

DEVELOPMENT OF A RICE-BASED FRUIT DESSERT AND ITS STORAGE PROPERTIES

G.A. GUNAWARDHANA¹ and I.Z. SARTAJ²

¹*Field Crops Research and Development Institute, Mahailuppallama, Sri Lanka*

²*Food Research Unit, Peradeniya, Sri Lanka*

ABSTRACT

An attempt was made to develop a rice-based fruit dessert with the objective of seeking alternative uses of rice together with combined health and nutritional benefits of rice and fruits. The product was successfully prepared by heating cooked rice slurry (where the ratio of cooked rice to water was 2:3 w/w) with fruit pulp and sugar (where the ratio of each to the slurry was 1:6 w/w) for 15 minutes, to a thick consistency, followed by refrigerating overnight at 4°C. The basic physical and chemical characters of the dessert were established. The product had a shelf life of two weeks at 4°C and it was successfully prepared using wood apple, pineapple, mango and papaya. After two weeks of storage, the product underwent physical changes, apparently due to retrogradation caused due to high amylose content. The study was extended to evaluate the effect of rice variety on storage behavior. Rice varieties with high amylose contents were more sensitive to retrogradation at low temperature storage, with a rate of moisture separation of above 0.27 % per day and an increase of hardness above 5.1 g cm⁻²day⁻¹. In the rice variety with low amylose content (Bg HR 6), the moisture separation was 0.06 % per day and increase of hardness was 3.7 g cm⁻²day⁻¹. This variety showed the highest consumer acceptability and highest stability during storage, due to the stability of amylopectin to retrogradation.

KEYWORDS: Rice based Dessert, Storage Properties, Retrogradation

INTRODUCTION

Rice, the staple food of Sri Lanka, is mainly consumed as cooked rice and also used to prepare other forms of meals such as hoppers, string hoppers, etc. Apart from the preparation of traditional sweet meal, alternative uses of rice are limited to incorporation with wheat flour-based products such as noodles and biscuits. Through facilitating rice processing, economic value of milled or broken rice can be increased and employment can be generated at village level (Juliano *et al.*, 1988).

When heated with water, swelling of amylose and disintegration of amylopectin makes a random configuration of starch causing thickening of the matrix leading to gelatinization (Sajilata *et al.*, 2006). When the starch concentration is high this paste forms a gel during cooling (Lii *et al.*, 1996). Hence, a slurry of cooked rice could be used to prepare a dessert with a texture similar to a pudding, with incorporation of fruit pulp and sugar to add colour and flavor to the final product and increase nutritional and health benefits. Specific rice varieties are preferred by the producers for different products

development and processing can even magnify the varietal differences (Juliano *et al.*, 1988).

Retrogradation, the changes that occur in a starch paste or gel on aging (Hsu and Heldmand, 2005), is caused due to inherent tendency of starch molecules to align with one another by increased hydrogen bonding causing loss of water molecules originally included in the starch matrix (Wei, 2006). This phenomenon has been observed during low temperature storage of dessert (Hsu and Heldmand, 2005), which is caused due to amylose moiety, as the linear structure facilitates cross linkages through formation of hydrogen bonds. The branched nature of amylopectin inhibits this recrystallization (Sajilata *et al.*, 2006).

The present study was conducted with the objectives of introducing an alternative use of rice by using a slurry of cooked rice to prepare a dessert with incorporation of fruit pulp and sugar. The effect of rice varieties with different amylose content were also studied on the storage behavior of the dessert.

MATERIALS AND METHODS

Optimization of processing method for rice based dessert

For the experiment aimed at optimizing the processing conditions, rice (*Oryza sativa* L) var. Bg 304 and wood apple (*Limonia acidissima* L.) were used. Rice was milled (Yanmar rubber roll sheller, Type ST50) and polished (McGill, No 2). Processing method which was optimized after several preliminary studies is given in Figure 1.

The amounts of ingredients for preparation of one batch of dessert weighing approximately 1200 g, which is equivalent to 15 cups with approximate net weight of 75 g, were 400 g cooked rice, 600 g water, 200 g sugar and 200 g wood apple pulp. The prepared dessert was stored under ambient condition (27-30°C) or in a refrigerator (4°C) for further studies.

Evaluation of basic physico-chemical and microbial qualities of the dessert

Moisture content of raw and cooked rice and that of the dessert soon after preparation and one day after refrigerated storage was measured using standard oven drying method (AOAC, 1990).

