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Sensory and physical quality assessment of *Sie reuboh* (Cooked Meat- an Acehnese traditional cuisine)

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Abstract. *Sie reuboh* is an Acehnese traditional cuisine which uses red-meat as the main protein and is prepared specifically with addition of beef tallow, traditional vinegar and blend of spices. The dish was extremely popular, has a long shelf life, exquisite and complex taste. However due to the changing in life styles and modernization, nowadays the dish hardly prepared at home and has varied of recipes. Based on previous studies, the updated recipe was formulated by varying the amount of beef tallow and vinegar as independent variables. Furthermore, this study aims to assess the physical quality (pH and cooking weight loss) and sensory attributes (color, aroma, flavor, texture). The sensory attributes were divided onto ten specific attributes, which were assessed with Qualitative Descriptive Analysis (QDA) method. The analysis of variance (ANOVA) showed that addition of beef tallow significantly affected ($P \leq 0.01$) the umami flavor of *sie reuboh* , whereas addition of vinegar significantly ($P \leq 0.01$) affected pH, cooking weight loss, color, meat flavor, sour flavor, tenderness and chewiness of produced *sie reuboh* descriptively. The sensory profiles of each treatment were also described, where the increasing amount of vinegar tend to decrease pH, prevent cooking weight loss and elevate color, tenderness and sour flavor of the product. [1]

1. Introduction

A traditional such as *sie reuboh,* a cuisine from Aceh Province-Indonesia, is considered as one of indigenous knowledge which carries on the local cultural wisdom. According to [1], *sie reuboh* is red-meat boiled with palm vinegar, dried and then fried or served as preferred. Its appearance is quite similar with dendeng, the thin slices of dry cooked red-meat, but it is moister and has a complex acid flavor. In ancient times, this cuisine was commonly used as a packed meal during war, since it has a long shelf-life. Its long shelf-life is manifested by a combination of palm vinegar and beef tallow added during preparation [2,3]. Palm (*Arenga pinnata*) vinegar is known as natural food's preservative, which commonly used in South East Asean cuisines. Palm vinegar contains acetic acids as the product of vinegar fermentation. The addition of vinegar has been reported to decrease pH, where foods with lower pH (higher acidity) is considered to be more resistance towards microbial growth [4]. An acetate acid also helps to sustain the food quality hedonically [5]. On the other hand, the addition of beef tallow was reported to increase the shelf-life of *sie reuboh* in room temperature. Beef tallow which has solid form in room temperature, is covering the food surfaces, this condition successfully inhibits the microbes to interact with food at room temperature during storage [3].

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However due to the changing in life styles and the consumer health concerns, the preference towards *sie reuboh* is also rapidly change. Modern life styles nowadays prefer to convenience and ready to eat foods, as well as healthier foods. Many reports mentioned that the re-heated processing of *sie reuboh* established higher peroxide value since it consisted of many amount of beef tallow [3], [6]. The mentioned factors above have brought *sie reuboh* as feast cuisine, where the dish is eaten for occasional moments only [7]. Moreover, as the dish is not required to be preserved for a long time storage anymore, the recipe is changed, especially for the amount of palm vinegar and beef tallow being used. Previous research reported by [5] mentioned that consumers prefer to use up to 5% of palm vinegar and up to 50% of beef tallow for *sie reuboh* recipes, which is less than previous formulation. Therefore, this research aims to observe the effect of the developed recipe conducted by [5] towards the physical properties and sensory assessment of the product, both descriptively and hedonically.

2. Materials and Methods

2.1. *Materials*

This study used the meat from thigh (beef round) and beef tallow, of 3 year old Aceh local female cow which was freshly bought at Lambaro Kaphe traditional market, Aceh Besar district, palm vinegar (pH 3.6) from 3 month fermentation process, was bought at Ulee Kareng traditional market, Banda Aceh. The palm vinegar was then pasteurized before used, whilst the red-meat and beef tallow was cut onto square bites (4 cm x 6 cm x 2 cm) with weight 90-100 g per pieces. The recipe percentage was in the basis of the used red-meat [5]. The cooking utensils used were digital scales, blender, basins, gas stove, clay pot and wood stirrer.

