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# Effect of Xanthan Gum and Homogenization on the Stability of Palmyrah (*Borassus flabellifer* L) Ready-to-Serve Drink

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## ABSTRACT

**Palmyrah (*Borassus flabellifer* L) fruit pulp is widely utilized in the preparation of many value-added products. The problem identified in the production of Palmyrah ready-to-serve drink (RTS) is the layer separation and loss of uniformity during storage. Hence, this study was conducted with the intention of producing a customer-appealing product with the optimization of stability with stabilizer (xanthan gum) and homogenization. The concentration of xanthan gum and the application of homogenization were selected as the two factors in the experimental design. The effect of different treatments on the physical properties (sedimentation height, turbidity, viscosity, pH, brix and colour) over the storage period was studied. Five treatments were selected based on sedimentation height and they were subjected to sensory evaluation with fifteen trained panelists. According to the experimental results, sedimentation was not observed during the storage period of 30 days for the homogenized and non-homogenized RTS with xanthan gum (0.3%). Increasing concentration of xanthan gum and the application of homogenization significantly increased the stability and turbidity of RTS. The concentration of xanthan gum has a positive effect on the viscosity of the RTS. The viscosity of the RTS decreased with the storage time. Application of xanthan gum decreased the L* value and slightly increased a* value and drastically increased the b* value. Based on the sensory analysis of the above treatments homogenized RTS with the inclusion of 0.3% xanthan gum was selected as the best based on the ranking of overall acceptability.**

**Keywords:** Homogenization, Palmyrah, Ready-to-serve drink, Stability, Xanthan gum.

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## INTRODUCTION

Palmyrah (*Borassus flabellifer*) fruit pulp contains many nutritional and medicinal values. Flabelliferins in the pulp reduces the glucose absorption and decrease the blood cholesterol level (Sangheetha et al., 2015). Further,

palmyrah fruit is rich in antioxidants which are beneficial in the prevention of cardiovascular diseases and cancer (Sangheetha *et al*., 2015). The fruit pulp provides a number of traditional preparations. These include a type of chewing gum (pinnatu), jams, cordials, sauces, toffees, and can be a component in ice cream, biscuits, fruit bars and other confectionaries (Jansz *et al*., 2002).

Palmyrah fruit ready-to-serve drink available currently in the market contains palmyrah fruit pulp, sugar, sodium metabisulphite, citric acid, artificial color, and artificial flavor. The problem identified in the production of the above product is the layer separation, when adding the pulp as it is. Usually in the production centers, the pulp was filtered and only the filtrate was added into the beverage to avoid the layer seperation. Hence, the water insoluble nutrients such as dietary fibers in the pulp are lost. Meanwhile addition of artificial flavor and color causes the loss of Palmyrah flavor to the product.

The beverages should be stable and homogeneous without particle aggregation. However, there are three physical phenomena that cause instability of a suspension: sedimentation, aggregation and coalescence (Márquez Cardozo *et al*., 2017). In food industry, polysaccharides are commonly used as stabilizers to stabilize beverages (Márquez Cardozo *et al*., 2017). For example, some researches have addressed the influence of these biopolymers on the stability of cloudy apple juices, mango energy drink and cloudy strawberry beverages (Akkarachaneeyakorn and Tinrat, 2015; Márquez Cardozo *et al*., 2017; Teleszko *et al*., 2019).

This research was conducted with the intention of solving the above problems with the application and optimization of suitable stabilizers and also to check the effect of stabilizers on the physical, chemical and sensory parameters over the storage period.

## MATERIALS AND METHODS

### *Sample Collection*

Preserved palmyrah fruit pulp was purchased from production center of Palmyrah Development Board, Jaffna, Sri Lanka. Sugar, sodium metabisulphite (SMS), citric acid, Xanthan gum were purchased from local market, Jaffna, Sri Lanka.

***Formulation of Ready-to-Serve Drink***

Sterile water (100ml), sugar (10g) and palmyrah fruit pulp (13g) were measured and mixed well. An additional step introduced in the production was the addition of stabilizer, xanthan gum (XG). Then they were homogenized using a homogenizer (VELP Scientifica - OV5, Italy) at 10,000rpm for 3 minutes followed by pasteurization until reaching $90^0$C. After the above step, drink was cooled until $85^0$C. Then citric acid (0.07g) and SMS (0.005g) were added and stirred well. Then the drink was hot filled into the sterilized glass bottles.

***Experimental Design***

Three concentrations of xanthan gum with 0.1%, 0.2%, and 0.3% and application of homogenization (homogenization at 10,000 rpm for 3 minutes, without homogenization) were selected as the two factors in the experimental design as shown in Table 1.