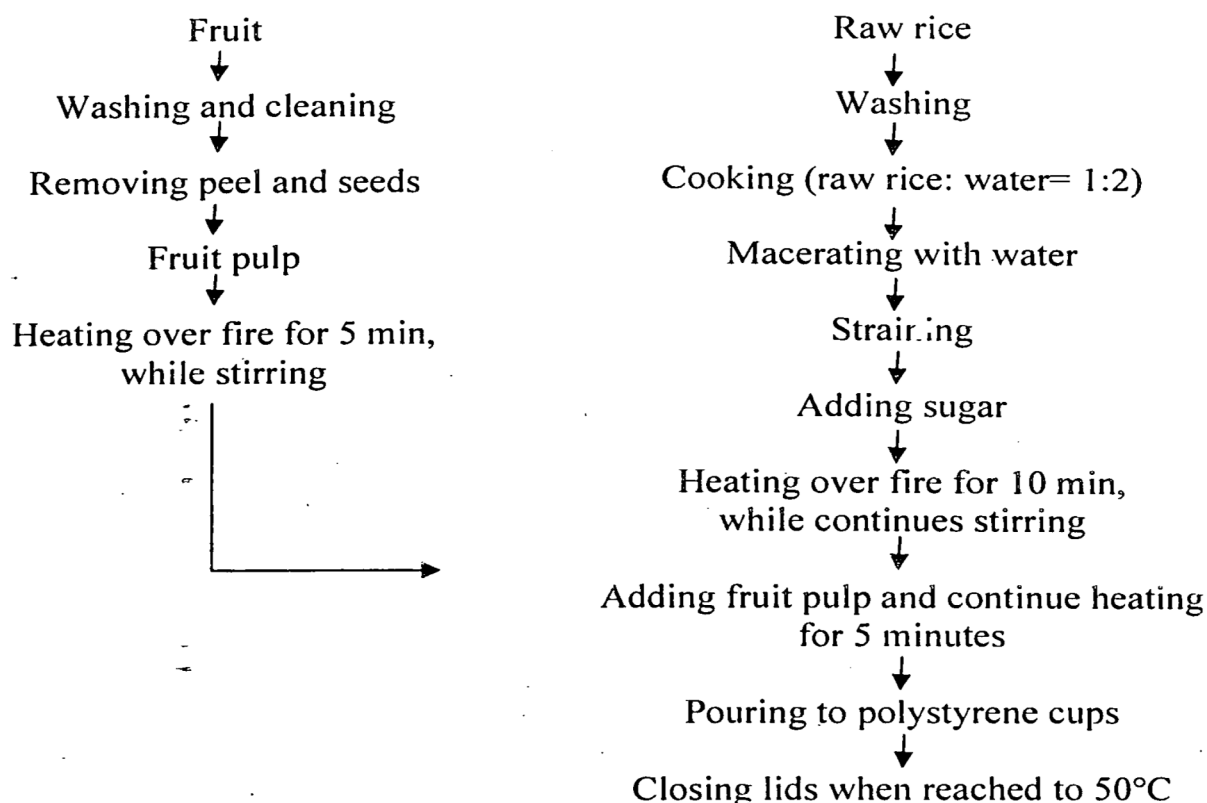


Figure 1. Process flow diagram for production of dessert

The initial microbial quality was examined by taking an aerobic plate count, yeast and mould count and determining the presence of coliforms (SLSI, 1991). Titratable acidity and Brix value of the product were also measured (AOAC, 1990). Hardness was measured using a locally designed penetrometer, where weight in grams needed to penetrate 1 cm through the gel by a wooden rod of 0.5 cm diameter was measured and values were presented in g/cm^2 . All readings were taken from three cups drawn from three separate batches. Values were expressed as the mean \pm standard deviation.

Effect of the type of fruit on the product quality

The possibility of preparing the dessert with the three other types of fruits, pineapple (*Ananas comosus* L), mango (*Mangifera indica* L. var. Karthakolomban) and papaya (*Carica papaya* L. var. Red lady) in place of wood apple was studied. The amount of fruit pulp and sugar were determined based on the taste. Ratio of cooked rice to fruit pulp were 4:2 (w/w), 4:2.5 (w/w) and 4:3 (w/w) for pineapple, mango and papaya, respectively, while it was 4:2 (w/w) for wood apple. Ratio of sugar to cooked rice were also in the same order except for mango in which it was 4:2.75 (w/w). Sensory characters were judged by seven semi-trained panelists for appearance, taste, odor, texture and overall acceptability using five-point hedonic scale (1) dislike

extremely, (2) dislike very much, (3) neither dislike nor like, (4) like very much, and (5) like extremely. Results were analyzed using Freidman's test ($p=0.05$).

