

## Changes in chemical constituents and overall acceptability of papaya jam fortified with soya protein during storage

*Perubahan karakteristik kimia dan tingkat penerimaan dari selai pepaya yang difortifikasi dengan protein kedelai selama masa penyimpanan*

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### Abstrak

Produk buah olahan umumnya mengandung protein yang sangat rendah akibat proses pemanasan selama pembuatannya. Tulisan ini menyajikan hasil penelitian mengenai peningkatan nilai gizi selai pepaya melalui fortifikasi menggunakan konsentrat protein kedelai. Selai pepaya disiapkan dengan perbandingan 40: 1, 40: 2, 40: 3, 40: 4, dan 40: 5 (v/v) antara bubur pepaya dan konsentrat protein kedelai. Pada perlakuan perbandingan dengan tingkat penerimaan tertinggi kemudian dilakukan analisis karakteristik kimia dan tingkat penerimaan setiap bulan selama tiga bulan penyimpanan. Karakter kimia yang dianalisis adalah kadar air, total padatan terlarut (TSS), pH, gula total, gula pereduksi, pencokelatan non-enzimatik, keasaman, asam askorbat, total karotenoid, total fenol, protein kasar, dan total plate count (TPC). Hasil penelitian menunjukkan bahwa selai pepaya yang telah difortifikasi dengan perbandingan konsentrat pulp dan protein kedelai 40: 1 memiliki tingkat penerimaan tertinggi. Selama proses penyimpanan menunjukkan bahwa kadar air, TSS, pH, gula total dan pereduksi, dan pencokelatan non-enzimatik meningkat, sementara tingkat keasaman, asam askorbat, total karotenoid, fenol, total antioksidan dan kandungan protein kasar selai menurun. Fortifikasi selai pepaya dengan konsentrat protein kedelai (40:1 v/v) meningkatkan kandungan protein kasar rata-rata dari 3,15% menjadi 4,16%. Total plate count (TPC) menunjukkan bahwa tidak ada kontaminasi mikroba selama periode penyimpanan 3 bulan. Disimpulkan bahwa selai pepaya yang mengandung konsentrat protein kedelai tetap dapat diterima selama penyimpanan meskipun tingkat penerimaan menurun seiring dengan waktu.

[Kata kunci: aktivitas antioksidan, fortifikasi makanan, formulasi selai, kadar air, evaluasi sensorik]

### Abstract

Processed fruit products commonly contain very low protein due to the heat treatment during processing period. This article presents the research results concerning the increase of nutrition value of papaya jam fortified with soya protein concentrate. Papaya jam prepared with ratio 40:1, 40:2, 40:3, 40:4, and 40:5 (v/v) of papaya pulp and soya protein concentrate. The treatment of papaya jam and soya protein with the highest acceptability was then analyzed for the changes in chemical constituents and overall acceptability at monthly interval during three months of storage. The parameters that being analyzed were moisture content, total soluble solids (TSS), pH, total and reducing sugars, non-enzymatic browning, acidity, ascorbic acid, total carotenoid, total phenol, crude protein, and total plate count. The results showed that fortified papaya jams prepared with papaya pulp and soy protein concentrate ratio at 40:1 had the highest acceptability. During storage time it revealed that moisture content, TSS, pH, total and reducing sugars, and non-enzymatic browning increased, while acidity, ascorbic acid, total carotenoids, phenols, total antioxidants and crude protein contents of jam decreased. Fortification of papaya jam with soya protein concentrate (40:1 v/v) increased crude protein content on average from 3.15% to 4.16%. Total plate count (TPC) indicated that no microbial contamination during 3 months storage period. It can be concluded that papaya jam fortified with soya protein concentrate remained acceptable during storage although the acceptability decreased over time.

[Keywords: antioxidant activity, food fortification, jam formulation, moisture content, sensory evaluation]

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## Introduction

Protein has known to have an important role structurally and functionally in human live. As structural role, protein provides strength and shape of cells or tissues such as cartilage. While, as functional role, protein has diverse roles depending on the structure, such as enzymes. Lacking of protein on human diet may cause severe weight lost, malfunction in growth, protein energy deficiency, and kwashiorkor (Wu, 2016; Pinandoyo *et al.*, 2019).