2.2. *Statistical Methods and Analytical Procedures*

2.2.1 Experimental design.

This study used a Randomized Block Design with two independent variables. The first variable was percentage of palm vinegar being used (C1=2.5% and C2=5%), whilst the second variables was percentage of beef tallow being used (L1=0%, L2=25% and L3=50%). Then all the treatment combinations were done in three repetitions, resulting the total experiments units of 18 samples. Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) was used for statistical analysis.

2.2.2. Sie reuboh preparation.

The *sie reuboh* cooking process was done refers to [5]. The tallow was firstly trimmed and removed from the fresh meat and the trimmed meat was cut into a block shape with the average weight of 90-100 g per piece, then the meat pieces was washed and drained for 5-10 minutes. The red-meat, salt and lime extract and tallow were placed in *beulanga* (a traditional cooking clay pot) and well-mixed. All spices such as dried ground red chilies (5%), cayenne pepper (1%), garlic (1%), galangal (5%), ginger (1%), turmeric (0.3%), slat (1%), lime juices (2%) and water (100%), were coarsely blended with spoon for 1-2 minutes, mixed with meat and added drinking water. Then all ingredients were cooked for 60 minutes without cover, then vinegar was added based on the treatment level and then continued to boil for ± 30 minutes. After the cooking process was done, *sie reuboh* was allowed to cool down to room temperature, then was placed into vacuum plastic bags and stored over night at 5^{o}C. Prior to analysis, *sie reuboh* was re-heated for 15 minutes and drained, then for each experimental unit, the meat was cut into 1 cm thickness without the curry, followed how the dish was normally eaten. The samples were randomly served to 8 trained panelists based on SNI 2346-2006 sensory evaluation procedure and [8], [9]. Figure 1 shows finished *sie reuboh* after the cooking process is done.

Figure 1. *Sie reuboh*

2.*2.3. Physical property determination.*

Acidity (pH) was determined by a pH meter (LaMotte pH plus Direct) based on [10], where about 10 grams of beef sample were minced using food processor, and then the sample was mixed with 100 ml of water. The homogenous and liquefied sample was placed in a beaker glass to measure its pH by pH meter, each sample was repeated three times. For cooking weight loss determination, the raw beef was weighted (W1) and then was cooked as *sie reuboh* cooking procedure. The cooked beef was weighted (W2) and cooking weight loss was calculated as below equation (1):

$$Cooking\ loss\ (\%) = \frac{W1-W2}{W1} x\ 100\% \quad (1)$$

2.2.4. Sensory analysis.

The sensory quality was descriptively assessed with a Qualitative Descriptive Analysis (QDA) Method [8]. The QDA used 8 trained panelists who were used to made and consumed *sie reuboh* on daily basis. The panelist were selected from several districts in Aceh Besar regency. They received training three times before the real test in order to habituate them with the test procedures. This QDA assessed the intensity of color, aroma (sour, spicy and meaty), flavor (sour, spicy, salty and umami) and texture (tenderness and chewiness) of *sie reuboh* . The intensity was measured using 5-point descriptive scales (1= very weak; 2=weak; 3=just right; 4= strong and 5=very strong) (Setyaningsih et al., 2010). The obtained given score then calculated and normalized based on [9] with a 95% confidence interval for the standard distribution. The mean data of each treatment combination used for ANOVA. The correlation between sensory quality based on QDA and the consumer acceptance towards *sie reuboh* reported by [5] was also conducted.

3. Results and Discussion

3.1. Physical quality

Sie reuboh in this study had the cooking weight loss values about 40.47–44.52% and average 41.82%. The result of ANOVA showed that addition of vinegar has significantly influenced (P≤0,05) on the cooking weight loss of *sie reuboh* as showed in Figure 2. $DMRT_{0.05}$ indicated that the cooking weight loss value of *sie reuboh* which was added with 2,5% palm vinegar had a significant difference to *sie reuboh* added with 5% palm vinegar, where 2,5% vinegar had lower cooking weight loss than the other one (Figure 2). This result agrees with [12] who showed that when beef was immersed in 40 ml of vinegar, it had higher cooking weight loss value than the beef immersed in 20 ml of vinegar. Increasing the percentage of vinegar could increase the cooking weight loss of beef. Acidic properties in vinegar can extract meat protein due to its capability to weaken the miofibril protein bonds that result in a lot free water that comes out of the meat [13]. Later, it also stated that vinegar could affect coking loss value because acetic acid in vinegar can hydrolyse beef protein so that the nutrition of the beef decline [13], as well as the moisture contents [14]. The higher cooking weight loss value was the

