|---|---|---|---|---|---|
| TS | 4.00 ± 0.1$^{a}$ | 4.02 ± 0.3$^{a}$ | 4.12 ± 0.2$^{a}$ | 4.10 ± 0.2$^{a}$ | 3.88 ± 0.2$^{a}$ | 4.02 ± 0.3$^{a}$ |
| TSA2 | 3.98 ± 0.2$^{a}$ | 3.80 ± 0.3$^{b}$ | 4.06 ± 0.4$^{b}$ | 3.82 ± 0.1$^{b}$ | 3.60 ± 0.1$^{b}$ | 3.85 ± 0.4$^{b}$ |
| TSC2 | 4.04 ± 0.4$^{a}$ | 4.12 ± 0.2$^{c}$ | 4.14 ± 0.1$^{a}$ | 4.12 ± 0.1$^{a}$ | 3.93 ± 0.2$^{c}$ | 4.08 ± 0.3$^{a}$ |
| TSG1 | 4.12 ± 0.3$^{b}$ | 4.02 ± 0.1$^{a}$ | 4.20 ± 0.2$^{c}$ | 4.55 ± 0.2$^{c}$ | 4.44 ± 0.1$^{d}$ | 4.26 ± 0.1$^{c}$ |
| TSX2 | 4.08 ± 0.2$^{b}$ | 4.15 ± 0.2$^{c}$ | 4.12 ± 0.2$^{a}$ | 4.38 ± 0.3$^{d}$ | 4.34 ± 0.2$^{d}$ | 4.20 ± 0.3$^{c}$ |

Five point hedonic scale ratings: 5 = like extremely and 1 = dislike extremely.
*Overall acceptability was calculated by weighted arithmetic mean, given the following weight to each attribute: Visual appearance 15%, Aroma 15%, Taste 25%, Mouth feeling 20% and Texture 25%.
Values are means ± SD of triplicates, n = 3.
Values in the same column with different superscript are significantly different ($P < 0.05$).

**Table 1c: Influence of Hydrocolloids (0.6 %) and Taro Starch (3 %) on the Sensory Characteristics of Milk Dessert**

| Sample | Visual Appearance | Aroma | Taste | Mouth feel | Texture | Overall* Acceptability |
|---|---|---|---|---|---|---|
| TS | 4.00 ± 0.1$^{a}$ | 4.02 ± 0.3$^{a}$ | 4.12 ± 0.2$^{a}$ | 4.10 ± 0.2$^{a}$ | 3.88 ± 0.2$^{a}$ | 3.98 ± 0.3$^{a}$ |
| TSA3 | 4.04 ± 0.2$^{a}$ | 4.15 ± 0.2$^{b}$ | 4.10 ± 0.2$^{a}$ | 3.67 ± 0.3$^{b}$ | 3.44 ± 0.2$^{b}$ | 3.89 ± 0.4$^{a}$ |
| TSC3 | 3.96 ± 0.1$^{a}$ | 4.02 ± 0.4$^{a}$ | 4.18 ± 0.3$^{b}$ | 4.18 ± 0.3$^{a}$ | 4.06 ± 0.4$^{c}$ | 4.06 ± 0.3$^{b}$ |
| TSG3 | 4.05 ± 0.2$^{a}$ | 4.00 ± 0.2$^{a}$ | 4.00 ± 0.2$^{c}$ | 4.47 ± 0.3$^{c}$ | 4.34 ± 0.2$^{d}$ | 4.21 ± 0.2$^{c}$ |
| TSX3 | 4.00 ± 0.3$^{a}$ | 4.13 ± 0.1$^{b}$ | 4.15 ± 0.3$^{b}$ | 4.26 ± 0.2$^{d}$ | 4.12 ± 0.3$^{c}$ | 4.13 ± 0.3$^{b}$ |

Five point hedonic scale ratings: 5 = like extremely and 1 = dislike extremely.
*Overall acceptability was calculated by weighted arithmetic mean, given the following weight to each attribute: Visual appearance 15%, Aroma 15%, Taste 25%, Mouth feeling 20% and Texture 25%.
Values are means ± SD of triplicates, n= 3.
Values in the same column with different superscript are significantly different ($P < 0.05$).

concentration the texture score for both blends were 4.34 and 4.44. On contrary, TSA received the low score of mouth feeling and texture as compared to control. TSA3 reduced the mouth feel score upto 3.67 from 4.10, whereas at the same gum concentration texture score was reduced upto 3.44 from 3.88. No positive or negative effect was observed by adding TSC as it almost maintained the somewhat similar sensory scores at all gum concentrations.

