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EFFECT OF PROCESSING CONDITIONS AND GELLING AGENTS ON THE PHYSICO-CHEMICAL AND SENSORY CHARACTERISTICS OF JACKFRUIT JAM ADDING TO YOGURT

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ABSTRACT

Jam is an effective and tasty way of preserving fruit. Most tropical fruits can be processed and preserved in order to reduce post harvest loss in small scale operations. The potential of the nutritious jackfruit (*Artocarpus heterophyllus*), has remained largely untapped. The study was conducted to investigate the effects of pectin concentration (0.7 to 0.9%) and gum arabic concentration (0.9 to 1.1%); vacuum pressure (450 to 650 mmHg) and holding time (2.5 to 4 minutes) on processing and jackfruit jam quality. Stirred and FOB-type fruit-flavored yogurt were made by adding jackfruit jam at different ratios (5 to 20%). In this work, vacuum technology was proven as adequate to obtain jam with the typical characteristics of water activity, degree Brix and viscosity of jam adding to yogurt. Proximate analysis showed vitamin C in jam 0.45 mg%, pH from 3.9 to 4 and ^{o}Brix from 53-54. The sensory evaluation showed that samples submitted to more intense vacuum pressure heating had significantly higher scores in color saturation, brightness, good texture and taste. These indicated that high vacuum pressure treatment prevents jackfruit jam color change and increases the consistency of the jam. In this way, jam was preferred by assessors mainly due to its higher consistency and suitability for adding to yogurt processing. The samples obtained by this procedure were stable during storage. Addition of 15% of Jackfruit jam into stirred yogurt and layered type of yogurt (FOB) provided products with strong aroma, good taste (sour and sweet harmony) and texture without water release.

Keywords: Jackfruit, jam, thickening agent, yogurt, vacuum cooking.

Ảnh hưởng của các điều kiện chế biến và tác nhân tạo gel đến các đặc tính lý hóa học và cảm quan của mứt đông mít bổ sung vào sữa chua

TÓM TẮT

Chế biến mứt đông là một trong các biện pháp bảo tồn chất lượng của trái cây. Hầu hết trái cây nhiệt đới có thể được chế biến và bảo quản nhằm giảm tổn thất sau thu hoạch với các hoạt động ở quy mô nhỏ. Tiềm năng của loại trái cây bổ dưỡng như mít (*Artocarpus heterophyllus*) vẫn chưa được khai thác triệt để. Nghiên cứu được tiến hành nhằm tìm hiểu ảnh hưởng của pectin (nồng độ 0,7-0,9%) và gum arabic (nồng độ 0,9-1,1%); áp suất chân không (450-650 mmHg) và thời gian giữ nhiệt (2,5-4 phút) đến tiến trình chế biến và chất lượng mứt đông. Sữa chua hương vị trái cây dạng khuấy và dạng lớp (FOB) được thực hiện bằng cách bổ sung mứt đông mít ở các tỷ lệ khác nhau (5-20%). Trong sản phẩm này, công nghệ chân không đã chứng minh ưu điểm vượt trội cho tiến trình chế biến để có được mứt đông mang các đặc tính lý hóa tốt về hoạt độ nước, độ Brix và độ nhớt phù hợp để bổ sung vào sữa chua. Phân tích sản phẩm cho thấy hàm lượng vitamin C của mứt khoảng 0,45 mg%, pH 3,9-4 và 53-54^{o}Brix. Các đánh giá cảm quan thực hiện để so sánh các sản phẩm cho thấy mứt đông được chế biến ở điều kiện áp suất chân không cao cho giá trị cảm quan cao về màu sắc, độ sáng, cấu trúc và hương vị. Kết quả cũng cho thấy ứng dụng chân không trong công nghệ nấu mứt đã hạn chế sự biến đổi về màu sắc và tăng khả năng đồng nhất của sản phẩm. Đây cũng là đặc điểm được người tiêu dùng quan tâm và thỏa mãn các tính chất lý hóa của sản phẩm mứt đông bổ sung vào sữa chua trái cây. Sản phẩm đảm bảo an toàn và ổn định trong thời gian lưu trữ. Bổ sung 15% mứt đông mít vào sữa chua dạng khuấy và dạng lớp (FOB) đã cung cấp được các sản phẩm yaourt trái cây có hương thơm mạnh, vị hài hòa, cấu trúc tốt và hạn chế tình trạng tách nước trong sản phẩm theo thời gian tồn trữ.