lower meat quality due to loss of nutrition [15]. According to [16], increasing cooking weight loss value can be caused by rising temperature of cooking and heating duration during meat processing. Figure 3 showed the effect of palm vinegar addition towards pH of produced *sie reuboh*. As palm vinegar given increased (5%), the pH of *sie reuboh* decreased. The addition of vinegar has been reported to decrease pH [4], as reported as well by [3], [13]. In this research, higher acid treatments tend to increase the color quality of product as can be explained in color attributes.

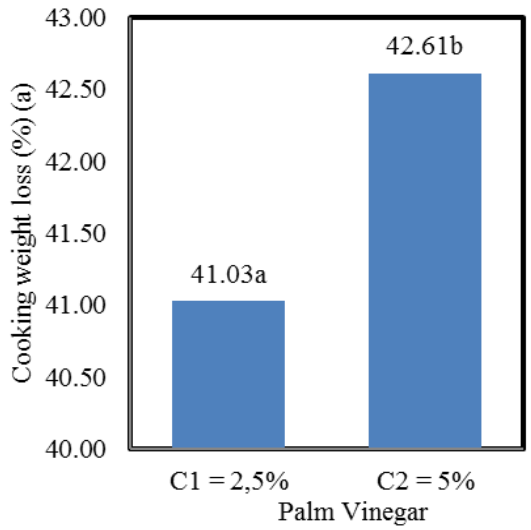

Figure 2. Effect addition of vinegar to cooking weight loss of *sie reuboh* (coefficient of variant was 0,55%)/ (The following values mark with different letter indicated the significantly different)

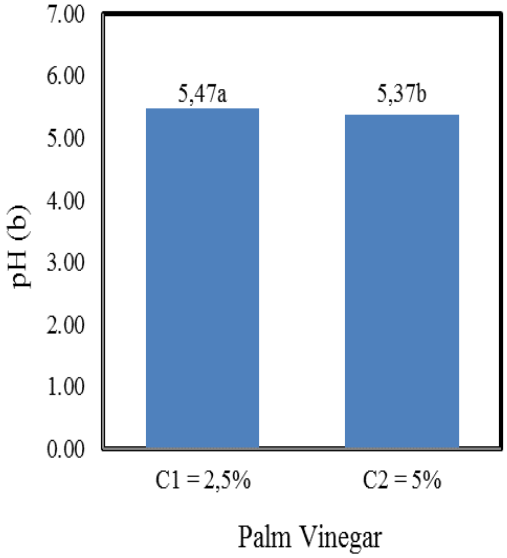

Figure 3. Effect addition of vinegar to pH *sie reuboh* (coefficient of variant was 0,25%). (The following values mark with different letter indicated the significantly different)

3.2 Color attributes

Brightness or color *sie reuboh* descriptively measured in range between 2.50 to 3.93 (pale to bright) with average value of 3.13 (just right). ANOVA shows that the amount of palm vinegar added has significantly influenced ($P \leq 0.01$) the color of *sie reuboh* descriptively, whereas the addition of tallow has showed any influence ($P > 0.05$). Furthermore DMRT test as seen in Table 1 shows that both of treatment levels of palm vinegar have different performed for the brightness of *sie reuboh* , where the trend shows a linear relation between the percentage of added palm vinegar and the increasing brightness level of *sie reuboh* descriptively. Even the spices being used in this product also affects the color of *sie reuboh* such as turmeric which is contributed to the yellow color. But since the amount for all treatments are similar, palm vinegar could be consider as main cause for the brightness. Five percent of palm vinegar produced *sie reuboh* with brighter color than the 2.5%. This might be occurred due to the acidity level of used palm vinegar (pH 3.6). Lower pH of palm vinegar could prevent the meat oxidation during cooking, which at the end could lead to myoglobin denaturation. Therefore by prevention of this oxidation reaction, the brightness or color of meat could be stable during cooking. Moreover in lower pH condition, muscle protein in red meat will be fractioned and enable meat to reflect the light and perform the brighter color [17].

