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MAPPING AND DEVELOPMENT STRATEGY OF PEMPEK — A SPECIALTY TRADITIONAL FOOD OF SOUTH SUMATRA, INDONESIA

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ABSTRACT

Pempek, a specialty traditional food of South Sumatra, has not been developed toward industrialization. A development process should not negate the preference taste of the consumer who is used to the taste of the traditional food. The innovation in the development of pempek to overcome its limitation for improving the marketing access as well as leading toward its industrialization was needed. A SWOT and AHP analysis were used to select the criteria and priority of consumer toward pempek development followed by the PCA to cluster the criteria and the preference of consumer. The analysis of the samples shows that pempek development requires a change in packaging design that meets the aspects of convenient and the right size by doing the engineering process to suppress the influence of inconsistent fish raw material quality. The analysis also shows that the pempek samples collected from the city of Palembang could be classified into 4 classes. The first one was the pempek which have a higher value and similarities in elasticity, chewiness, and hardness. The second one was the pempek which have a higher value and similarities in stickiness, aroma, taste, and brittleness. The third one was the pempek which have a lower value and similarities in the value of smoothness, colour, and juiciness. And the fourth one was the pempek which are not related in any of the quality attribute of pempek. The main characteristic of Pempek which could be used as the control variable on the development and processing of Pempek were taste, brittleness, stickiness, and aroma. The variables which needed an attention due to negative contribution to the development of pempek were hardness, ease of chew, elasticity, smoothness, juiciness, and color. The development of pempek should suppressed the variable aroma especially fish aroma and while the taste and brittleness should be improved.

Keywords: Pempek; traditional food; SWOT; AHP; PCA

INTRODUCTION

Pempek is a specialty traditional food of South Sumatra, Indonesia, which was made from ground fish flesh, tapioca flour, spices, salt, and water. Pempek is very famous in Indonesia and has the important position of cultural, identity, and heritage of South Sumatra. Due to its position, pempek, has been granted a certificate of intangible cultural heritage by the Indonesian government. Pempek, different from fish sausage, has a relatively higher concentration of starch, some time up to 40% starch for a good quality one (Amiza and Ng, 2015; Karneta, 2014).

Pempek, since its invention, has not been developed toward industrialization. Pempek, up until now, is processed manually and in a small scale home industry which resulted in a relatively short shelf life and a limited marketing access (Karneta, 2014). This limitation made pempek, even though has a high demand, could not be consumed anytime or exported fresh. Frozen pempek had

a relatively long shelf life but need thawing and reheating before consumed.

The innovation in the development of pempek to overcome its limitation for improving the marketing access as well as leading toward its industrialization was needed because innovation is the key for the success of the product (Galanakis, 2016). The probable direction of product development is to design the food according to the consumer demand (Celi and Rudkin, 2016). The consumer demand could be based on organoleptic attributes (Bednářová et al., 2015) such as taste (Kozelova et al., 2015; Guziyi et al., 2017), texture (Bobková et al., 2016; Pająk et al., 2010) and culture (Kozelová et al., 2011).

The development process is started with the conception of an idea and product concept as a starting point and because of that the development of pempek as a modern product should be started with the mapping and product development strategy. Mapping and product development

strategy is usually analyzed with the SWOT approach. SWOT is a common tool used to analyze situations, develop and implement appropriate strategies with internal and external factors (Chang and Huang, 2006). However, SWOT result was expressed qualitatively which resulted in a qualitative list that is often incomplete for analyzing the internal and external factors (Kangas et al., 2001). Another weakness of SWOT analysis is its factors often was not tested for consistency (Chang and Huang, 2006).

Analytically, SWOT could not be used to determine the importance of factors which affected the process, because the loading of the factor was not calculated to determine the influence of each factor on the proposed alternative strategy. The SWOT framework, then, needs to be transformed into a hierarchical structure by integrating analysis using Analytical Hierarchy Process (AHP) whose calculations are based on eigenvalues (Görener et al., 2012). This transformation would improve the qualitative of SWOT strategic planning into a quantitative information base to facilitate in making priority decisions strategic alternatives with high consistency (Kurttila et al., 2000). AHP is a multi-criteria decision-making method involving structuring multiple selection criteria into the hierarchy, assessing the relative importance of the criteria, comparing alternatives for each criterion, determining the overall ranking of alternatives, choosing the optimal alternative by taking into account the relative preference of weighting criteria (Yavuz and Baycan, 2013).