At least 20% of human global population were vegetarians in 2010. The number of vegetarians has been increased slightly compared to that of in 2002, but it indicated the trend was increasing each year (Leahy *et al.*, 2010). Vegetarian life-style often complemented with other healthy life style habits such as no-smoking, no-alcohol, and use of alternative therapies that proved to be more natural and cheaper than the ordinary ones. Furthermore, in social situations, identity was an important factor that affects dietary habits with reduced meat-consumption particularly in their adolescence stage (Gulliksen, 2018).

Jam has been commonly consumed as one of breakfast menu especially in India as a vegetarian country. Papaya jam has a high popularity, whether produced as mixed- or originally jams. It was claimed that jams, especially papaya jam, provide good energy with half bout of calories since the present of fibre and fructose that will maintain the sugar level and satisfied level of the consumers (Gupta *et al.*, 2016).

Papaya provides a good nutritional value, and can be easily processed to a wide variety of food products. It contains pro-vitamin A, carotenoids average of 232 µg β-carotene and 594 µg β-cryptoxanthin and vitamin A ranged from 18 to 74 µg RAE (retinol activity equivalents) per 100 g. Lycopene content in the red-fleshed papaya varieties ranged from 1350-3674 µg/100 g (Luximon-Ramma *et al.*, 2003). The vitamin C content was approximately 50 mg/100 g (Boshra & Tajul, 2013). Many papaya producing countries are facing difficulties since the fruits were very prone to physical stress. Post-harvest loss of papaya can reach 40% of the harvest (Oksuz *et al.*, 2015). Due to this high susceptibility, papaya is commonly served as papaya products such as juices, blended beverages, jam (including low calorie), jelly, dehydrated, osmo-dried, fruit bar, candy, and frozen products. Moreover, previous study showed that hexanal could extend papaya shelf-life until 6 days (Hutchinson *et al.*, 2018).

Papaya jam still preserve some nutritional values of papaya fruit. However, the protein content of papaya jam was very low. Since papaya jam is commonly popular in developing countries,

fortification of protein is recommended. WHO guideline in fortification stated that fortification against protein energy malnutrition should be prioritised especially in the developing countries (WHO, 2006). Fortification of protein in papaya jam may increase the nutritional and health values of papaya jam. However, adding protein to fruit product may affect the characteristics and acceptability of fruit products since protein powder is not easily soluble in acid condition like most of fruit products (Anju *et al.*, 2014). This research aimed to investigate the proper formula of fortification in papaya jam using soya protein concentrate.

## Materials and Methods

### Sample materials

Ripe papaya fruits cv. Disco and soya flour were obtained from the local market in Hisar, Haryana, India. Papaya fruits were extracted to produce pulp as the main material for papaya jam, while soya flour was used as the main material to make protein concentrate. The chemicals used for analysis were obtained from chemical stock of the Centre of Food Science and Technology, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India.

In order to obtain the papaya pulp, the papaya fruits were washed thoroughly with clean running water and cut into slices with a stainless steel knife. The papaya and sodium benzoate (C<sub>6</sub>H<sub>5</sub>COONa) (1 g/kg) were then ground in a grinder.

Soya protein concentrate was made according to Wang's method (Wang *et al.*, 2004). Briefly, soy flour was mixed in water (1:10; v:v). After mixed, the pH was set to 4 by adding 1 M HCl. Residue was kept and washed with distilled water. After that, the pH was adjusted to 7 by adding 1 M NaOH. The mixture was settled and the residue was washed with distilled water to remove the NaOH residue. Distilled water was added by ratio of 1:10 (v/v) and the mixture was centrifuged at 3000 rpm for 15 min. The residue was kept overnight in hot air oven at 55-60 °C. The dried flakes were grinded into very fine flour, sieved at 280 µm, packed in polyethylene bags, sealed and stored in a refrigerator for further analysis.