Preliminary storage studies

The dessert was prepared and stored using rice variety Bg 304 and wood apple with four different treatments *i.e.* 70 ppm Potasium Metabisulphite (KMS) in ambient storage (27-30°C), 70 ppm KMS in refrigerated storage (4°C), and without the addition of KMS at each storage temperatures. Each treatment was replicated 20 times in separate polystyrene cups. Five cups from each treatment was removed weekly for four consecutive weeks and counted for number of spoiled and unspoiled cups considering the physical changes by visual observation.

Effect of rice variety on the quality of the product

Six rice varieties, namely Bg 250, Bg 304, Bg 357, Bg 379-2, Bg 94-1, and Bg HR 6 were obtained from the Rice Research and Development Institute, Batalagoda, Sri Lanka. All were recommended varieties except Bg HR 6, which is a hybrid. The amylose content and gelatinization temperatures of these rice varieties are given in Table 1. The fruit used was wood apple. Based on positive results obtained in preliminary storage study, dessert was prepared without preservatives for refrigerated storage.

Table 1. Amylose content and gelatinization temperature or rice varieties

<i>Variety</i>	<i>Amylose content</i>	<i>Gelatinization temperature</i>
Bg 250	High	Intermediate
Bg 304	High	High
Bg 357	High	High
Bg 379-2	High	High
Bg 94-1	High	High to Intermediate
Bg HR 6	Low	High to Intermediate

Source: Rice Research and Development Institute, Batalagoda.

To study the pattern of physical changes hardness, the moisture content and weight of moisture separated from gel, were measured. Hardness and moisture content were measured as explained in the evaluation of basic physico-chemical and microbial qualities of the dessert. Initial weight of the dessert was measured by subtracting empty weight of the cup from the weight of the cups soon after reaching room temperature. Moisture separated from gel was calculated as a per cent of initial weight. To assess chemical changes, titratable acidity was measured (AOAC, 1990). All readings from each variety of rice, were taken weekly for four consecutive weeks in triplicate. The R^2 values for rate of moisture separation from the gel and rate of increase of hardness of the dessert made from each rice variety was calculated to

comprehend the correlation of the same with time. Sensory evaluation was done weekly to find the effect of fruit type on the product quality.

RESULTS AND DISCUSSION

Optimization of processing method

The optimum ratio of cooked rice to water was 2:3 (w/v), in order to achieve the final product texture. Lower ratio resulted in watery mixtures, which are unable to gel, while higher ratio showed quick gelling causing clotting during heating. Overnight refrigeration is required to achieve the texture of the gel.

Evaluation of basic physico-chemical and microbial qualities of the dessert

Basic physico-chemical properties of the dessert are given in Table 2. There was approximately 12 % moisture separation during preparation irrespective of the moisture added from the fruit pulp. Soon after preparation, dessert had a low level of hardness, which was difficult to measure. Hardness increased after refrigeration (Sajilata *et al.*, 2006). Initial aerobic plate count, yeast and mold count were zero and coliform were absent. A low acidity of 0.007 g/100g of the dessert indicates high perishability, however, higher Brix value contributed to osmotic preservation.

Table 2. Basic physico-chemical properties of rice and dessert

Property	Product	Mean \pm SD
Moisture content (wb)	Raw rice	12.67 \pm 3.25 %
Moisture content (wb)	Cooked rice	73.86 \pm 2.76%
Moisture content (wb)	Dessert soon after preparation	61.36 \pm 2.49%
Moisture content (wb)	Dessert after overnight refrigeration	61.14 \pm 3.02%
Hardness	Dessert after overnight refrigeration	11.05 \pm 2.06 g/cm ²
Titrateable acidity	Dessert	0.007 g/100g \pm 0.001
Brix	Dessert	37.2 \pm 0.8°

Values are means of three replicates.

Effect of fruit type on the product quality

The product can be successfully prepared with wood apple, pineapple, mango and papaya, with acceptable sensory qualities. Fruit pulp requirements for mango and papaya were higher than that of other fruits. Depending on the amounts of sugar and acid content of each fruit types, the amounts of sugar and fruit pulse need to be added to achieve final product quality varied.