Preference mapping is a strategy to understand the position of the product (food) as a basis toward the direction of a new product development by manipulating the sensory properties to get the ideal product profile to get a desired position from the position of other similar products with the aim of increasing market share (MacFie, 2007; Perrot et al., 2017). A method often used to construct product mapping of difference, disadvantages, advantages, and comparison of sensory profile data is Principal Component Analysis (PCA). Although PCA does not account for average score variants due to product variants but the result of PCA mapping was as good as the method of Canonical Analysis Variation (CVA) (Peltier et al., 2015). The PCA method has been used very well in mapping the products of orange cake (Volpini-Rapina et al., 2012), apple and raspberry juice (Endrizzi et al., 2014), sausage (Braghieri et al., 2016; Jakobsen et al., 2014; Pires et al., 2017; Zając et al., 2015), honey (Kalaycıoğlu et al., 2017), sensory characterization of ultra pasteurized milk (Chapman et al., 2001), and differentiation of milk fatty acids (Werteker et al., 2017).

Scientific hypothesis

The main hypothesis of this work is that the modern pempek could be developed accordingly to the cluster of quality attribute required by the consumer.

MATERIAL AND METHODOLOGY

Identification toward the development and quality mapping of pempek was performed with the method of Focus Group Discussion (FGD). The participants for this FGD were a selected 19 expert people. The participant was selected from the academician, the business person, the government officers, and the consumers who were then facilitated by a facilitator.

All the participant at least has a BS degree and fond of pempek. At the FGD the participants were asked to discuss the level of importance of the SWOT factors while doing the sensoric grading by a description with scale. The expert panels were asked to grade all the attributes of SWOT and sensorics of 10 different sample, which was bought from 10 different famous pempek's vendor in Palembang. The sensoric grading of all the samples were performed using the AHP method. The sensoric grading was performed by filling up a description questioner which was arranged by scale. The data were later processed and the Principal Component Analysis (PCA) of the data were computed with the help of XLSTAT 2016[©] (Addinsoft) software.

Statistical analysis

Statistical analysis of data collected was analyzed with the help of Microsoft Excel version 2010 (Microsoft) to determine the attribute of SWOT and then sensoric grading of AHP. The PCA was performed with the help of XLSTAT 2016[©] software (Addinsoft) to determine the Principal Factor which could describe the most variation of the data collected.

RESULTS AND DISCUSSION

Identification of the direction of the development

Based on the SWOT analysis performed by the experts in the FGD toward the ten sample of commercial pempek from Palembang then the internal and external factors of pempek were identified as shown on Table 1.

The level of importance of SWOT factors were then analyzed using the AHP method by means of Scale Pairwise Comparison (Saaty, 2008). The comparison results were shown on Table 2. The pairwise comparison for each factor of SWOT were then calculated and its level of priority were computed. The result of pairwise comparison for all factors of SWOT were shown on Table 3.

Based on SWOT analysis, the percentage of each SWOT factors are strength (6%), weakness (21%), opportunity (21%) and threat (52%). The priority score for all the SWOT factors (Table 3) show that the highest score for, consecutively, the strength is the factor of nutrition value of pempek (42%); the weakness is the factor of inconsistent fish raw material quality (42%); the opportunity is the factor of consumer preference (48%); and the threat is the factor of packaging design which does not meet the aspect of ease and exact proportion (57%). Therefore, the alternative strategies that could be proposed is to take the advantage of high consumer preferences because of pempek high nutritional value which require a development in packaging design that meets the aspects of ease and the right size by doing the engineering process to suppress the influence of inconsistent fish raw material quality.

Table 1 SWOT matrix of Pempek.

Strength (S)	Weakness (W)
(S1). Intangibel Cultural Heritage (S2). Wide product variations (S3). Accepted by most people (S4). Nutritiouss	(W1). Relatively short shelf life (W2). Need a special handling on shipping (W3). Fishy flavor (W4). The quality of raw material (fish) is not consistent.
Opportunity (O)	Threat (T)
(O1). Could be furtherly developed (O2). Has a great market opportunity (O3). Consumer preferences are high (O4). Could become an alternative to basic food	(T1). The main raw material (fish) is limited (T2). Competition among gel products are on the rise (T3). Improper and unhygienic presentation methods (T4). The packaging design does not meet the aspect of ease and proper servings

Table 2 Pairwise comparisons factor of SWOT.