Từ khóa: Mít, mứt đông, nấu chân không, tác nhân tạo đông, sữa chua.

1. INTRODUCTION

Historically, jams were originated as an early effort to preserve fruit for consumption in the off-season (Baker et al., 2005). In traditional jam manufacture, all the ingredients are mixed in adequate proportions, and the mix is concentrated by applying a thermal treatment to reach the required final soluble solids content. Nevertheless, this process also implies an undesirable impact on color, nutritional value and flavor properties due to the high temperature in the cooking process. Vacuum cooking represents one of the most important technical innovations. It shows many nutritious, qualitative, hygienic and economic advantages. From a nutritional point of view, the low and constant cooking temperature allows for the minimization of changes in the vitamin content of jam. In addition, the process of cooking the jam inside a closed hermetic container avoids the loss of principal nutrients. The organoleptic characteristics of jam also benefit from vacuum cooking, the fruit's natural tastes could be maintained after cooking.

Fruit yogurts are very popular among milk products. Today, the consumer's desire for a healthy and fresh diet that is also low in calories, thus, a wide range of fruit yogurts can be found. In the manufacturing of fruit yogurts, the fruit is usually added to the milk product in the form of fruit preparations (as jam). The addition of pectin or arabic gum as a thickening agent results in high-quality fruit preparations with exceedingly positive technological and sensory properties. Fruit yogurts are mainly distinguished by the way the fruit preparation and the yogurt are combined. The majority of yogurts are stirred yogurts where the fruit preparation is directly mixed with the stirred yogurt and then filled into the containers. Another large group are layered products. Fruit jam was prepared for this purpose. The formulation parameters such as content of soluble solids, pH as well as type and dosage of the thickening agents used have a significant effect on both the gelling properties and the texture of the fruit preparation.

The aim of this work was to determine the type and dosage of thickening agents in Jackfruit jam processing. In addition, the vacuum conditions was monitored to obtain high quality jam and to manufature fruit yogurt.

2. MATERIALS AND METHODS

2.1. Materials

Jackfruit pulp was collected from jackfruit variety of Thai origin cultivated in Vietnam. The jackfruit pulp collected was ground into small pieces. The ingredients used for jackfruit jam production included sucrose (CASUCO, Vietnam), thickeners (High-methoxyl pectin from apple, USA and Gum Arabic Powder - KB121, USA) and citric acid (China). Vacuum evaporation equipment (or jam evaporator) was used.

2.2. Sample preparation

- Jackfruit jam preparation

Ten kilogram batches of jackfruit were prepared with 1: 1 Jackfruit pulp to tape water ratio. Next, the soluble solids were monitored during the process until the total soluble solids (TSS) reached 45° Brix. The pH value was controlled with a pH meter and adjusted in the range of 3.2÷3.4 by citric acid. High methoxyl pectin (0.7; 0.8; 0.9 %w/w per total amount of jackfruit pulp, water and sugar) and gum arabic (0.9; 1.0; 1.1 %w/w per total amount of jackfruit pulp, water and sugar) were mixed with sugar and added into the vacuum chamber. The final mixture was boiled in vacuum pressure at 450, 500, 550, 600 and 650 mmHg and holding time of 2.5, 3.0, 3.5 and 4.0 minutes (with evaporated steam temperature of 54-66°C). The hot jam was then removed from the cooker and poured into sterile containers. Finally, jam were covered with lid tightly and cooled down to 37-39°C.