## DISCUSSION

The stability of texture of prepared dessert was related to amount of free water released by the dessert gel. The released water was separated by centrifugation and measured as percent syneresis. It was found that syneresis was effectively reduced when both TSG and TSX were added with taro starch in the formulation of milk dessert. This remarkable reduction may be due to the ability of TSG and TSX to hold the water molecules and make them immobilized in gel network. It was observed that, TSC was found to be ineffective at 0.2 % but at high gum concentrations it reduced the syneresis to a significant extent. It was interesting to note that TSA did not affect dessert gel syneresis, in spite of the fact that the TSA decreased the syneresis in simple gel-hydrocolloid system. This variation could be the result of complex dessert system where the other ingredient affected on the overall water separation by weakening the polymeric networking. It was found that, at 0.2 % hydrocolloid concentration, the firmness of milk dessert was found to be significantly high when both TSX2 and TSG2 were added in dessert formulation with taro starch. It was already discussed that xanthan gum possessed better ability to form firm gel by promoting the reassociation of amylose chains and build-up of continuous network during the cooling process. This effective gelling role of xanthan and guar has already been reported by various author [19, 20]. As a matter of fact, during gelatinization of starch, water penetrates into the starch granules and consequently amylose is leached out and disperses into aqueous phase. When starch paste is cool down polymeric chains form three dimensional networking and form gel like matrix. Hydrocolloids, particularly xanthan gum encouraged the formation of gel matrix and this resulted in cross-links between amylose, amylopectin and hydrocolloid chains [21]. In another report, it was discussed that when hydrocolloids are added to starch paste the gel is strengthened because the adhesion between the starch granules bonded them firmly and subsequently the strength of gel increases [22]. On contrary, TSA and TSC decreased the firmness and made the texture of dessert soft.

The sensory evaluation of the dessert with or without hydrocolloid blends was conducted by ten trained judges and they were asked for scoring numbers of sensory attributes including visual appearance, aroma, taste, mouth feeling and texture. It was observed that both guar and xanthan gums along with taro starch gave better performance to improve the sensory parameters of milk dessert. Conversely, TSA adversely affected the dessert and reduced the score of mouth feeling and texture at all gum concentrations. It was noteworthy that both TSG2 and TSX2 received high score, suggesting that at 0.4 % concentration of both guar and xanthan gums is sufficient in order to perceive better mouth feel and texture attributes. In comparison, TSG is more functional to improve the mouth feeling and texture of prepared dessert. The improvement in sensory characteristics of dessert by xanthan gum was also reported by Sikora *et al.* (2007) [23]. In milk based desserts, mouth feel creaminess is an important quality attribute for the acceptance of consumer [24]. It has been reported that mouth feel palatability and acceptance of dessert can be correlated with other texture parameters particularly, thickness and smoothness [25]. In our study, however, there was a clear relation between perceived variations in thickness and in creaminess when guar and xanthan gums.

## CONCLUSION

The study concluded that taro starch-hydrocolloid blends particularly arabic, guar and xanthan gums blended with taro starch can be utilized as functional ingredients to improve the textural and sensory characteristics of milk dessert. It was also established that addition of various hydrocolloids with native taro starch is an alternative modification treatment to improve the functional properties of native starches.

## REFERENCES

[1] Hoover R. Composition, molecular structure, and physicochemical properties of tuber and root starches: A review. Carb Polym 2001; 45(3): 253-267. http://dx.doi.org/10.1016/S0144-8617(00)00260-5

[2] Tattiyakul J, Pradipasena P, Asavasaksakul S. Taro (*Colocasia esculenta*) amylopectin structure and its effect on starch functional properties. Starch/Stärke 2007; 59(7): 342-347. http://dx.doi.org/10.1002/star.200700620

[3] Lauzon RD, Shiraishi K, Yamazaki M, Sawayama S, Sugiyama N. Physicochemical properties of cocoyam starch . Food Hydrocol 1995; 9(2): 77-81. http://dx.doi.org/10.1016/S0268-005X(09)80268-3

[4] Adebayo AS, Itiola OA. Properties of starches obtained from Colocasia esculenta and Artocarpus communs. Nigerian J Nat Prod Med 1998; 2: 29.

