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Physico-Chemical Properties and Acceptability of Purple Sweet Potato Jams with Various Levels of Pectin

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Abstract: Purple Sweet Potato (PSP), both raw and flour can be processed into jam. This study was aimed to evaluate the physico-chemical properties and acceptability of PSP jams made from raw material and flour with the variation of pectin levels. The research was conducted by making jams from both raw PSP and PSP flour, each was added with various pectin levels, i.e., 1.50, 1.75 and 2.00 g. The quality of jams was then measured from the viscosity, pH, moisture and acceptance levels. The results showed that the viscosity of jams from flour (jam-F) was higher than that from the raw PSP (jam-R). The greater the pectin level, the higher the viscosity of the jams. The pH of jam-R was lower than jam-F where the higher the pectin level used, the lower the pH of jams. There was no effect of pectin levels on the moisture content of both jam-R and jam-F. However, the type of preparation affected the moisture content that the jam-F indicated to have higher moisture than the jam-R. Generally, the jam-R displayed higher acceptability than the jam-F. The jam-R with 2.00 g pectin revealed the highest acceptability.

Key words: Purple sweet potato, jam, viscosity, pH, acceptability, properties

INTRODUCTION

Purple Sweet Potato (PSP) is one of the food sources providing various health benefits for the human body, hence known as a functional food (Zhao *et al*., 2013). PSP affects the levels of circulating endothelial cell in diabetic rats. The PSP extract can control blood glucose in diabetic rats (Jawi *et al*., 2012; Wicaksono and Yunianta, 2016). Extract of PSP can reduce malondialdehyde levels and control blood sugar levels of type 2 diabetes patients (Mahadita *et al*., 2016). PSP is also reported to inhibit the growth of rectal cancer cells in mice (Zhao *et al*., 2013) and colon cancer (Tokusoglu and Yildirim, 2012). The various health benefits of PSP are related to the presence of anthocyanins.

Anthocyanin is a phenolic group which is water soluble natural pigment compound found in plant groups including red and blue pigments in fruits, vegetables, flowers and various parts of plants (Khoo *et al*., 2017). Anthocyanin is an unstable pigment that can cause color changes and a decrease in color intensity (Ibrahim *et al*., 2011). Anthocyanin discoloration can occur during processing (Castaneda-Ovando *et al*., 2009), due to the increase in light intensity and temperature (He *et al*., 2015) and roasting (Sui *et al*., 2015). The color change is not expected, so, the factors that can maintain anthocyanin stability need to be considered. Acidity is one of the factors that influence the anthocyanin stability, where the lower the pH, the better the stability of anthocyanins (Oancea and Draghici, 2013). Anthocyanins are more stable at pH = 5, while at pH = 7 the stability decreases (Wang *et al*., 2010). Therefore, in the development of anthocyanin-based products, such as PSP, acidic products should be considered, like jam.

PSP contains pectin, making it possible to be processed into jams. The consistency of the gel, however, is not good because of the high starch level (Devi *et al*., 2017). So, it is necessary to add pectin to improve the consistency of the gel. Pectin is the methylated ester of polygalacturonic acid which is divided into two major groups on the basis of their degree of esterification (Srivastava and Malviya, 2011). Pectin is commonly used as gelling, thickening and stabilizing agents in foods including making jam (Siddiqui *et al*., 2015).

PSP jams can be made from both raw PSP and PSP flour. Different treatments, blanched and unblanched, in making PSP flour can have impacts on physico-chemical characteristics (Jangchud *et al*., 2003). The influence of the processing, the use of raw and flour can give different characteristics of jams. The purpose of this study was to evaluate the physico-chemical properties and acceptability of PSP jams made from raw PSP and PSP flour with the variation of pectin levels.

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MATERIALS AND METHODS

PSP was obtained from a farmer in the Ngawi District, Province of Jawa Timur, Indonesia, harvested 4 months after planting. The pectin, citric acid and sugar were acquired from a supermarket in Surakarta, Province of Jawa Tengah.