- Yogurt preparation

A solid non fat of fresh cow milk was standardized to 15% by milk powder (Vinamilk, Vietnam). To improve the texture of yogurt, 0.1% of gelatin (blom 220) was added to the milk at 40-45°C. The resulting mixture was homogenized at 65oC and 2500 psi and followed by heating to 80-85°C for 30 minutes. Then the mixture was rapidly cooled to 40-43°C. Incubation with starter culture (0.006 g/l) was performed in fermentation tank at 40-43°C for 6-8 hours. The obtained yogurt (pH 4.6) was cooled to 20-25oC before mixing with jackfruit jam (5, 10, 15 and 20%) to produce stirred and FOB-type fruit-flavored yogurt. For making of FOB-type yogurt, the jam was laid on the bottom of the container which was further filled by yogurt. On the other hand, the jackfruit jam was directly mixed, stirred well with yogurt and then filled into the containers for making stirred yogurt. All experiments were performed in triplicate.

2.3. Chemico-physical measurements

The chemico-physical analysis of the Jackfruit jam was conducted in triplicates. Ascorbic acid content of the final products was analyzed by AOAC standard (2004). Total soluble solids (TSS-°Brix) and pH value was determined by using a refractometer (Model Atago Digital DBX-5) and digital pH meter (Model PHS-2F), respectively. The water activity of the samples was measured by Water Activity (a_w value) Measurement Instruments (NOVASINA, Sweeden). The color of the jam treatments was determined using Minolta colorimeter (Model CR-200, N.J.); the apparatus was first calibrated using a white standard and then the L value was taken (L = lightness or darkness, 100 = white, 0 = black). The viscosity of Jackfruit jam was measured at room temperature by Brookfield Viscometer.

2.4. Sensory evaluation

Sensory analysis was done on the texture, color, flavor (taste), and smell of the Jackfruit jam and resultant fruity yogurt. The sensory evaluations were carried out by the panel of 10 fixed panelists.

For QDA analysis, each panel was requested to evaluate the fruit for various attributes using 5-point hedonic scale (0 = unacceptable, 1 = moderately unacceptable, 2 = neither good nor bad, 3 = moderately good, 4 = good) (Chapman et al., 2001).

For logistic regression analysis (Menard, 2002), the relationship between Logistic Regression and independent variable(s) could be described by the equation of the fitted model: Logistic Regression = exp(η)/(1+exp(η)), where $\eta = \alpha + \beta_1 X + \beta_2 X^2$, α = intercept and β_i = coefficients. Observed values for P (Y=1) must lie between 0 (unacceptable) and 1 (acceptable).

2.5. Statistical analysis

All statistical analyses were performed using Statgraphics Centurion Statistical Software (Version 15.2.11) for Microsoft Windows. The results were analyzed by ANOVA (Multiple Range Test) and the means were separated by LSD (P<0.05). The means and standard deviations were also calculated and plotted using Microsoft Excel software.

3. RESULTS AND DISCUSSIONS

The quality analysis of jackfruit is shown in Table 1. The TSSs in jackfruit were rather high (16.6°Brix) with the major component being sugar (15.84%). Jackfruit is also considered as a good source of antioxidant. 10.32 mg% of vitamin C content in the raw material was observed.

Table 1. Quality criteria of jackfruit

Quality criteria	Content
TSS (°Brix)	16.6±0.3*
Sugar content (%)	15.84±0.25
Acid content (%)	2.47±0.17
pH	4.78±0.18
Vitamin C content (mg%)	10.32±0.22
Pectin content (%)	4.5±0.5

*Note: *Mean value±standard deviation*

3.1. Effects of thickening agents on quality of Jackfruit jam

3.1.1. Physico-chemical properties

Traditional and major application of gelling agent in jam utilise gel forming activity of high methoxyl pectin (HMP) at low pH, high sugar concentration or low water activity. Dissolved sugar and acid conditions ensure that chain-chain interactions dominate over chain-solvent interactions and high sugar condition creates low water activity which can be obtained by other solutes with the same resulting gels (Sharma, 2006). The effect of hydrocolloid concentration on the water activity, total soluble solid, pH value and viscosity of Jackfruit jam is shown in Table 2.

The TSS of Jackfruit jam was 53 to 54ºBrix. Traditional jams carry up to 65ºBrix according to CODEX STAN 79-8 (CODEX STAN 79, 1981). However, all jams formulated in this study carried 53ºBrix, it can be labeled as reduced-calorie jams.