Mean sensory scores are given in Figure 2. Sensory analysis indicated that pineapple has a significantly higher ($p < 0.05$) acceptable aroma, while mango had the least accepted odor. All four fruits were acceptable without significant difference in the overall acceptability ($p > 0.05$).

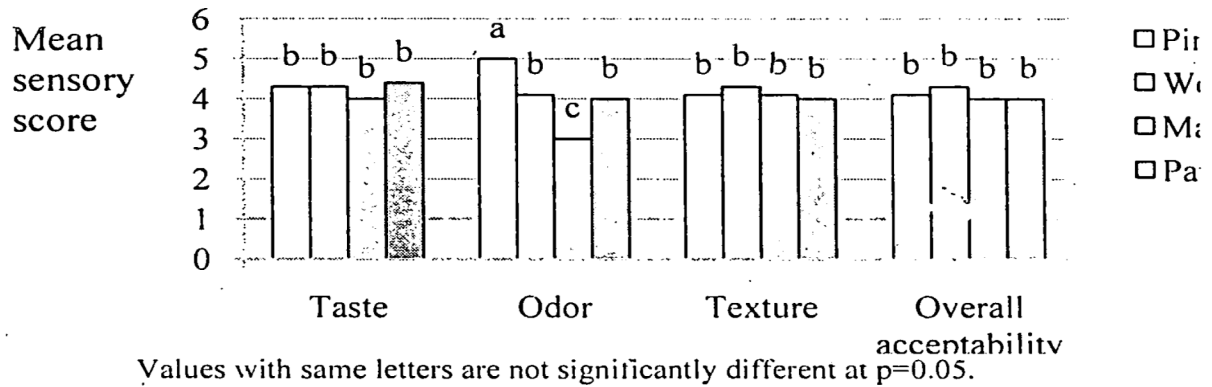


Figure 2. Sensory attributes of the dessert prepared with different fruits

Preliminary storage study

The % of spoiled cups and cups with physical changes are presented in Table 3. Storage life of the dessert without preservatives under ambient storage was less than two days, but could be extended to two weeks by adding 70 ppm KMS. Spoilage pattern was similar in KMS-treated samples under ambient and refrigerated storage.

Table 3. Percentage of spoiled cups and cups that underwent physical changes

	% spoiled cups				% of cups with physical changes				
	Day	2	9	16	23	2	9	16	23
Blank, Ambient		20	40	80	80	0	0	0	0
Blank Refrigerated		0	0	0	0	0	0	100	100
Ambient with KMS		0	0	0	40	0	0	0	0
Refrigerated with KMS		0	0	0	0	0	0	40	60

Dessert stored under ambient condition did not undergo physical changes until day 23 in storage. Physical changes were observed only in refrigerated samples starting from the 3rd week, while they were not observed in sample stored at ambient condition even at the 4th week. Two main physical changes observed, apparently due to retrogradation, were separation of water from the gel and shrinking of the gel making it to separate from the container. Loss of flavor to the removed water and loss of colour was also observed. Retrogradation was observed at low storage temperatures above -5°C (glass transition temperature) at concentrations above 70 % (Hsu and Heldmand, 2005). Juliano (1990) explained that cooked rice starch granules can be retrogradated by cooling for 4 hrs or keeping overnight at 4°C .

The KMS was not successful in extending shelf life due to its inability to prevent physical changes of the product. In general, consumer preference for products without preservatives is higher and these preservatives are believed to cause harmful effects on human (Papazian, 1996). Moreover, this product is comparable to yoghurt, a dessert having a shelf life of two weeks under refrigerated storage. It is thus, concluded to produce the dessert without preservatives and stored under refrigerated conditions for subsequent studies.

Effect of rice variety on the quality of the product

Figure 3 illustrates the changes in basic physico-chemical properties of the dessert during refrigerated storage. Table 4 gives the rates of moisture separation from the gel and hardness increase. Results revealed that changes in titratable acidity were irregular with less variation and moisture content of all varieties reduced with time.