Manufacture of PSP flour: The production of PSP flour was carried out as conducted by Olapade and Ogunade (2014). The PSP was washed and peeled, then was sliced into 2 mm, followed by drying using a cabinet dryer at 60°C for 20 h. The slices of dried PSP were milled and sieved for 80 mesh.

PSP jams making The procedure for making PSP jams was modified from Devi *et al.* (2017). There were different treatments in the preparation of materials for making jam-R and jam-F. For making jam-F, the PSP flour and pectin were boiled at 82±2°C for 3 min the mixture was added with sugar and citric acid and continued boiling for 7 min. The jam was then packaged in the glass jars. For jam-R, raw PSP was washed and peeled, then, steamed for 15 min. The steamed PSP was blended with water and pectin. Then, boiling the mixture at 82±2°C for 3 min, added with sugar and citric acid and continued boiling for 7 min. The jam was then packaged in the glass jars. The weight of raw PSP and PSP flour used in making jam-R and jam-F was based on dry weight. The ingredients for jam making are given in Table 1.

Viscosity measurement: The viscosity of PSP jam was assessed by Rion VT04 viscometer (Japan). The sample was placed in the chamber of viscometer and the temperature was set at room temperature. The viscosity was measured for 10 min.

Moisture content measurement: The moisture content of PSP jams was measured using the procedure of AOAC. (2000).

Measurement of pH: The pH of jams was determined by using Adwa AD 110 pH meter. The pH meter was standardized using pH 4.0 and 7.0 buffer solutions.

Table 1: The ingredients of PSP jams making

Ingredients	Jam-R_1	Jam-R_2	Jam-R_3	Jam-F_1	Jam-F_2	Jam-F_3
PSP raw (g)	239.30	238.70	238.14	-	-	-
PSP flour (g)	-	-	-	98.50	98.25	98
Pectin (g)	1.50	1.75	2	1.50	1.75	2
Sugar (g)	158	158	158	158	158	158
Citric acid (g)	1.50	1.50	1.50	1.50	1.50	1.50
Water (mL)	307	307	307	450	450	450

Acceptability test: The acceptability test has obtained the Ethical Clearance Letter No: 760/B.1/KRPK-FKUMS/X/2017. The acceptance test was conducted by 50 panelists From the Department of Nutrition Science, Universitas Muhammadiyah Surakarta. Samples were tested for color, aroma, texture, taste and overall. The acceptance test was based on 7-point hedonic scale, namely 1 = dislike very much, 2 = dislike moderately, 3 = dislike slightly, 4 = neither like nor dislike, 5 = like slightly, 6 = like moderately and 7 = like very much. Panelists were given an explanation of the samples to be tested and how to perform detailed testing. Panelists performed testing from the left sample to the right in sequence. Each sample was given 3-digit random number code. Panelists wrote the results for the color, aroma, texture, taste and overall acceptability on the form.

Statistical analysis: This study used a factorial design with 2 factors. The first factor was the main ingredients, i.e., PSP raw and PSP flour. The second factor was pectin levels (1.50, 1.75 and 2 g). The data were analyzed using the general linear model, univariate test, one-way ANOVA, Kruskall-Wallis and independent t-test. Significant data were followed by Duncan's test at the level of 0.05.

RESULTS AND DISCUSSION

Viscosity of PSP jams: The results showed that viscosity measurements at 10-60 sec for all samples indicated stable viscosity statistically with $p>0.05$. These stable viscosities reveal a Newtonian type. The Newtonian type of the sample is provide a constant viscosity during measurement (Tiwari *et al.*, 2016). According to Awasthi (2011) an aqueous pectin solution shows a Newtonian type. The viscosity of PSP jam is shown in Fig. 1.

Statistically using the t-test, there is a significant difference in viscosity of both jam-R and jam-F with a value of $p<0.05$. In general, jam-F provides higher

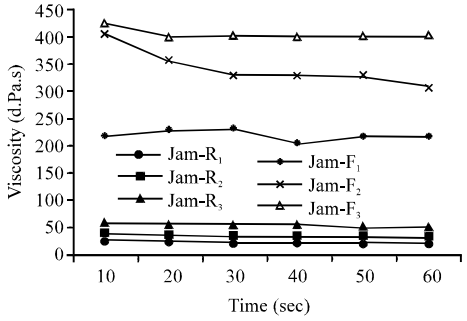

Fig. 1: Viscosity of PSP jams

viscosity than jam-R. According to Malumba *et al.* (2010), steaming affects the product viscosity caused by the increased resistance of starch granules to heat through the formation of inter and intra-molecular amylose. This causes a decrease in the ability of the granule to expand which further decreases the viscosity.