### Jam production

For each kilogram of papaya pulp, 700 g sugar, 4 g citric acid, and 2 g pectin were added. The mixture was cooked with constant stirring until thick consistency has been achieved. End point was judged by sheet test and measuring total soluble solids (68%) using hand refractometer (58-92%). The product was packed in 150 g capacity sterilized glass jars and then stored.

### Formulation of fortified jam and experimental design

The experiment was arranged using a Completely Randomized Design (CRD) in this following treatments:

- i) 40 parts papaya pulp: 1 parts soy concentrate
- ii) 40 parts papaya pulp: 2 parts soy concentrate
- iii) 40 parts papaya pulp: 3 parts soy concentrate
- iv) 40 parts papaya pulp: 4 parts soy concentrate
- v) 40 parts papaya pulp: 5 parts soy concentrate

As control, 100% papaya pulp without addition of concentrate was used as material of jam. Gelling characteristic and the result of sensory evaluation for each combination was used to determine which proportion that would be further analysed for chemical constituents and acceptability during storage period.

### Chemical analysis

Total soluble solids (TSS) of the fruit and jam calculated in °Brix were determined using Abbe refractometer (Bausch and Lomb, Switzerland). Samples were placed on the sample holder of the refractometer that had been standardized to the zero mark with distilled water. The refractive index and °Brix were read from the refractometer. pH was determined using pH meter (model BA 350 EDT instruments, UK). Moisture content was analyzed using oven method. Acidity level, ascorbic acid content, total phenolic content, and crude protein content were analyzed using AOAC standard method (AOAC, 1990). Total and reducing sugars were analyzed using Hulme and Narain's method (Hulme & Narain, 1931), while total carotenoid was determined according to Rivera-Vélez (2016) and Rodriguez-Amaya (2001). Antioxidant activity was measured using 2,2-diphenyl-1-picrylhydrazyl (DPPH) method. Non-enzymatic browning was recorded for fresh and stored products according to Rangnna (2007). In order to investigate the microbial contamination during storage, total plate count (TPC) in a serial dilution technique was used.

Organoleptic evaluation was conducted using 9 (nine) level of hedonic scale on 15 semi trained panelists. Data were taken in three replications. All the data were collected during 3 months of storage time.

### Statistical analysis

In order to investigate the significantly effect of treatment, all collected data were subjected to analysis of variance (ANOVA) at  $\alpha = 0.05$ .

## Results and Discussion

### Formula of soya protein concentrate fortified papaya jam

Fortification of protein in fruit products may affect their acceptability and characteristics. Formulation is the key to ensure that the fortification of protein will not significantly change the characteristics of the fruit products and the products still have a good acceptability to the consumers (Karanjalkar *et al.*, 2013; Anju *et al.*, 2014; Kaul, 2017). In this research, the characteristic of jam produced with various combinations of papaya pulp and soy concentrate is shown in Table 1. The results then had been justified using the standard described by CODEX STAN 296. Products had soft even consistency without distinct pieces of fruit, bright color, good fruit flavor, semi-jellied texture without free liquid, and easy to spread would be subjected to further analysis.

Based on the CODEX STAN 296 standard, the results showed that only control (100% papaya pulp) and treatment with combination of 40:1 and 40:2 papaya pulp: soya protein concentrate were acceptable. These two combinations and the control had appropriate gelled consistency, normal colour and flavour. The combination of 40:1, 40:2 and control showed glossy, a little pasty, soft gel, a little sticky, and a little loose characteristics. The ratio of 40:1 and 40:2 showed acceptable jam while other combinations did not performed a proper formation of jam. The protein addition in fruit product was

Table 1. Characteristics of jam prepared from different combinations of papaya pulp and soybean concentrate  
Tabel 1. Karakteristik selai yang berasal dari beberapa kombinasi bubur pepaya dan konsentrat kedelai