SWOT Groups	S	W	O	T	Priority
Strength (S)	1.00	0.14	0.33	0.20	0.06
Weakness (W)	6.00	1.00	0.50	0.33	0.21
Opportunity (O)	3.00	2.00	1.00	0.25	0.21
Threat (T)	5.00	3.00	4.00	1.00	0.52
CR = 0.092					

Table 3 Priority Score for all the SWOT factor.

SWOT groups	Group priority	SWOT factor	Priority within Group	Overall Priority factor
Strength	0.06	Intangibel Cultural Heritage	0.05	0.003
		Wide product variety	0.26	0.017
		Accepted by most people	0.28	0.018
		Nutritiouss	0.42	0.027
Weakness	0.21	Relatively short shelf life	0.05	0.010
		Need a special handling on shipping	0.28	0.058
		Fishy flavor	0.27	0.056
		The quality of raw material (fish) is not consistent	0.41	0.085
Opportunity	0.21	Could be furtherly developed	0.15	0.031
		Has a great market opportunity.	0.15	0.031
		Consumer preferences are high	0.48	0.100
		Could become an alternative to basic food	0.23	0.048
Threat	0.52	The main raw material (fish) is limited	0.14	0.074
		Competition among gel products are on the rise	0.09	0.045
		Improper and unhygienic presentation methods	0.20	0.101
		The packaging design does not meet the aspect of ease and proper servings	0.57	0.296

Quality Mapping

Sensory data from the ten pempek samples were then processed using Principle Component Analysis (PCA). PCA is a method that can explain the amount of variability from the largest to the smallest and also the hidden variability. The average value of each parameter was processed into the standard value (Z) and then the Z value

with the help of XLSTAT® were converted into the eigenvalues, percentage of variation, and the cumulative of variation (Table 4). It was shown that the number of Principal Component or Factor (F) needed to describe the variability were nine components with the percentage explain by the eigenvalue range from 35.8% to 0.1%. The percentage of variability shows the variability that could

Table 4 Eigenvalues, percentage and cumulative variation of sensory data of pempek.

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
Eigenvalue	3.58	2.82	1.22	0.93	0.72	0.49	0.19	0.06	0.01
Variability, %	35.8	28.2	12.1	9.3	7.2	4.9	1.9	0.6	0.1
Cumulative, %	35.8	64.0	76.1	85.4	92.5	97.5	99.3	99.9	100.0

Table 5 Eigenvector for Pempek sample.

Factor	PC1	PC2
Hardness	-0.031	0.521
Elasticity	-0.165	0.176
Brittleness	0.422	0.261
Stickiness	0.402	0.246
Ease of Chew	-0.160	0.495
Smoothness	0.346	-0.148
Juiciness	0.311	-0.394
Taste	0.457	0.126
Aroma	0.384	0.218
Color	0.181	-0.288

Table 6 The loading of factor of Pempek.

	PC1	PC2
Hardness	-0.059	0.874
Elasticity	-0.313	0.295
Brittleness	0.800	0.438
Stickiness	0.762	0.413
Ease of Chew	-0.302	0.831
Smoothness	0.656	-0.248
Juiciness	0.589	-0.661
Taste	0.865	0.212
Aroma	0.726	0.365
Color	0.343	-0.484

be described by each of the main component. The percentage of variability was found by the value of each eigenvalue divided by the total value of eigenvalue times 100%.

It was shown on Table 4 that the variability describe by PC1 was 35.8% which means the main component PC1 could explain the variability of data 35.8% from of all data. The lower the value of eigenvalue means the lower the variability that could be explained by the related component.

The main objective of using PCA was to describe the largest amount of variation of original data with the smallest number of main component. For that reason, some components (PC) were chosen to explain the largest variation of data. The number of component chosen were based on the eigenvalue which could describe the variability of the main component. Plot of the nine components and its variability was shown on Figure 1.

The number of main component needed for principal component analysis was based on the amount of variability which could be described by those components. The components chosen must be able to explain at least 60% to 70% of all the variability. The total variability which could be described by PC1 (35.8%) and PC2 (28.1%) was 63.9% which was adequate to explain the variability of Pempek. If PC3 was included the amount of variability would be 76.1%, however the contribution of PC3 was only 12.1%. The value of eigenvector for each factor for PC1 and PC2 were shown on Table 5. The eigenvector value could be used to determine the variable which characterized the Pempek quality. The high eigenvector value act as the main characteristics of Pempek which the taste is, the brittleness, the stickiness, and the aroma.