There was no significant difference ($P<0.05$) in water activity between the jams which were cooked with different combined concentrations of HMP and gum arabic. Water activity (a_w) determines the lower limit of available water for microbial growth (Decagon Devices Inc, 2007). In general, the minimum a_w for most moulds was 0.8, most yeasts 0.85, osmophilic yeasts 0.6-0.7 and most bacteria 0.9. pH of the jams remained constant at 3.9-4.0.

The results also demonstrated that an increase in HMP concentration had a significant effect ($P < 0.05$) on the viscosity of Jackfruit jam. Because pectin was used to control viscosity or characteristics the gel-like solution associated with fruits (Caballero et al., 2003) and high molecular weight pectin tend to increase jam viscosity and these values depend upon pectin concentration (Imeson, 2010). According to McWilliams (1997), the role of hydromethoxyl pectin is to form a network or create a thickening effect for jam. Hence, the more pectin used, the thicker the jam. However, high viscosity jam is not suitable for adding to yogurt. Therefore, a combination of HMP and gum arabic was necessary to add into Jackfruit jam. The aim of this work was to reduce the stickiness and the combination of HMP and gum arabic is often used for desirable texture of yogurt. Gum arabic exhibits very low viscosity in water, it has a high branched compact arabinogalactan structure which gives a low viscosity solution together with a central protein fraction that provides good emulsification properties (Thevenet, 2010).

3.1.2. Sensory evaluation

Results from QDA were informative for statistical analysis, and means of attributes in the same sensory category are graphically presented in Figure 1. There was a significant difference in all sensory attributes (color, odor, flavor and texture) among products. The stickiness decreased with the addition of gum arabic to gel formulation without water release. In general, the use of HMP (0.8%) and gum arabic (1%) in Jackfruit jam produced the best structure including moderate viscosity that is suitable for fruit yogurt production.

Table 2. Effect of different combined concentration of High-Methoxyl Pectin (HMP) and gum arabic on the physico-chemical quality of Jackfruit jam

Ratio of HMP and Gum Arabic (in total 1.8% per batch - w/w)	Water activity (a_w)	pH	TSS(ºBrix)	Viscosity (cP)
0.7 : 1.1	0.929±0.006*	3.88±0.09	53.9±0.7	8998.4±727.7
0.8 : 1	0.932±0.003	4.08±0.07	54.3±0.7	10786.4±627.5
0.9 : 0.9	0.933±0.004	3.98±0.18	53.2±0.2	19764.8±1183.1

*Note: *Mean value±standard deviation*

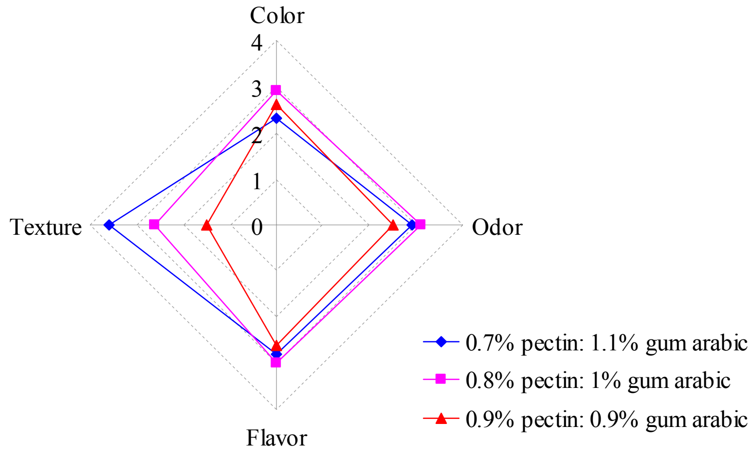

Figure 1. Radar graph showing the sensory profile of the Jackfruit jam samples prepared with different combined concentration of pectin and gum arabic

3.2. Effects of vacuum conditions (vacuum pressure and holding time) on Jackfruit jam's qualities

Vacuum evaporation reduces detrimental changes in quality. By the evaporator, pressure on the surface of liquid decreased. At the same time, the evaporation temperature also declined that minimized undesirable changes in color and prevented loss of vitamin C (Sinha et al., 2012). Proper control of boiling is necessary to avoid over concentration of soluble solids, over inversion of sugar and hydrolysis of pectin (Vibhakara and Bawa, 2006). Manufacture of jams may be considered rather simple; however, unless scientific approaches are not adhered to, the finished product will not be perfect (Hui et al., 2006). Thus, the parameters have to carefully monitored during cooking operation.