Table 1 Effect of palm vinegar and tallow towards color and aroma of *sie reuboh* descriptively

Factors/Level Treatments		Measured Parameters							
		Colour/Brightnes[b]		Sour Aroma[b]		Spicy Aroma[a]		Meaty Aroma[b]	
Palm Vinegar (%)	C1 (2.5%)	2.58	±0.02a	2.58	±0.07a	3.08	±0.08	3.54	±0.03b
	C2 (5.0%)	3.69	±0.07b	3.84	±0.13b	3.27	±0.14	3.04	±0.12a
Tallow (%) (ns[a])	L1 (0%)	3.08	±0.61	3.50	±0.71	3.40	±0.05	3.17	±0.65
	L2 (25%)	3.22	±0.66	3.20	±0.66	3.43	±0.09	3.13	±0.63
	L3 (50%)	3.10	±0.62	2.93	±0.59	3.78	±0.01	3.38	±0.65

[a] Factors and treatments are not significant towards measured parameters.
[b] Factors and treatments are significant towards measured parameters
Sensory attributes are measured by its intensity descriptively with range scale 1 to 5 (1= very weak; 2 = weak; 3 = just right, 4 = strong and 5 = very strong).
a and b the notation as symbol the statistic differentiation within treatment levels, where numbers followed by same alphabetic symbol in similar row show any differentiation exists

3.3. Aroma attributes

Aroma attributes assessed in this research consist of sour aroma, spicy aroma and meaty aroma. The ANOVA shows that only percentage of added palm vinegar has significant influence towards the aroma of *sie reuboh* descriptively, namely for sour and meaty aroma. On the other hand the percentage of beef tallow added during cooking showed any influences for three descriptive attributes. Moreover underlining the spicy aroma of *sie reuboh*, which is not influenced by both factors, this condition could be occurred due to the amount of spices using in this research were similar for all treatment, since it is not the dependent factor.

Sour aroma of all samples of *sie reuboh* is measured in range of 2.43-4.20 (weak to strong) with average score 3.21 (just right) and meaty aroma is in range 2.63-3.63 (just right to strong) with mean value is 3.29 (just right). From Table 1, it could be seen that the addition of palm vinegar influenced the sour and meaty aroma of *sie reuboh* , where palm vinegar showed direct proportion with sour aroma but it performed inversed proportion with meaty aroma. Sour aroma is an aroma produced by organic acid added or contained in the product, respectively acetic acid inside the palm vinegar. Therefore as the percentage of palm vinegar added increased the sour aroma intensity also increased respectively [13].

On the other hand, the reaction of palm vinegar factor towards meaty aroma was reversed. Meaty aroma defines as aroma which is originally came from fresh meat, descriptively the meaty aroma is combination of bloody and fishy of meat. Several researchers have mentioned that lipid oxidation as the essential cause of meaty aroma [18-20]. So it is potential the meaty aroma increases as the tallow given the cooking process of *sie reuboh* . However, the intensity of meaty aroma decreased as the percentage of palm vinegar increased. In addition, a certain prediction stated by [21] that acetic acid is diffused in meat during cooking process and led to protein denaturation, which finally produced the volatile compounds during the maillard reaction.

3.4 Flavour attributes

In this research, flavor intensity is measured based on its hot spiciness, sourness, saltiness and umami descriptively. ANOVA statistically mentioned that palm vinegar factor only has significant effect ($P \leq 0.05$) on sour flavor, whilst beef tallow factor only influenced ($P \leq 0.05$) the umami flavor. For measured parameters which are unaffected ($P > 0,05$) by dependent factors, namely as hot-spicy and salty flavor could be caused by the amount of chilly, salt and other spices in this research are similar for all unit experiments.