Besides eigenvector value there was also the loading of the factor which shown on Table 6. Factor loadings are the correlation between the original variables and the factors, and the key to understanding the underlying nature of a

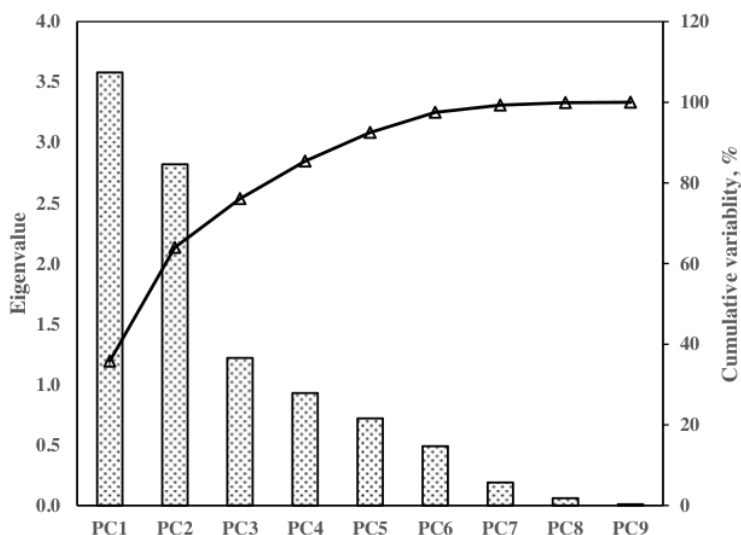


Figure 1 Plot of principal component of Pempek.

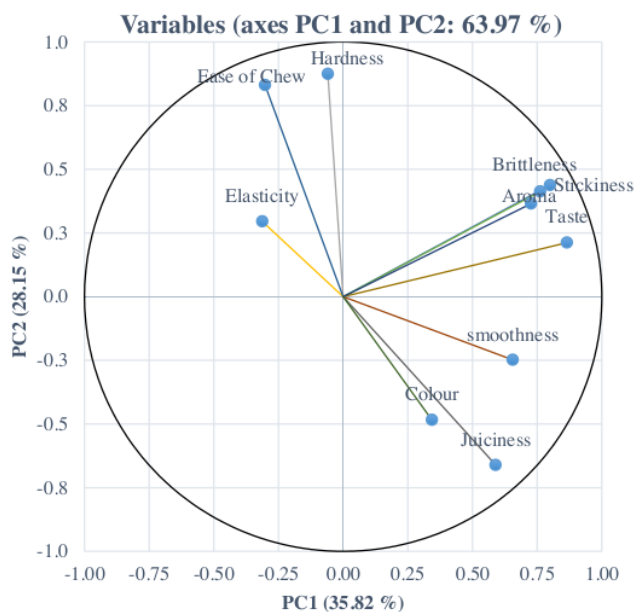


Figure 2 Plot of Pempek Loading factor PC1 versus PC2.

particular factor. Based on the two main componen of PC1 and PC2, the relationship of the two could be determined by taking the absolute value the vector as shown on Figure 2.

The line on Figure 2 shows the variable name of Pempek. The length of the line indicates the variability of each variable. The variables with a less variability was shown by

a shorter vector line while the variables with a highest variability was shown by the longest vector line. Figure 2 shows that the variable taste, brittleness, stickiness, and aroma have the highest variability. These four variables are in the First quadrant of Figure 2 which means these four variables are the main characteristics of Pempek which could be uses as the control variable in processing Pempek or in the product development of Pempek. Whilst

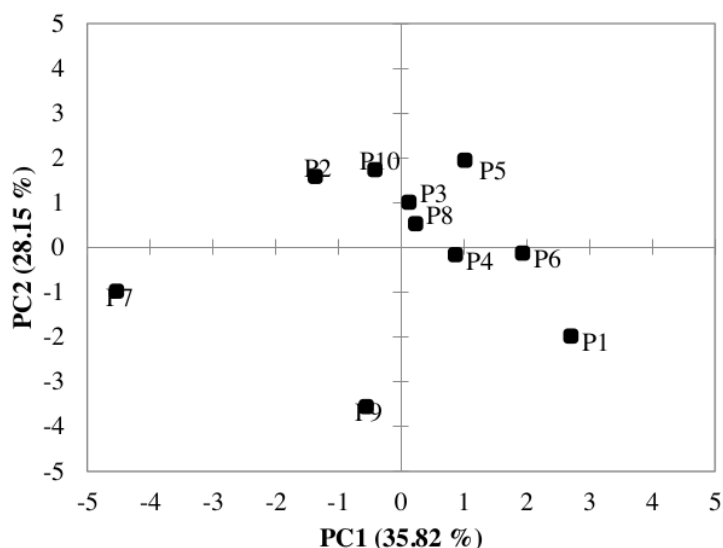


Figure 3 Plotting of Pempek's sample score on PC1 and PC2.