3.2.1. Physico-chemical characteristics

Water activity (a_w)

As can be seen in Table 3, water activity (a_w) slightly decreased from 0.93 to 0.921 at longer holding time (2.5–4 min). In contrast, a slight increase in a_w from 0.92 to 0.93 with the rise of vacuum pressure (450 to 650 mmHg) was observed. In general, the water activity of jam from 0.90 to 0.95 is categorized into low calorie jam type. Fruit products, such as jams and jellies, are heated for long period during preparation. This not only destroys vegetative microorganisms, but also reduces a_w by partial inversion of the sucrose present (Lund et al., 2000).

Table 3. Effect of vacuum pressure and holding time on water activity (a_w) of Jackfruit jam

Holding time (minutes)	Vacuum pressure (mmHg)					Average
	450	500	550	600	650	
2.5	0.929	0.927	0.931	0.930	0.935	0.930^{c}
3	0.925	0.925	0.929	0.933	0.93	0.928^{b}
3.5	0.927	0.924	0.925	0.925	0.930	0.926^{b}
4	0.907	0.923	0.925	0.927	0.926	0.921^{a}
Average	0.922^{a}	0.925^{b}	0.928^{c}	0.929^{cd}	0.930^{d}	0.927

Note: Significant differences were indicated by different letters in the same row or column

Viscosity

The viscosity of the products was high in low pressure vacuum condition or long holding time (Figure 2). The highest value was obtained at 22,000 cP when applying vacuum pressure of 450 mmHg and holding time of 4 min for jam processing. It was observed that high evaporation temperature and long cooking time of jam resulted in increasing evaporation intensity and viscosity. And then, the viscosity decreased to the lowest level, nearly 10,000 cP as cooking condition at 650mmHg and 2.5 min was applied. At the same holding time, it seems not significantly different between the viscosity of samples which were cooked at higher vacuum pressures (from 500 to 650 mmHg).

Color (L value)

Vacuum evaporation, since it happens in a medium depleted of oxygen and at lower temperature, preserved color, flavor and vitamins (Sinha et al., 2012). In addition, it also limited caramelization that gave the final products with caramel flavor and brown color. Table 4 shows the vacuum pressure increase from 450 to 650 mmHg at the same holding time (2.5 min), a brighter color of products was observed (or L value increases). Besides, L value decreased slightly in holding time between 2.5 and 4 minutes at the same vacuum pressure level (650 mmHg). The optimum cooking conditions for Jackfruit jam may be at vacuum pressure of 650 mmHg during 3 minutes due to high score of sensory value obtained. Therefore, coloring is not required for jams produced from fresh fruit, when the boiling time is short and the heat is not excessive (Hui et al., 2006).

Ascorbic acid content

The main objective of the vacuum evaporation system is to reduce the boiling point of the liquid to be evaporated, thus reducing the heat requirement in both the boiling and condensation processes. Besides, another technical advantage is the limitation of the decomposition of substances that are sensitive to temperature, such as vitamin C, thiamine... Among water-soluble vitamins, vitamin C is one of the most important substances in evaporation or concentration operation. Therefore, this process must be performed in as short time as possible and at the lowest temperature in order to save heat sensitive substances (Watzl, 2003).

Ascorbic acid is generally considered as a important nutritional quality indicator in food processing. The obtained data indicated that ascorbic acid content reduced when the products were heated at low pressure vacuum (or high evaporation temperature) or long holding time. The highest content of ascorbic acid was observed in jam was boiled at 650 mmHg and the duration of 2.5 to 3 minutes (Figure 3). The degree of ascorbic acid lost is closely related to the oxidation-reduction conditions and the residual enzyme activity (Bayindirli, 2010).