[5] Aboubakar, Njintang YN, Scher J, Mbofung CMF. Physicochemical, thermal properties and microstructure of taro (*Colocasia esculenta* L. Schott) flours and starches. J Food Engg 2008; 86: 294-305. http://dx.doi.org/10.1016/j.jfoodeng.2007.10.006

[6] Yanli W, Wenyuan G, Xia L. Carboxymethyl Chinese yam starch: synthesis, characterization, and influence of reaction parameters. Carb Res 2009; 8(13): 1764-1769. http://dx.doi.org/10.1016/j.carres.2009.06.014

[7] Rosell CM, Rojas JA, Benedito de Barber C. Influence of hydrocolloids on dough rheology and bread quality. Food Hydrocol 2001; 15: 75-81. http://dx.doi.org/10.1016/S0268-005X(00)00054-0

[8] Shi X, Bemiller JN. Effects of food gums on viscosities of starch suspensions during pasting. Carb Polym 2002; 50: 7-18. http://dx.doi.org/10.1016/S0144-8617(01)00369-1

[9] Chaisawang M, Suphantharika M. Effects of guar gum and xanthan gum additions on physical and rheological properties of cationic tapioca starch. Carb Polym 2005; 61(3): 288-295. http://dx.doi.org/10.1016/j.carbpol.2005.04.002

[10] Gómez M, Ronda F, Caballero PA, Blanco CA, Rosell CM. Functionality of different hydrocolloids on the quality and shelf-life of yellow layer cakes. Food Hydrocol 2007; 21(2): 167-173. http://dx.doi.org/10.1016/j.foodhyd.2006.03.012

[11] Kohajdová Z, Karovicová J. Influence of hydrocolloids on quality of baked goods. Acta Scientiarum Polonorum Technologia Alimentaria 2008; 7(2): 43-49.

[12] Cai XR, Gu ZB, Hong Y. Effects of guar gum and xanthan gum on pasting and rheological properties of native and modified potato starch. Food Sci 2011; 32(17): 22-26.

[13] Anjum N, Feroz A, Abid H. Functional properties of cowpea (Vigna unguiculata) starch as modified by guar, pectin, and xanthan gums. Starch/Stärke 2014; 66: 832-840. http://dx.doi.org/10.1002/star.201300268

[14] Englyst HN, Anderson V, John HC. Starch and non-starch polysaccharides in some cereal foods. J Sci Food Agric 1983; 34(12): 1319-1443. http://dx.doi.org/10.1002/jsfa.2740341219

[15] Khalil AH. Quality of french fried potatoes as influenced by coating with hydrocolloids. Food Chem 1999; 66(2): 201-208. http://dx.doi.org/10.1016/S0308-8146(99)00045-X

[16] Bárcenas ME, Benedito C, Rosell CM. Use of hydrocolloids as bread improvers in interrupted baking process with frozen storage. Food Hydrocol 2004; 18(5): 769-774. http://dx.doi.org/10.1016/j.foodhyd.2003.12.003

[17] Feroz AJ, Abid H, Khalid J, Tahir A. Isolation, determination and characterization of taro (Colocasia esculenta) starch. Pak J Sci Ind Res 2005; 48(4): 292-296.

[18] Hoover R, Senanayake PJN. Composition and physicochemical properties of oat starches. Food Res Int 1996; 29(1): 15-26. http://dx.doi.org/10.1016/0963-9969(95)00060-7

[19] Babbar SB, Jain R. Xanthan gum: an economical partial substitute for agar in microbial culture media. Curr Microbiol 2006; 52: 287-292. http://dx.doi.org/10.1007/s00284-005-0225-5

[20] Saha D, Bhattacharya S. Hydrocolloids as thickening and gelling agents in food: a critical review. J Food Sci Technol 2010; 47: 587-597. http://dx.doi.org/10.1007/s13197-010-0162-6

[21] Keetels CM, Van Vliet T, Walstra P. Relationship between the sponge structure of starch bread and its mechanical properties. J Cereal Sci 1996; 24: 27-31. http://dx.doi.org/10.1006/jcrs.1996.0034

[22] Liu H, Lelièvre J. A differential scanning calorimetry study of melting transitions in aqueous suspensions containing blends of wheat and rice starch. Carb Polym 1992; 17: 145-149. http://dx.doi.org/10.1016/0144-8617(92)90108-3

[23] Sikora M, Kowalski S, Tomasik P, Sady M. Rheological and sensory properties of dessert sauces thickened by starch–xanthan gum combinations. J Food Engg 2007; 79: 1144-1151. http://dx.doi.org/10.1016/j.jfoodeng.2006.04.003

[24] Elmore JR, Heymann H, Johnson J, Hewett JE. Preference mapping: relating acceptance of "creaminess" to a descriptive sensory map of a semi-solid. Food Quality Prefer 1999; 10: 465-475. http://dx.doi.org/10.1016/S0950-3293(99)00046-4

[25] Kokini JL, Cussler EL. Psychophysics of fluid food texture. In H. Moskowitz, ed. Food Texture: Instrumental and Sensory Measurement. Dekker, New York 1987; 97-127.

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