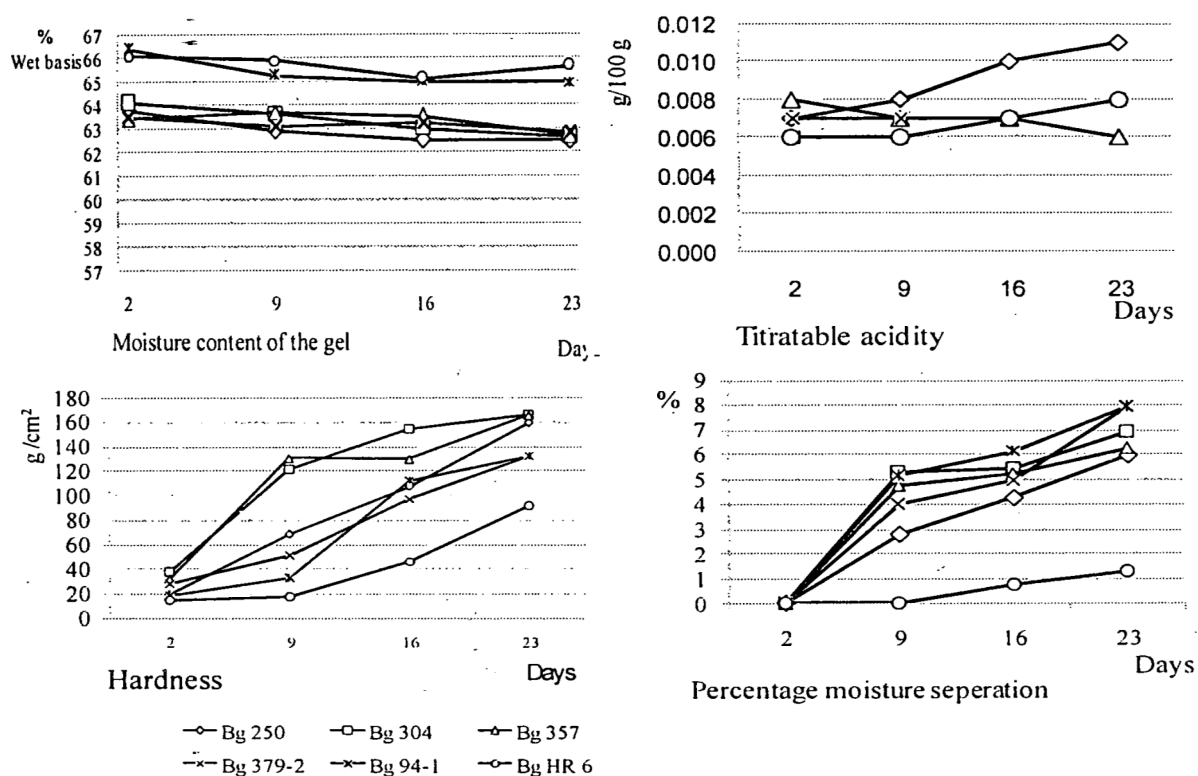


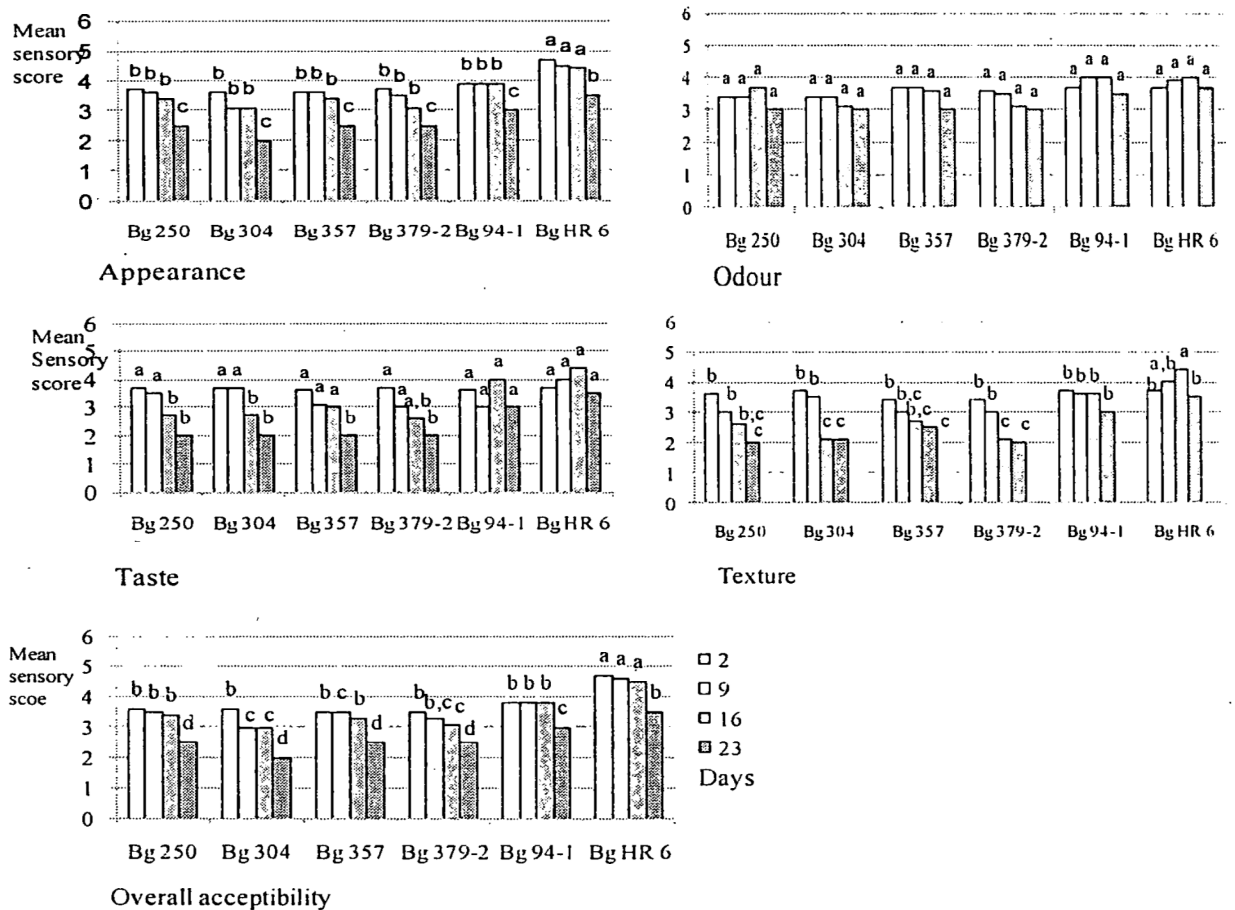
Figure 3. Physico-chemical changes of the dessert prepared with different rice varieties with wood apple over time

Lii *et al.* (1996) explained that rigidity of starch granule depends on amylose content, where low amylose granules are less firm. The rice variety containing low amylose contents, Bg HR 6, showed the lowest hardness. Juliano *et al.* (1988) explained that varietal difference of rice products in terms of texture is correlated to amylose content, but not to gelatinization

temperature. Amylose content has the most direct influence on the rice product, with a dramatic effect on the texture and physico-chemical properties (Del Mundo and Juliano, 1981).

Table 4. Rates of separation of moisture from the gel and increase of hardness of the dessert over time

Variety	Moisture separation		Increase in hardness	
	% separation / day	R ²	gcm ⁻² / day	R ²
Bg 250	0.277	0.979	6.54	0.997
Bg 304	0.298	0.795	5.94	0.864
Bg 357	0.274	0.799	5.71	0.807
Bg 379-2	0.353	0.950	5.14	0.886
Bg 94-1	0.354	0.884	6.02	0.919
Bg HR 6	0.064	0.899	3.72	0.880



Values with same letters are not significantly different at p=0.05.

Figure 4. Changes in sensory qualities of the dessert prepared with different rice varieties over time

Changes in sensory attributes of the dessert (Figure 4) illustrated that there was a significantly high acceptability for the variety Bg HR 6 in terms of appearance, texture and even the taste, than other varieties during the storage period. The variation in sensory scores of the product was minimum compared to other varieties. All the varieties except Bg HR 6 and Bg 94-1 were rejected at the day 16 (sensory score ≤ 3) and Bg 94-1 was rejected at day 23. Odour did not change significantly in all varieties. All varieties except Bg HR 6 were high amylose varieties. The higher retrogradation of high amylose varieties affects texture and consumer acceptability (Hsu and Heldmand, 2005). Retrogradation can be reduced by production of cross linked starch, hypochlorite-oxidized starches, starch phosphate monoesters and pre-gelatinized starch (Wei, 2006).

CONCLUSIONS

Rice-based fruit dessert can be successfully prepared by heating cooked rice slurry with fruit pulp and sugar for 15 min over fire, followed by cooling at 4°C overnight. The dessert has a shelf life of two weeks under refrigerated conditions and has acceptable sensory qualities when prepared with wood apple, pineapple, mango and papaya. Rice varieties with low amylose content such as Bg HR 6, was the most suitable due to higher stability during refrigerated storage and high consumer acceptability.

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