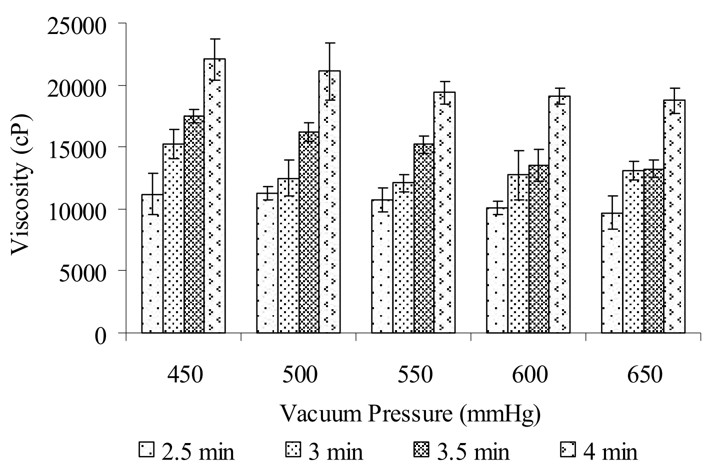

Figure 2. Effect of vacuum pressure and holding time on viscosity of Jackfruit jam

Note: Error bars indicate the standard deviation of the mean values

Table 4. Effect of vacuum pressure and holding time on the color (L value) of Jackfruit jam

Holding time (minutes)	Vacuum pressure (mmHg)				
	450	500	550	600	650
2.5	61.53±0.22	61.09±0.71	62.85±0.03	63.66±0.28	64.78±0.87
3	61.34±0.62	61.68±0.30	61.78±0.05	62.88±0.62	64.84±0.56
3.5	61.66±0.30	61.00±0.52	61.34±0.43	62.41±0.55	63.58±0.37
4	60.44±0.28	60.59±0.13	61.15±0.85	61.04±0.69	61.86±0.67

*Note: *Mean value±standard deviation*

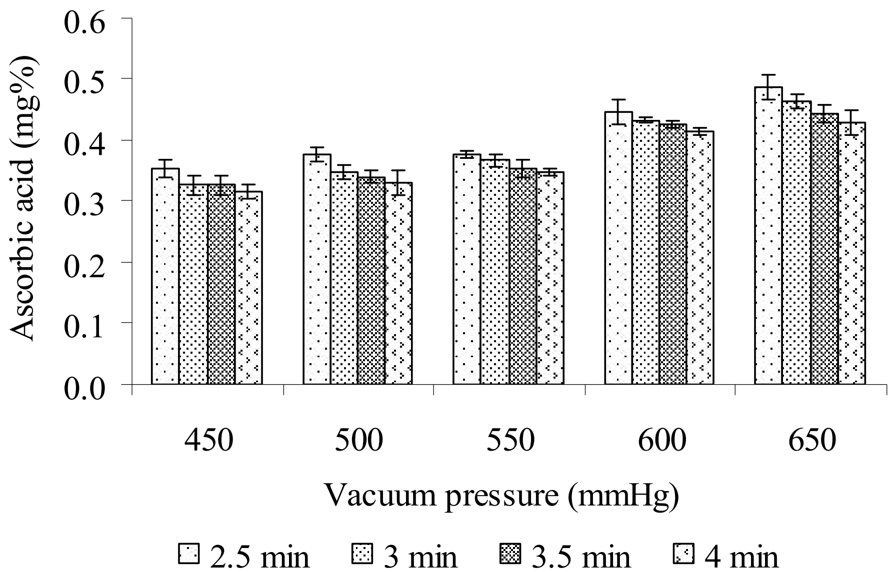

Figure 3. Effect of vacuum pressure and holding time on ascorbic acid content of Jackfruit jam

Note: Error bars indicate the standard deviation of the mean values

3.2.2. Sensory evaluation

Jam cooked in vacuum evaporator limited the loss of fruit aromas and retained fruity characters because the fragrant substances are lost to the condenser water in vacuum pan, instead of to the atmosphere (Phillips et al., 1952).

The sensory attributes (color, odor, flavor and texture) of Jackfruit jam cooked in different vacuum pressure levels (450 650 mmHg) were evaluated by a panel of trainees. There was no significant difference in the texture among the products (Figure 4). However, in general, the higher score of sensory evaluation (in terms of color, odor and flavor) of finished product was associated with increasing vacuum pressure levels from 450 to 650 mmHg (in the same holding time of 3 minutes) for jam processing. This can be explained by the negative effects of high temperature (low vacuum pressure) on fruity flavor, color and aroma changes. In addition, cooking in lower vacuum pressure (or higher temperature) could promote browning reactions in Jackfruit jam.