The viscosity of jams, both jam-R and jam-F, increases with increasing levels of pectin. This is in line with the research of Javanmard and Endan (2010) that the higher the level of pectin, the higher the viscosity of jam. An increase in viscosity by pectin is through a gel formation mechanism. Raj *et al.* (2012), explained that gel formation was caused by the formation of hydrogen bonds between free carboxyl groups on pectin molecules and hydroxyl groups of adjacent pectin molecules.

Moisture level of PSP jams: Based on the GLM Univariate test, the moisture content of jam significantly ($p<0.05$) is influenced by the type of preparation materials, namely raw PSP and PSP flour but it is not influenced by the pectin level factor. Both of these factors statistically provide an interaction effect on the moisture level of jams. In general, the moisture level of the jam-F is higher than the jam-R, although, both have been conditioned to get the same volume of water before boiling. According to Rauf when starch granules were added to water then heated, they would swell caused by the diffusion of water. The higher the swelling is, the greater the amount of diffusing water is. The diffusing water can form hydrogen bonds with starch granules. Harianingsih and Wibowo in 2016 stated that, the hydrogen bonds formed could hold water out of the starch granule, so that, evaporation of water was blocked during boiling which resulted in high moisture level of jam-F compared to jam-R. Moreover, Malumba *et al.* (2010) reported that steaming could have an effect on reducing the ability of the starch granules to expand due to the formation of inter and intra-amylose bonds. This reduction in swelling ability causes the presence of free water which is not absorbed and bound to the starch granules, so that, during boiling it is more easily evaporated. This condition causes the moisture content of jam-R to be lower than jam-F. The moisture level of PSP jams is given in Fig. 2.

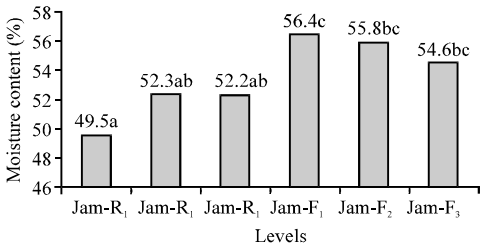

Fig. 2: Moisture levels of PSP jams

Statistically, there is no effect of the pectin level on the moisture content of jam-R and jam-F. The moisture contents of jam-R and jam-F are in the range of 49.52-52.28 and 54.46-56%, respectively. Generally, the moisture content of fruits jams is lower than the PSP jams. Naeem *et al.* (2017) stated that moisture content of several fruit jams products in the Malaysian market was 31-33%. The high moisture content in the PSP jams is related to the high levels of starch. Generally, the moisture content of fruits jams is lower than this PSP. Naeem *et al.* (2017) stated that moisture content of several fruit jams products in the Malaysian market was 31-33%. The high moisture content in PSP jams is related to the high level of starch. Jangchud *et al.* (2003) reported that PSP starch showed the swelling power at temperatures of 55 and 85°C were 140 and 470%, respectively. The highest moisture level in this study was given by jam-F jam with the addition of 2.00 g pectin (moisture level = 56.4%) while the lowest moisture level was given by jam-R with pectin addition of 1.50 g (moisture level = 49.52%).

pH of PSP jams: Statistical test using GLM-univariate indicated that there was an effect of preparation materials (raw PSP and PSP flour) and pectin level on the pH of PSP jams. However, there was no interaction for both, preparation materials and pectin levels. Statistically, the jam-F (t-test) was significantly different from the jam-R, with a significance value for the pectin level of 1.50, 1.75 and 2.00 g which was p = 0.002; 0.001 and 0.001, respectively. The jam-F shows a higher pH than the jam-R. The high pH of jam-F is associated with the reduction of anthocyanin in the flour making. El Husna *et al.* (2013) reported that the reduction of anthocyanins in PSP flour is more than steamed PSP. The pH of PSP jams is displayed in Fig. 3.