***Evaluation of Physiochemical Parameters***

Ready-to-serve drink prepared in the above treatments were stored at room temperature and sedimentation height, pH, brix, viscosity, turbidity, colour were checked using a measuring scale, pH meter (sension$^{TM+}PH_3$, Germany), automatic refractometer (SMART-I, Japan), viscometer (SMART series, Japan), turbidity meter (2100M 15, USA) and colorimeter (NR20XE, China), respectively.

***Sensory Evaluation***

Sensory analysis was conducted for the selected five treatments based on the least sedimentation height with the help of ten trained panellists in Palmyrah Research Institute considering the attributes such as appearance, colour, texture, aroma, taste, and overall acceptability.

**Table 1**. Experimental design of treatments.

| No | Xanthan gum (w/v %) | Homogenization |
|---|---|---|
| 1 | 0.0 | Not Applied |
| 2 | 0.0 | Applied |
| 3 | 0.1 | Not Applied |
| 4 | 0.2 | Not Applied |
| 5 | 0.3 | Not Applied |
| 6 | 0.1 | Applied |
| 7 | 0.2 | Applied |
| 8 | 0.3 | Applied |

### *Statistical Analysis*

One-way analysis of variance (ANOVA) and Turley's Test were Performed using Minitab 17 Statistical Software. Sensory data was analysed by Friedman test.

## RESULTS AND DISCUSSION

### *Variation in Sedimentation Height*

Figure 1(a) shows the variation of sedimentation height of Palmyrah RTS with the application of different treatments. Sedimentation was not observed for homogenized and non-homogenized RTS with xanthan gum (0.3%) after the completion of one month of storage period. Sedimentation was not observed in homogenized and non-homogenized RTS with 0.2% xanthan gum after the completion of 1$^{st}$ week. But sedimentation was observed after completion of 2$^{nd}$ week. Normally sedimentation height is directly proportional to the stability of the RTS. Hence, the increasing concentration of stabilizers and the application of homogenization reduce the sedimentation height of RTS.

### *Variation in Viscosity*

Figure 1(b) Shows that increasing concentration of stabilizers increased the viscosity of the RTS and the viscosity decreased with the storage time, while application of homogenization did not have an effect on viscosity. Similar trend was observed in the RTS of mulberry juice by Akkarachaneeyakorn and Tinrat (2015). Application of stabilizers like pectin and Carboxy Methyl Cellulose (CMC) has also been reported to increase the viscosity of the mango energy drink (Márquez Cardozo *et al*., 2017).

### *Variation in Turbidity*

Figure 1(c) shows that increasing concentration of stabilizers and application of homogenization increased the turbidity of the RTS. Products that have separated have lower turbidity because they are more transparent to light than products with less separation. Therefore, the turbidity decreased as separation of the product increased. Increasing the mass fraction of the stabilizer improved the stability of RTS of mulberry juice (Akkarachaneeyakorn and Tinrat, 2015).

***Variation in Brix and pH***

A significant difference was observed in the brix and pH within the treatments at 95% confidence level. But there were no uniform trends observed within the treatments. Addition of stabilizers like CMC and pectin in mango energy drink has increased the brix and increased the pH (Márquez Cardozo *et al*., 2017). These results show some contradiction with the application of xanthan gum. (Figure 1(d) and Figure 1(e)).

***Variation in Colour***

According to Table 2, in the control sample, the value of parameter L* (lightness) was 43.58, whereas that of a*parameter (proportion of red/green color) was 4.9 and that of b* parameter (proportion of yellow/blue color) was 1.01. Application of stabilizers decreased the L* value and increased the a* value slightly and increased the b* value drastically. L* value and b* value decreased with storage time, while a* value increased with the storage time. Application of homogenization to the control sample significantly decreased the L* value and increased the a* value, while it does not have any significant effect on the b* value. Increasing the concentration of stabilizers significantly decreased the L* and a* values and increased the b* value. Carotenoid compounds in the palmyrah fruit pulp is responsible for the bright yellow colour of the RTS and it was indicated by b* value. We can suggest the addition of stabilizers increasing the concentration of stabilizers to maintains the homogeneity of the carotenoid compounds in the RTS. A significant increase in brightness was reported in the strawberry beverages containing XG for doses of 0.2% and 0.3% (Akkarachaneeyakorn and Tinrat, 2015).