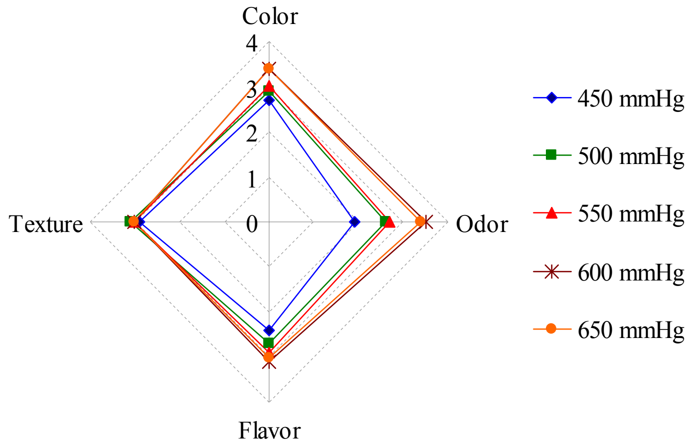

Figure 4. Radar graph showing the sensory profile of the Jackfruit jam samples cooked with different vacuum pressure levels (holding time of 3 minutes)

3.3. Effect of percentage of Jackfruit jam on the sensory characteristics of fruit yogurt (stirred or layered yogurt types)

Stirred yogurt

The yogurt mixed with jackfruit jam (5-20%) had different organoleptic value. After blending yogurt with jam (the concentrations of 5, 10, 15 and 20%), the sensory characteristics (syneresis, smoothness, sweetness, acidity, flavor and color) of the fruit were evaluated (Figure 5). By increasing fruit jam from 5 to 20%, the sweetness of yogurt was observed. Adding lower jam (<5%) in yogurt, the natural flavor of fruit in yogurt was less recognized. In contrast, the yogurt was more difficult to make and required longer time of stirring when higher amount (>15%) of jam added to in yogurt...

The acceptability of consumers for fruit yogurt prepared with different percentage of Jackfruit jam was also analysed using Logistic regression model (Figure 6). With the obtained data from the panelists, the Logistic Regression was estimated using non-linear regression analysis by 2 parts of equation:

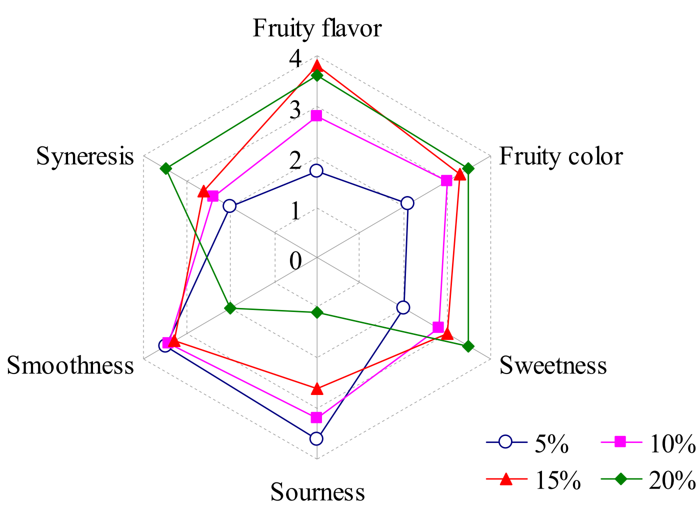

Figure 5. Radar graph showing the sensory profile of the Jackfruit yogurt samples prepared with different percentage of Jackfruit jam

For the first part of equation (observed values for 5 to 15% of Jackfruit jam adding to yogurt), the output shows the results of fitting a logistic regression model to describe the relationship between Logistic Regression (1) and 1 independent variable. The equation of the fitted model is:

Logistic Regression (1) = $\exp(\eta_1)/(1+\exp(\eta_1))$ (1)

where $\eta_1 = 1.899 - 1.125X + 0.079X^2$ (X: percentage of Jackfruit jam)

For the second part of equation (observed values for 10 to 20% of Jackfruit jam adding to yogurt), the output shows the results of fitting a logistic regression model to describe the relationship between Logistic Regression (2) and 1 independent variable with the equation of this fitted model as:

Logistic Regression (2) = $\exp(\eta_2)/(1+\exp(\eta_2))$ (2)

where $\eta_2 = -29.331 + 4.08X - 0.128X^2$ (X: percentage of Jackfruit jam).