Treatments combinations/ <i>Kombinasi perlakuan</i>	Ratio/ <i>Nisbah</i> (v/v)	Descriptive attributes of jam/ <i>Deskripsi sifat selai</i>		
		Appearance/ <i>Tampilan</i>	Texture/ <i>Tekstur</i>	State/ <i>Kondisi</i>
Control [papaya]/ <i>Kontrol [pepaya]</i>	100	Glossy, tender	Soft, gel	A little loose
Papaya: soya concentrate/ <i>Pepaya: konsentrat kedelai</i>	40:1	Glossy, tender	Soft, gel	A little loose
	40:2	Glossy, a little pasty	Soft, gel, a little sticky	A little loose
	40:3	Cloudy, pasty	Soft, sticky	Loose
	40:4	Dull, pasty	Hard, sticky	Loose
	40:5	Dull, very pasty	Hard, very sticky	Firm

difficult due to insoluble in acid conditions, so the persistence and gelling characteristic may be affected. This also involved in Maillard reaction and may also affect fruit product appearance (Anju *et al.*, 2014; Sharma *et al.*, 2016).

For further analysis, papaya jam that prepared from combination of 40:1 and 40:2 were subjected to sensory test. The results showed that fortified papaya jam with soya protein concentrate ratio of 40:1 had a higher acceptability than that of 40:2 (Table 2). Soya protein concentrate was good in complementing food with high protein content but low production cost. According to Mao & Hua (2012) these characteristics give a strong taste and odor and may affect the taste of incorporated product. In our research, the combination of 40:1 did not affect the taste of product, thus this formula would be used for further analysis.

*Changes of chemical constituents of papaya jam pH*

During storage, pH of both control and treatment were increased. The pH was affected by fortification of soya protein concentrate (Table 3). Average of pH in control during storage time was 3.50, while treatment showed average of pH was 3.14. In the fruit product, pH was affected by ascorbic acid and polyphenol content and during storage time both factors were hydrolyzed. This degradation occurred

because the increasing of pH value (Gomes *et al.*, 2014). In soya protein concentrate fortified papaya jam, protein that being added was hydrolyzed to amino acid resulting lower pH compared to control. The pH and acidity were characteristic that responsible for astringency of fruit product. Change of pH and acidity need to be observed to decide whether the fortification will affect the final taste of product or not, especially in astringency aspect.

*Ascorbic acid*

Ascorbic acid of fortified papaya jam and control decreased during storage time. Fortification of protein in this research affected the ascorbic acid content of papaya jam. Ascorbic acid of papaya jam was lower than that of the control (Table 3). Ascorbic acid is easily oxidized by heat, light, enzymes, or oxygen. According to Bhardwaj & Mukherjee (2011) ascorbic acid content was decreased during storage time. The ascorbic acid content of fortified papaya jam was lower than that of control might be caused by the involvement of Maillard reaction preventing. Ascorbic acid provided optional substrate to be oxidized to generate dehydro-ascorbic acid and then finally furfural compound instead of forming brown pigments (Kuchi *et al.*, 2014). The evidence was supported by a lower occurrence in non-enzymatic browning in fortified papaya jam.

Table 2. Sensory score (on 9-point hedonic scale) of jam prepared from different combinations of papaya pulp and soya concentrate

Tabel 2. Skor sensoris (pada skala hedonis angka-9) dari selai kombinasi bubur pepaya dan konsentrat kedelai

Treatments combination/ <i>Kombinasi perlakuan</i>	Ratio/ <i>Nisbah</i>	Colour and appearance/ <i>Warna dan tampilan</i>	Aroma/ <i>Aroma</i>	Taste/ <i>Rasa</i>	Overall acceptability/ <i>Total penerimaan</i>
Papaya : soy concentrate/ <i>Pepaya: konsentrat kedelai</i>	40:1	8.6	7.9	8.0	8.2
	40:2	7.8	7.3	7.6	7.6