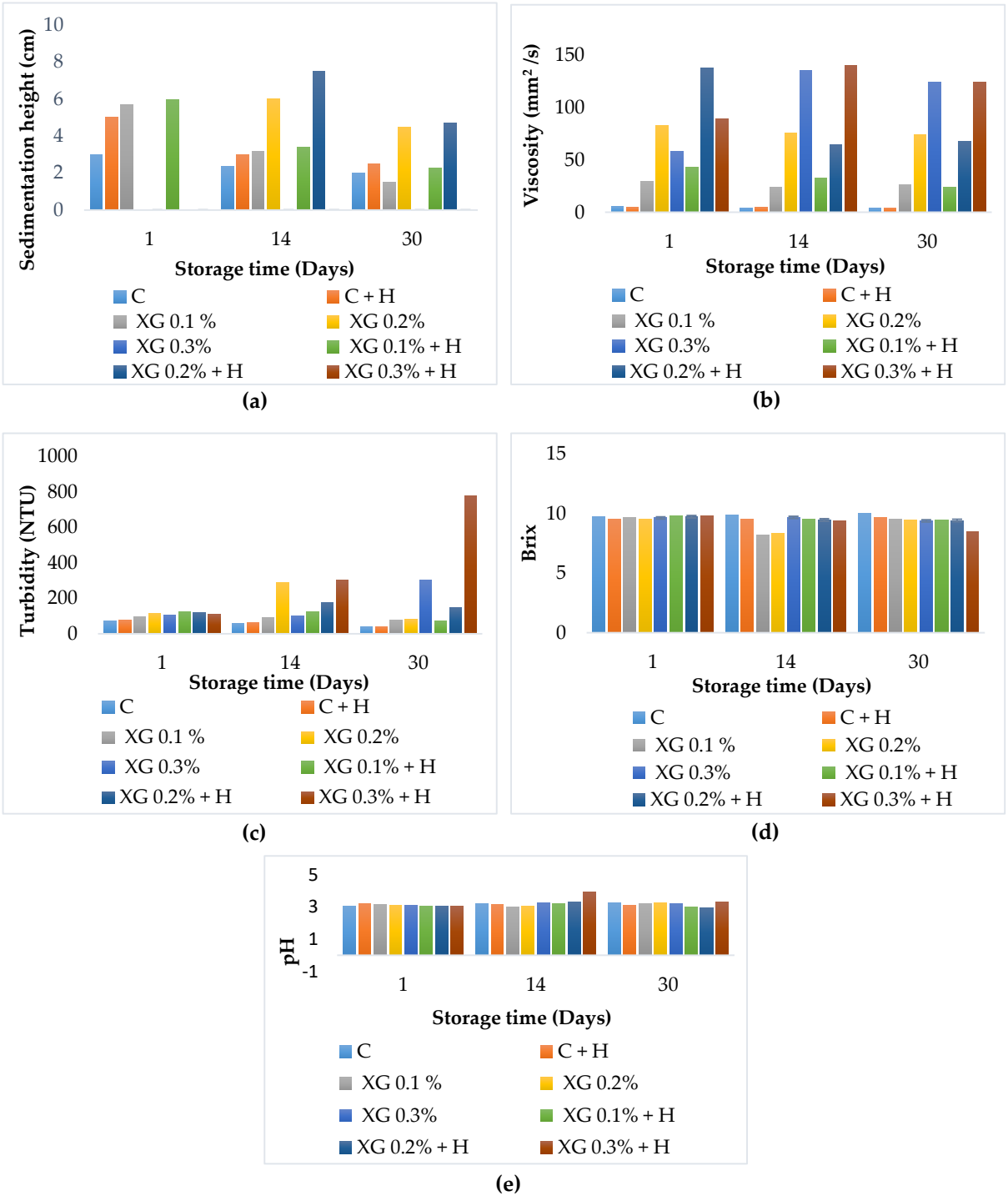



**Figure** 1. Variation of physical properties of RTS with storage time (a)Variation of sedimentation height, (b)Variation of viscosity, (c)Variation of turbidity, (d)Variation of brix, (e)Variation of pH, C-Control, C+H- Homogenized; XG 0.1% - 0.1% of xanthan gum; XG 0.2% - 0.2% of xanthan gum; XG 0.3% - 0.3% of xanthan gum; XG 0.1% +H – Homogenized and 0.1% of xanthan gum; XG 0.2% +H –Homogenized and 0.2% of xanthan gum; XG 0.3% +H – Homogenized and 0.3% of xanthan gum.