The P-value for these models (equa. 1 and 2) in the Analysis of Deviance tables are less than 0.05, indicating that there is a statistically significant relationship between the variables at the 95% confidence level. The results showed the highest acceptability of consumers for fruit yogurt with 15 to 17% Jackfruit jam added into yogurt. Thus, mixing 15% of jam into yogurt seemed to be a good and economical choice.

FOB yogurt

SY: Stirred yogurt; FOB: Fruit on bottom

This study also investigated layered yogurt or FOB yogurt style to reduce water separation and to limit the structural breakdown of product. FOB yogurt type contained the jam on the bottom of the cup, followed by the top layer of fermented yogurt. Before consumption it requires blending to mix the fruit preparation (Chandan, 2006). The results indicated that the additional methods and percentage of jam affect sensory values of the finished product (Table 5).

The percentages of added jam from 10 to 20% provided FOB yogurt with high acceptance scores. However, 15 to 20% of added Jackfruit jam gave products more attractive, but there was no significant difference ($p<0.005$) based on the sensory evaluation among these samples. Layered yogurt, by comparison, was of much higher overall acceptable score because the natural structure of yogurt was broken by blending. The final products, including stirred yogurt and FOB yogurt, were shown in Figure 7.

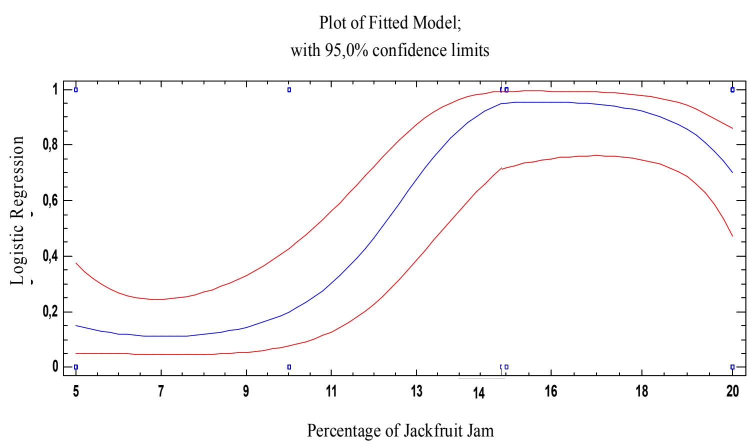

Figure 6. Consumer acceptability of stirred yogurt prepared with different percentage of Jackfruit jam

Note: The blue line (middle) is the mean of observatory values, the red line (above and below the mean) is deviation of the mean was evaluated from the panelists

Table 5. Effect of additional methods and percentage of jam on overall acceptability of 2 types of yogurt (based on hedonic scale 0 to 9)

The additional method - Percentage of jam	Overall acceptability
SY – 5%	5.9^{ab}
SY – 10%	7.6^{c}
SY – 15%	6.9^{bc}
SY – 20%	5.5^{ab}
FOB – 5%	5.3^{a}
FOB – 10%	7.5^{c}
FOB – 15%	8.1^{c}
FOB – 20%	8.3^{c}

Note: Significant differences were indicated by different letters in the same row or column

a. Fruit on bottom (FOB) yogurt

b. Stirred yogurt

Figure 7. Jackfruit yogurt

4. CONCLUSION

Vacuum technique improved Jackfruit jam texture and color and it might be considered as a new technique for producing high quality fruit containing products. Fruit jam additions have developed fruit marketing an increasing effect on yoghurt consumption. Fruit yogurt was rated with higher acceptances by panelists because of coordination between jackfruit flavor and dairy products. The evidence from this study suggested that fruit additives to yogurt increased acceptability of yoghurt.

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