Table 3. Changes of chemical constituents that affect astringency

Tabel 3. Perubahan kimiawi yang mempengaruhi keasaman

Storage time/ <i>Lama penyimpanan</i> (Month/ <i>Bulan</i> )	pH/ <i>Derajat keasaman</i>		Acidity/ <i>Keasaman</i> (%)		Ascorbic acid/ <i>Asam askorbat</i> (mg/100g)	
	Fortified product/ <i>Produk fortifikasi</i>	Control/ <i>Kontrol</i>	Fortified Product/ <i>Produk fortifikasi</i>	Control/ <i>Kontrol</i>	Fortified Product/ <i>Produk fortifikasi</i>	Control/ <i>Kontrol</i>
0	2.98	3.27	0.48	0.53	34.5	39.3
1	3.01	3.41	0.45	0.50	30.5	31.1
2	3.20	3.55	0.42	0.48	25.9	27.9
3	3.41	3.76	0.40	0.46	21.0	24.2
Mean/ <i>Rata-rata</i>	3.14	3.50	0.44	0.50	28.0	30.6
CV at 5%	NS		NS		NS	

Notes/ *Keterangan:*

CV= Coefficient of Variation/ *Koefisien Keragaman*

NS= Non Significant/ *Tidak Nyaa.*

### Acidity

Acidity was affected by fortification of soya protein concentrate. All fortified products had lower acidity than that of control (Table 3). Acidity of both control and treatments were decreased during storage time. The increasing of acidity might be ascribed to rise in the concentration of weakly ionized acids by degradation of polysaccharides and oxidation of reducing sugars or by break down of pectic substances and uronic acid. The increase of pH also indicated by reducing in acidity level (Jiang *et al.*, 2018).

### Total sugar

Total sugar of fortified papaya jams were slightly lower than that of control during storage time (Table 4). In addition, during storage time, TSS of control and fortified products were also increased. The increasing of total sugar might be due to the hydrolysis of polysaccharides such as pectin, starch, and others into simple sugars (Madeira-Nunes *et al.*, 2007; Menezes *et al.*, 2011). Sugar content of jam not only affected the sweetness level, but also gelling characteristic. Furthermore, sugar content may also affected the water content of jam. If total sugar is too high, the jam will have harder texture, while lower sugar content may lead to syneresis causing a loose consistency of jam (CODEX STAN 296).

### Moisture content

During 3 months of storage, the moisture contents of fortified papaya jam have been decreased steadily (Table 4). The moisture content between control (31.05%) and fortified products (31.00%) was not significantly different. The decreasing of the moisture might occur due to utilization of free water

in polysaccharides hydrolysis into monosaccharides and oligosaccharides (Majumdar & Chattopadhyay, 2011). The moisture content in jam might decrease or increase depending on the temperature and humidity of the storage. Changes in moisture was commonly happened in jam during storage time (Ajenifujah-Solebo & Aina, 2011). Moisture content of jam should to be observed since protein may binds the water molecules inside the jam so that it will affect the jam characteristics.

TSS of both control and fortified jams increased during storage time (Table 4). TSS of fortified jam (68.4%) was not different than that of the control (68.5%). The increasing of TSS during storage may be caused by hydrolysis of polysaccharides and oligosaccharides (Majumdar & Chattopadhyay, 2011). The result of this study was in accordance with previous research studies in mango jam (Nour *et al.*, 2011; Safdar *et al.*, 2012), karonda jam (Wani *et al.*, 2013) and jamun-mango blended jam (Sharma *et al.*, 2016).

### Reducing sugar

Unlike total sugar, reducing sugar of fortified jam (33.8%) was slightly higher than that of control (33.0%) (Table 4). The reducing sugar of both fortified jam and control increased during storage time. The increase in reducing sugar content during storage was mainly due to the inversion of non-reducing sugars into reducing sugars (Bons & Dhawan, 2013). Reducing sugar may affect to the appearance and aroma characteristics of jam. According to Asikin *et al.* (2014) this involved in Maillard reaction that produce brownish colour and baked-like aroma. Based on this the reducing sugar needed to be measured in this research.