Table 2 shows the DMRT0.05 effect of dependent factors towards flavor of *sie reuboh* , where sour flavor intensity showed the raising trend as the percentage of palm vinegar increased, and has

significantly differentiated for both treatment levels. This might be occurred due to the acetic acid compounds in palm vinegar, which is produced during the fermentation process. Acetic acid considers to have specific flavor, which is commonly used in South East Asian cuisine as synthetic flavor agents. In detail in Table 2, it is clearly showed that the increasing trends are also performed by others three flavor attributes, but without any statistical differentiation between the treatment levels followed. Umami flavor of all *sie reuboh* samples descriptively measured in range of 2.20 to 3.93 (weak to strong) with average score is 3.15 (just right). Moreover, The DMRT0.05 statistically mentioned that the addition of beef tallow up to 50% is successfully elevated the umami flavor which reached the score 3.87 (strong) that is significantly different than other lower levels. This increasing intensity could be caused by the presence of primer product of lipid oxidation as the given percentage of beef tallow higher [22] which is also interacted with formation with umami flavor in maillard reaction during cooking process [21]. Later several reports also added that lipid such as tallow derived volatiles in larger amounts [22]; and plays multiple roles in flavor development, in terms of producing distinctive flavor during the lipid oxidation during the thermal cooking processing [22],[23],[20], as occurred in *sie reuboh* .

Table 2 Effect of palm vinegar and tallow towards flavor of *sie reuboh* descriptively

Factors/Level Treatments		Measured Parameters							
		Hot-spicy Flavor [a]		Sour Flavor [b]		Salty Flavor [b]		Umami[b]	
Palm Vinegar	C1 (2.5%)	3.30	±0.04	2.74	±0.07a	3.08	±0.07	3.03	±0.02
	C2 (5.0%)	3.52	±0.13	3.56	±0.16b	3.19	±0.10	3.27	±0.24
Beef Tallow	L1 (0%)	3.67	±0.16	3.50	±0.38	3.37	±0.07	2.33	±0.06a
	L2 (25%)	3.37	±0.12	3.10	±0.31	3.17	±0.05	3.25	±0.13b
	L3 (50%)	3.20	±0.05	2.85	±0.18	2.87	±0.00	3.87	±0.03c

Table 3 Effect of palm vinegar and tallow towards texture of *sie reuboh* descriptively

Factors/Level Treatments		Measured Parameters			
		Tenderness[b]		Chewiness[b]	
Palm Vinegar (%)[b]	C1 (2.5%)	2.77	±0.08a	3.30	±0.16b
	C2 (5.0%)	3.60	±0.09b	2.49	±0.13a
Beef Tallow (%)[a]	L1 (0%)	3.20	±0.47	3.18	±0.48
	L2 (25%)	3.32	±0.22	2.55	±0.32
	L3 (50%)	3.03	±0.19	2.95	±0.06

[a] Factors and treatments are not significant towards measured parameters
[b] Factors and treatments are significant towards measured parameters
Sensory attributes are measured by its intensity descriptively with range scale 1 to 5 (1= very weak; 2 = weak; 3 = just right, 4 = strong and 5 = very strong).
a,b and c are the notations used as symbol the statistic differentiation within treatment levels, where numbers followed by same alphabetic symbol in similar row shows any differentiation exists

3.5 Texture attributes

As meat products, texture of *sie reuboh* is descriptively assessed based on the tenderness and chewiness of meat during gustation and chewing process. Based on ANOVA, only palm vinegar factor has significant influence ($P \leq 0.05$) towards the tender and chewy texture of *sie reuboh*. All samples of this cuisine is reported have tenderness scale in range within 2.57 to 3.87 (just right to strong) with average score 3.18 (just right) descriptively. Based on Table 3, it is clearly seen that the

increasing level of palm vinegar given in formulation product, could significantly elevated the tenderness of *sie reuboh* , as 5% of palm vinegar produced meat with higher tenderness level (3.60 – strong). This might be occurred since the palm vinegar has ability to hydrolyze the protein muscles which impact the activity of binding water and loose the interval spaces within the muscles. On the other hand, chewiness emphasizes to the hard feeling occurred during meat chewing process in the mouth, where the score of all samples is varied from 2.10 to 3.87 (weak to strong) and average score is 2.89 (just right). $DMRT_{0.05}$ showed that when less percentage palm vinegar given, the chewiness score is higher. This phenomenon shows that chewiness is revised version of tenderness as presented in Table 3 below.

3.6 Correlation between the measured parameters with sie reuboh consumer acceptance scores

Table 4 shows the correlation between the physical/sensory quality of *sie reuboh* and consumer acceptance. Firstly discussed is the correlation within pH and color which assessed hedonically. The coefficient is -0.48 which refers to negative relationship within both parameters. This negative correlation is also proven by the consumer acceptance towards color and flavor of *sie reuboh* elevated as the pH level decreased due to the higher percentage of palm vinegar being used. On the other hand cooking weight loss statistically proven to have positive correlation (+0.40) with consumer acceptance towards texture of *sie reuboh* . It is can be explained by as the tendency of higher acceptance of texture increases aligned with higher value of cooking weight loss, which led to the tenderness of meat.