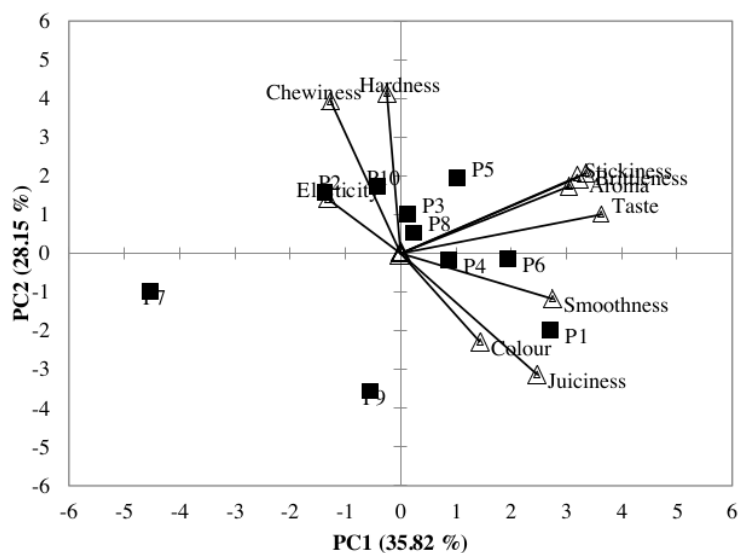


Figure 4 Bi-plot sample position and variable types of pempek.

these four variables had a positive impact to the development of Pempek, the other six variables needed a careful attention because of their negative values either in PC1 or PC2.

The variables hardness, ease of chew, and elasticity (Second quadrant) had a negative values on PC1; and the variables smoothness, juiciness, and color (Fourth quadrant) had a negative value on PC2. These negative values means that eventhough the main variables are taste, brittleness, stickiness and aroma, some attention should be

given to the other variables because these other variables would give negative impression to the overall characteristics of Pempek.

The coordinate value of each Pempek sample tested on PC1 and PC2 was shown on Table 7. Each coordinate value will determine the position of the coordinate on the quadrant. The coordinate value of the first sample (P1) on PC1 is 2.7 (positive value) and on PC2 is -1.9 (negative value) then the first sample is in the positive and negative quadrant (Fourth quadrant).

Table 7 The ordinate value of sample and its main value on PC1 and PC2.

Sample (Pempek)	PC1	PC2
P1	2.705	-1.979
P2	-1.369	1.584
P3	0.124	1.008
P4	0.865	-0.162
P5	1.016	1.945
P6	1.936	-0.129
P7	-4.534	-0.979
P8	0.231	0.529
P9	-0.555	-3.554
P10	-0.418	1.736

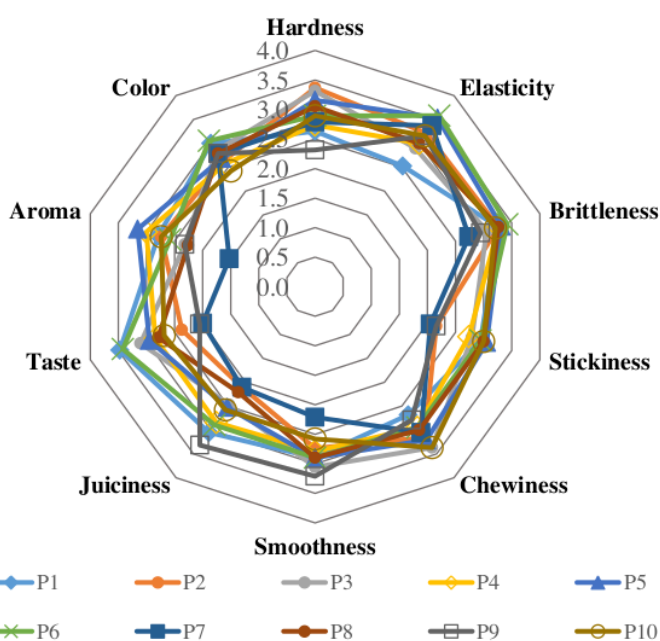


Figure 5 Diagram area of Pempek variable.