Table 4. Changes of chemical constituent that affect jelling characteristic and consistency  
Tabel 4. Perubahan komposisi kimiawi yang memengaruhi karakter dan konsistensi selai

Storage time/ Lama penyimpanan (Month/ Bulan)	Moisture content/ Kadar air (%)		Total soluble solid (TSS)/ Total padatan terlarut (%)		Total sugar/ Gula total (%)		Reducing sugar/ Gula reduksi (%)	
	Fortified product/ Produk fortifikasi	Control/ Kontrol	Fortified product/ Produk fortifikasi	Control/ Kontrol	Fortified product/ Produk fortifikasi	Control/ Kontrol	Fortified product/ Produk fortifikasi	Control/ Kontrol
0	31.45	31.51	68.0	68.0	52.9	54.1	33.4	32.5
1	31.14	31.18	68.2	68.2	53.3	54.4	33.6	32.7
2	30.89	30.93	68.5	68.6	53.9	55.0	33.9	33.2
3	30.54	30.57	68.8	69.0	54.5	55.5	34.3	33.6
Mean/ Rata-rata	31.00	31.05	68.4	68.5	53.4	54.5	33.8	33.0
CV at 5%	NS		NS		NS		NS	

Notes/ Keterangan:

CV= Coefficient of Variation/ Koefisien Keragaman

NS= Non Significant/ Tidak Nyata

*Non-enzymatic browning*

Non-enzymatic browning of fortified jam was observed slightly lower than that of control (Table 5). During storage, non-enzymatic browning of fortified jam and control increased gradually. Theoretically, the addition of protein to papaya jam should increase the non-enzymatic browning reaction. However, it may affect contradictory since the presence of anti-oxidant agent in jam, such as ascorbic acid and phenols (Kuchi *et al.*, 2014). Conversion of non-reducing to reducing sugars also increased the potential susceptibility of processed papaya products to non-enzymatic browning during high-temperature or prolonged storage conditions (Barlianti *et al.*, 2016).

*Total carotenoid content*

Total carotenoid of control was slightly higher than that of fortified jam (Table 5). During storage time, total carotenoid of both control and fortified jam have been decreased with the prolonged the storage time. Total carotenoid was responsible to the color formation of papaya jam. The presence of Maillard reaction might affect the appearance. This research result showed that the fortification did not significantly affect to the appearance of papaya jam.

*Total phenol*

Total phenol content in fortified papaya jam was the same as control (Table 5). Total phenols of both control and fortified jam decreased during storage.

Phenol compounds are easily oxidized and very volatile. They will be decreased during storage time regardless of environmental or chemical factors of food products (Shahidi & Ambigaipalan, 2015). Similar decreased in total phenols were also reported in jamun jam (Singh & Siddiqui, 2010), blueberry jam (Fracassetti *et al.*, 2013), strawberry jam (Poiana *et al.*, 2011), and araça (Brazilian guava) jam (Damiani *et al.*, 2012).

*Crude protein*

Fortification of soya protein concentrate in papaya jam significantly increased the protein value by up to 32.06 %. Crude protein content of fortified product was 4.16 (% dwb) and control was 3.15 (% dwb) (Tabel 5). Crude protein contents of both fortified product and control decreased as the longer of storage time. Protein fortification of fruit product has been a problem regarding to protein solubility in acid environment. In some cases, the protein addition showed no efficiency at all. Previous study has also been carried out on protein fortification, such as: in guava jam (Perez-Rocha *et al.*, 2015). When exposed to excess of protein fortification, fruit products had of lower acceptance from the consumers (Khan *et al.*, 2012). Our research showed that fortification with soya protein concentrate at the ratio (40:1) still had an impact on protein content of papaya jam. The decreasing of protein during storage time may happened due to degradation of protein into amino acids (Paramita *et al.*, 2010).