Table 4 Correlation between the physical quality of *sie reuboh* and consumer acceptance

Physical Measurement	Consumer Acceptance							
	Color		Aroma		Flavor		Texture	
	Corr	R^2	Corr	R^2	Corr	R^2	Corr	R^2
Ph	--	-0.48	Ns	0,16	+	0,55	ns	-0.38
Cooking weight loss	ns	0,10	Ns	-0.07	ns	0,00	+	0,41
Sensory Descriptive Measurement	Consumer Acceptance							
	Color		Aroma		Flavor		Texture	
	Corr	R^2	Corr	R^2	Corr	R^2	Corr	R^2
Color/Brightness	+++	0,81	+	0,40	+	0,45	ns	0,30
Sour Aroma	++	0,60	Ns	0,21	Ns	0,30	++	0,52
Spicy Aroma	ns	0,04	-	-0,43	Ns	-0,23	+	0,47
Meaty Aroma	--	-0,50	Ns	-0,09	Ns	-0,13	-	-0,47
Hot-spicy Flavor	ns	-0,10	Ns	-0,26	Ns	-0,01	ns	0,29
Sour Flavor	+	0,45	Ns	0,19	Ns	0,17	+	0,45
Salty Flavor	ns	-0,14	Ns	-0,28	Ns	-0,21	+	0,48
Umami	-	0,44	++	0,61	++	0,67	ns	-0,12
Tenderness Texture	+	0,61	Ns	0,32	+	0,47	++	0,66
Chewiness Texture	-	-0,53	Ns	-0,31	-	-0,46	ns	-0,32

+++/++/+ positive correlation exists within the parameters with very strong/strong/slightly strong
---/--/- negative correlation exists within the parameters with very strong/strong/slightly strong
ns not significantly correlated

Table 4 also presents the correlation within the sensory quality and consumer acceptance. *Sie reuboh* which descriptively has brighter color tend to have higher consumer acceptance, as proven by very strong positive correlation (+0.82). The similar trend also appears for correlation between

tenderness, sour aroma and sour flavor towards consumer acceptance for texture attributes. All above parameters are linked with palm vinegar factor, as a cause of intensity of sour and flavor aroma, as well as tenderness in *sie reuboh* increases.