The research indicated that there was an effect of the pectin level on the pH of jam. In general, for both jam-R and jam-F, the lowest pH was given by the addition of 2.00 g pectin, i.e., 3.61 and 3.83, respectively. Water-soluble pectin is in the form of pectic acid (Srivastava and Malviya, 2011) which can reduce the pH of the PSP jams.

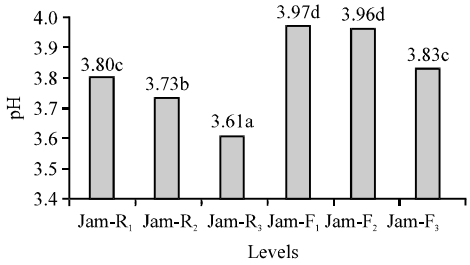

Fig. 3: pH level of PSP jams

Table 2: Acceptability of PSP jams

Treatments	Color	Aroma	Texture	Taste	Overall
Jam-R_1	5,06±1,20^a	3,98±1,34^a	5,44±0,95^c	4,88±1,13^b	4,82±1,082^c
Jam-R_2	4,96±1,22^a	3,74±1,45^a	5,12±1,28^c	4,50±1,40^b	4,62±1,27^c
Jam-R_3	5,40±1,08^a	3,42±1,48^a	5,50±1,03^c	4,80±1,29^b	4,84±1,21^c
Jam-F_1	5,04±1,47^a	3,62±1,49^a	2,54±1,24^b	3,84±1,58^a	3,46±1,32^{ab}
Jam-F_2	5,24±1,37^a	3,48±1,72^a	2,96±1,16^b	3,56±1,44^a	3,52±1,23^a
Jam-F_3	4,94±1,59^a	3,44±1,48^a	2,00±1,05^a	3,38±1,46^a	3,00±1,12^a
(p)	0,447	0,300	0,000	0,000	0,000

$^{a-c}$ Significant values

Acceptability of PSP jams: Statistical analysis shows that there is no significant difference in color and aroma of jam-R and jam-F, indicated by p = 0.447 and p = 0.300, respectively. For taste, texture and overall acceptability of both jam-R and jam-F, however, the pectin level gives the significant effect with p = 0.001. There is no effect of pectin level on all acceptance variables for each of the same preparation materials, namely jams-R and jam-F. The detail acceptability test of PSP jams is shown in Table 2. It can be seen that, there is no significant different in color and aroma of jam-R and jam-F, indicated by p = 0.447 and p = 0.300, respectively. For taste, texture and overall acceptability of both jam-R and jam-F, however, the pectin level gives the significant effect with p = 0.001. There is no effect of pectin level on all acceptance variables for each the same preparation, namely jams-R and jam-F.

Panelists gave a response of "like slightly" for the color of PSP jams and response of "neither like nor dislike" for the aroma of PSP jams. The texture of jam-R shows a significant difference with jam-F. In general, panelists preferred jam-R texture than jam-F texture. The textures of jam-R display "like slightly" to "like moderately" ratings while jam-F texture gives "dislike moderately" ratings to "dislike slightly". The taste acceptability of the jam-R by panelists is higher than the jam-F. In general, the overall acceptability of the jam-R is higher than the jam-F.

CONCLUSION

PSP jams can be made from both raw PSP (jam-R) and its flour (jam-F). Using statistical analysis, the addition of pectin is proved to affect the quality of jams in particular to viscosity, pH and acceptance levels. In general, the addition of pectin increases the viscosity of jam where the viscosity of jam-F is higher than that of jam-R. In fact, the effect of pectin addition is vise versa for the pH. The moisture content, on the other hand is not affected by the pectin level but is affected by the type of preparation materials. The jams made from the raw material (jam-R) which involve steaming process have lower moisture than that from the flour (jam-F). From the overall acceptability test, jam-R is more accepted than jam-F.

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