Table 5. Changes of chemical constituents in term of nutrition factor  
Tabel 5. Perubahan kandungan kimia terkait faktor nutrisi

Storage time/ Lama penyimpanan (Month/ Bulan)	Non-enzymatic browning/ Warna coklat bukan pengaruh enzim (OD at 440 nm)		Total carotenoid/ Karotenoid total (mg/100g)		Total phenol/ Total fenol (mg/100g)		Crude protein/ Protein kasar (% dwb)*	
	Fortified product/ Produk fortifikasi	Control/ Kontrol	Fortified product/ Produk fortifikasi	Control/ Kontrol	Fortified product/ Produk fortifikasi	Control/ Kontrol	Fortified product/ Produk fortifikasi	Control/ Kontrol
	0	0.067	0.070	2.88	2.98	0.56	0.57	4.28
1	0.072	0.079	2.81	2.88	0.54	0.53	4.18	3.19
2	0.088	0.098	2.74	2.80	0.52	0.51	4.11	3.10
3	0.098	0.102	2.63	2.72	0.50	0.50	4.06	3.05
Mean/ Rata-rata	0.081	0.086	2.77	2.85	0.53	0.53	4.16	3.15
CV at 5%	NS		NS		NS		0.12	

Notes/ Keterangan

\*Protein fortification value = (4.16-3.15)/3.15 X 100% = 32.06 / \* Nilai protein fortifikasi= (4.16-3.15)/3.15 X 100% = 32.06

CV= Coefficient of Variation/ Koefisien Keragaman

NS= Non Significant/ Tidak Nyata

### Total plate count

In order to investigate the presence of microbial contamination, the plate count method was applied. The results showed that no microbial growth in both of control and fortified jams during storage time up to 3 months. Jam must be free from microbial contamination, bacterial and fungal toxins for at least 6 months storage time (Rawat, 2015). The right handling may be the key to prevent microbial growth in fruit product. However, microbial growth in jam products might be prevented by a high concentration of sugar.

### Overall acceptability

Sensory evaluation showed that overall acceptability of both fortified product and control were decreased as the longer of the storage period (Table 6). Fortified papaya jam had a slightly lower acceptability than that of control during storage time (Table 6), but the difference was not significant. With fortification of soya protein concentrate in papaya jam was proved to the final output. The papaya jam still had acceptability similar to conventional papaya jam (control).

In term of color, the addition of protein might enhance the Maillard reaction of papaya jam resulting decreased acceptability on color. Formulated fortification of soya protein concentrate showed no significantly difference in this term so that the acceptability was still in the range almost the same as the control. Changes in chemical factor that involved in astringency also not significantly affected the final taste of the products. However, some contents like ascorbic acid and total phenol might be affected. The reason might be due to the involvement of both factors in retention of original taste and color of fortified papaya jam.

Table 6. Overall acceptability and microbial content  
Tabel 6. Tingkat penerimaan dan kandungan mikroba

Storage time/ Lama penyimpanan (Month/ Bulan)	Overall acceptability/ Tingkat penerimaan	
	Fortified product/ Produk fortifikasi	Control/ Kontrol
0	8.5	8.6
1	8.2	8.4
2	7.9	8.3
3	7.8	8.0
Mean/ Rata-rata	8.0	8.3
CV at 5%	NS	

Notes/ Keterangan:

CD= Coefficient of Variation/ Koefisien Keragaman

NS= Non Significant/ Tidak Nyata

### Conclusion

Fortification of soya concentrate protein in papaya jam with the highest acceptability was formulated using proportion papaya pulp and soya concentrate of 40:1. With this composition, the moisture content, TSS, total sugar, reducing sugar, and total carotenoid content of fortified papaya jam were not significantly different from control. Whereas, acidity, pH, ascorbic acid, and total phenol were still be affected slightly, but these did not significantly affected in overall acceptability. During storage time, moisture, TSS, pH, total and reducing sugars, and non-enzymatic browning were increased, while acidity, ascorbic acid, total carotenoids, phenols, total antioxidants, and crude protein contents of jam were decreased. The jams were still acceptable and free of microbial contamination during 3 months of storage time. The average crude protein content during storage of fortified papaya jam was 4.16% (dwb) while control was only 3.15% (dwb). Both fortified papaya jam and control showed decreasing of acceptability during storage time with average of 8.0 and 8.3, respectively. Protein fortification using soya bean as material was considerably cheap. However, with the composition used in this research showed only able to increased the protein value by 33.3%. Application of fortification using soya protein in papaya jam for healthier and cheaper products still need further studies.

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