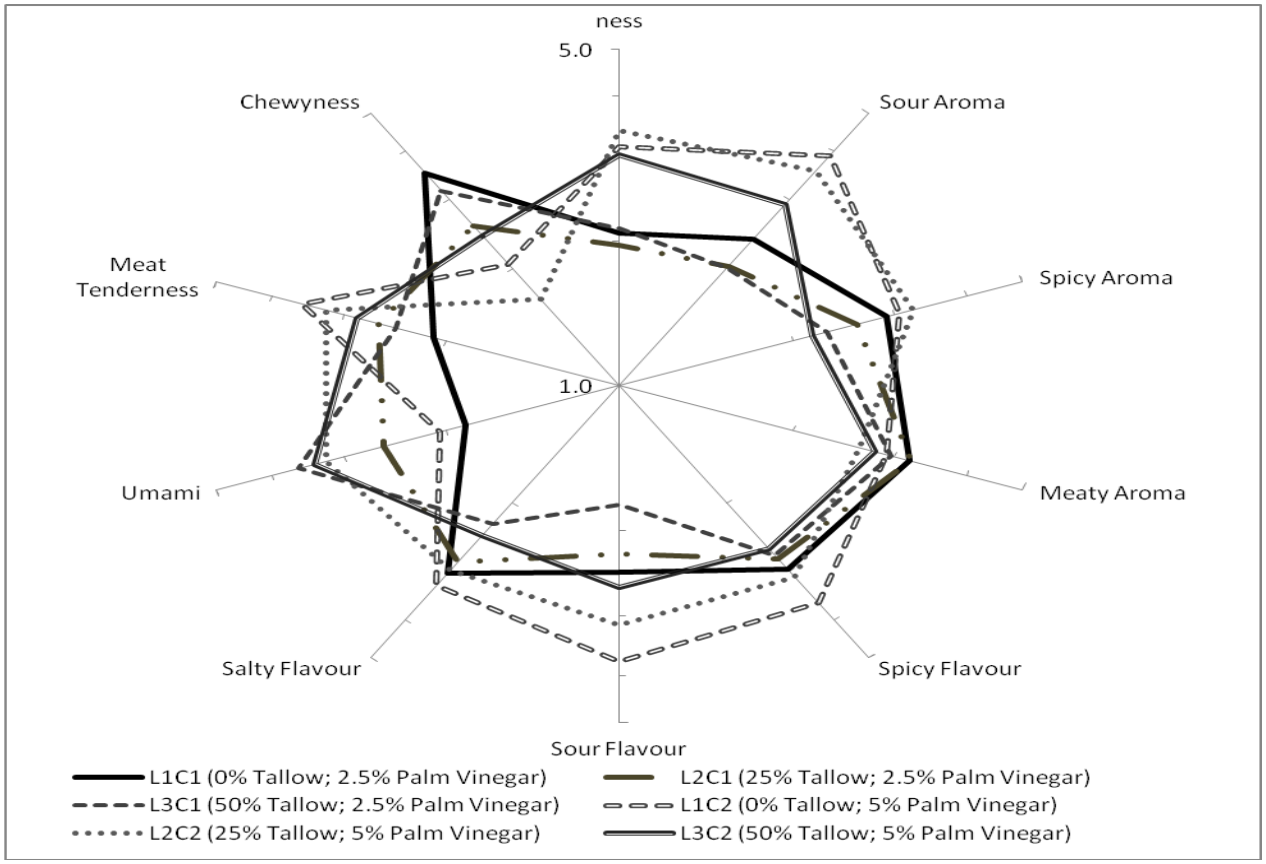

Figure 4. Sensory profile of *sie reuboh* with different treatment levels, with scale 1 to 5 (very low intensity to very strong intensity).

3.7. Sensory profile of 'Sie rebouh'

Sensory profile of *sie reuboh* could be seen in Figure 3, where all ten descriptive attributes assessed in this research are presented in spider web diagram, performs each different sensory profile for all six unit experiments. The Figure uses five scale intensity as performed during data collection where 1 refers to very weak intensity and 5 refers to very strong intensity. Unit experiment which is combination of absence of beef tallow (L1=0%) and highest percentage of palm vinegar added (C2=5%) produced *sie reuboh* with high intensity of sour aroma and flavor, brightness and tenderness of *sie reuboh* rather than the units which used less percentage of palm vinegar. However, the above attributes will have less intensity as the percentage of beef tallow increased (L2= 25% and L3=50%). Therefore it can be clearly said that palm vinegar factor is substantially forming up the sensory profile by determination its color, sour aroma and sour flavor, whilst the beef tallow factor has major contribution to formulate the meaty aroma and umami flavor of *sie reuboh* . After detail investigation of *sie reuboh* sensory profile, it can be said the best unit experiment with optimum physical and optimum quality is combination of 25% beef tallow and 5% palm vinegar (L3C2).

4. Conclusions

Taking everything into consideration it can be concluded that there is a considerable changes in formulation of *sie reuboh* recipes and the changes also has major impact on physical quality and sensory quality of the cooked meat product. As percentage of palm vinegar used increases, pH of

product decreases and the sensory quality especially the brightness color, the sour aroma and flavor as well as tenderness of product tend to elevate onto higher intensity, whilst the contradiction occurred towards meaty aroma and chewiness attributes. Palm vinegar factor also built up positive correlation between brightness, sourness and tenderness of product and whole consumer acceptance hedonically. On the other hand, factor of beef tallow has considerable influenced towards umami flavor. Lastly mentioned that the best combination treatment which produced optimum sensory quality of *sie reuboh* is combination of 25% beef tallow and 5% palm vinegar (L3C2) with this sensory quality descriptively (3.40 color; 3.60 sour aroma, 3.20 spicy aroma, 2.60 meaty aroma, 3.10 spicy flavor, 3.10 sour flavor, 3.0 salty flavor, 3.2 umami, 3.2 tenderness and 1.70 chewiness).

5. Acknowledgements

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