**Table 2**. Variation of colour of the RTS with storage time.

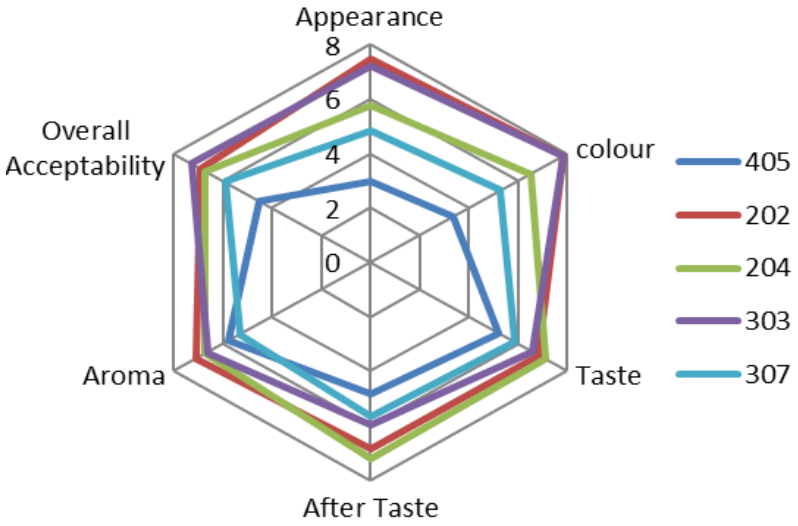
| Treatments | L* | | a* | | b* | |
|---|---|---|---|---|---|---|
| | Day 01 | Day 30 | Day01 | Day 30 | Day 01 | Day 30 |
| C | 43.58±0.09$^{a}$ | 4.90±0.03$^{g}$ | 4.9±0.03$^{e}$ | 15.31±0.06$^{g}$ | 1.01±0.02$^{g}$ | 7.02±0.04$^{c}$ |
| C+H | 33.47±0.04$^{c}$ | 6.73±0.05$^{d}$ | 6.74±0.05$^{d}$ | 28.93±0.06$^{b}$ | 1.21±0.08$^{g}$ | 6.94±0.05$^{c}$ |
| XG 0.1% | 39.23±0.05 $^{b}$ | 10.54±0.03$^{a}$ | 10.53±0.03$^{c}$ | 24.86±0.03$^{e}$ | 14.31±0.06$^{e}$ | 9.75±0.18$^{a}$ |
| XG 0.2% | 31.73±0.02$^{e}$ | 5.82±0.08$^{f}$ | 5.82±0.09$^{b}$ | 21.53±0.68$^{f}$ | 14.93±0.08$^{d}$ | 7.26±0.06$^{b,c}$ |
| XG 0.3% | 32.23±0.15 $^{d}$ | 6.51±0.06$^{d}$ | 6.52±0.06$^{a}$ | 27.87±0.16$^{c}$ | 17.42±0.04$^{b}$ | 7.32±0.06$^{b,c}$ |
| XG 0.1% +H | 27.20±0.09 $^{h}$ | 6.93±0.04$^{c}$ | 6.93±0.04$^{b}$ | 29.94±0.06$^{a}$ | 9.59±0.09$^{f}$ | 7.87±0.16$^{b}$ |
| XG 0.2% +H | 31.06± 0.09$^{f}$ | 8.02±0.04$^{b}$ | 8.02±0.05$^{a}$ | 26.19±0.04$^{d}$ | 18.07±0.01$^{a}$ | 7.37±0.53$^{b,c}$ |
| XG 0.3% +H | 29.57±0.18$^{g}$ | 7.86±0.03$^{b}$ | 7.86±0.03$^{c}$ | 28.73±0.06$^{b,c}$ | 15.94±0.07$^{c}$ | 7.16±0.09$^{b,c}$ |

*C-Control, C+H- Homogenized; XG 0.1% - 0.1% of xanthan gum; XG 0.2% - 0.2% of xanthan gum; XG 0.3% - 0.3% of xanthan gum, XG 0.1% +H – Homogenized and 0.1% of xanthan gum; XG 0.2% +H – Homogenized and 0.2% of xanthan gum; XG 0.3% +H – Homogenized and 0.3% of xanthan gum. Figures sharing same letters as the superscript in a same column are not significantly different at 95% confidence level.*

Considering the changes in the other parameters of the chromatic space (a*, b*), increasing the contribution of a particular colour component in relation to the control sample is proportional to the hydrocolloid dose used (Teleszko et al., 2019).

***Sensory Analysis***

Based on the sensory analysis of the above treatments homogenized RTS with the inclusion of 0.3% was selected based on the ranking of overall acceptability. Inclusion of xanthan gum (2%) had the highest ranking for taste and after taste attributes. Increasing concentration of xanthan gum increased the viscosity of the RTS and reduced the taste of the product. Increasing concentration of xanthan gum increased the ranking for appearance and colour of the product (Figure 2).




**(a)**


**(b)**

**Figure 2**. Sensory evaluation; (a) Results of sensory evaluation; 405 – Control, 204 – 0.2% Xanthan gum, 307 – 0.2% Xanthan gum and Homogenization, 202 – 0.3% Xanthan gum, 303 – 0.3% Xanthan gum and Homogenization, (b) Treatments subjected to sensory evaluation as the same order of the results.

## CONCLUSION

Increasing concentration of xanthan gum and application of homogenization significantly affect the sedimentation height, turbidity, viscosity and colour. Based on the sensory analysis of the above treatments homogenized RTS with the inclusion of 0.3% was selected based on the overall acceptability.

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