Score plots obtained from graphic ordinate between PC1 and PC2 could explain the relationship of similarity between samples. The adjacent samples had similar characteristics, whereas the samples that were located far apart had a different characteristic. Figure 3 shows that the sample spreads across all quadrants, samples in the same quadrant also have similarities. The Strength and weaknesses of the similarity of one variable to the other were determined by the closeness of the position among them in one quadrant. Sample P3, P5 and P8 are in the first quadrant, so that the three samples have similarity to one particular variable, but because the location of sample P3 is closer to P8 or vice versa than to P5 then P3 and P8 has a strong resemblance compared to the sample P5. In the third quadrant, although the sample P7 and P9 are in the same quadrant they are similar in one variable, but the

resemblance is not strong due to its position that is far apart. Similarly, the samples P2 and P10 in the second quadrant, and the sampel P4, P6, P1 in the fourth quadrant.

The similarity among the variables of the sample in each quadrant could be explained through biplot image which is a combination of loading plot and score plot as shown on Figure 4.

Figure 4 show the position of the sample on the ordinate axis (solid box) and the type of determining variables of pempek which was shown by the line toward the center of the axis with triangle at each end. Some information could be drawn from this biplot. The first information that can be drawn from the biplot image is: on the first quadrant the samples P3, P8 and P5 have similarities in the variability of brittleness, stickiness, aroma and taste. While in the

second quadrant the samples P2 and P10 have similarities in the variable elasticity, chewiness and hardness. Sample P2 has a special similarity to the variable elasticity than can be said that P2 has a more specific characteristic of the elasticity. In the third quadrant there are samples P7 and P9, both samples have no similarity to any of the pempek variables. The sample P4, P6 and P1 in the fourth quadrant have the similarity in color, smoothness and juiciness.

The second information which could be drawn from Figure 4 is the variable value of a sample. If a sample that are located in the direction of a variable then that sample has a value above the average, on the other hand if a sample is located opposite to the line of the variable then it has a value below the average. Samples P7 and P9 have variable values below the average value of all variables. Sample P1 has a variable value below the average on the smoothness, samples P4 and P6 have a variable values above average on the variables value of smoothness, color and juiciness. While the samples P3, P5, P8 have a variable values above the average on the variable value of aroma, taste, stickiness and bittleness. The sample P10 has a variable value above the average on chewiness and elasticity while sample P2 has a variable value above the average on elasticity.

The third information that could be drawn from the biplot of Figure 4 is that the correlation between variables shown by biplot line direction. Positive correlation is indicated by direct line direction, the closer or narrower the angle of the variable line indicates the stronger the correlation. The variable of taste, aroma, brittleness and stickiness (first quadrant) has a strong correlation, along with smoothness, color and moist (fourth quadrant) and hardness, elasticity, chewiness (second quadrant). Then between groups of variables that are in first, second and fourth quadrants have a strong negative correlation.

In the product development process there is one factor that should not be missed is the range of development, especially on the variables that become the main character of pempek that is taste, aroma, brittleness and stickiness. The magnitude of the value indicated from the size of the area on the four variables becomes the optimal range of the pempek product development process. The size of the development area for each variable is shown in Figure 5.

Based on the main characteristic of pempek development variables, it could be shown on Figure 5 that the upper limit of the development for taste and aroma is on sample P1 and the lower limit is on sample P7. While the development of stickiness the upper limit is on the sample P5 and the lower limit was on sample P7 and the variable of brittleness the upper limit was on sample P6 and the lower limit was on sample P7.

CONCLUSION

By utilizing the high consumer preferences on Pempek's nutrition value, Pempek could be developed by using new packaging design and shape with respect to the aspect of convenience and bite size.

Sample P3, P8 and P5 had the similarity on the variabel of brittleness, stickiness, aroma, and taste. Sample P2 and P10 had the similarities on the variable of elasticity (specifically on P2), chewyness, and hardness; while the sample of P1, P4 and P6 had the similarities on colour,

smoothness, and moist; and P7 with P9 did not have the similarities on all the variable.

The main characteristic of Pempek which could be used as the control variable on the development and processing of Pempek were taste, brittleness, stickiness, and aroma.

The development of pempek should suppressed the variable aroma especially fish aroma and while the taste and brittleness should be improved.

The upper limit of Pempek's development variable for taste and aroma was found on the P1 sample; and its lower limit was found on sample P7. Meanwhile the development for the stickiness variable upper limit was on the sample P5 and its lower limit was on sample P7; and the brittleness upperlimit was on sample P6 and its lower limit on sample P7.

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