A comparative study of sensory quality of sie reuboh (an Acehnese cooked meat) based on its cooking ware

D Hasni¹, C Nilda¹, Yusriana¹, D I Annabila¹, Y Y Asna¹

¹Department of Agricultural Product Technology, Agriculture Faculty, Universitas Syiah Kuala. Kopelma Darussalam, Banda Aceh -Indonesia 23111

E-mail: hasni_dian@unsyiah.ac.id

Abstract. Sie reuboh is a traditional festive cuisine from Aceh Besar district – Aceh Province. Sie reuboh named by Acehnese for a 2:1 comparison of red-meat and separated beef tallow boiled with palm vinegar and blended spices. It reported having a long shelf life, exquisite of taste and flavor. Normally, Acehnese cooks this cuisine with traditional clay pot. As cooking utensil, clay pot is vulnerable to breakage and has slow heat propagation compared to stainless steel pot which has long usage and good heat conductor. This study aims to compare the quality of produced sie reuboh based on its sensory quality (Hedonic and Qualitative Descriptive Analysis = QDA) and consumer acceptance by hedonic test. Sie reuboh was cooked in two types of cooking ware (earth clay pot and stainless steel pot) in four times repetitions. The obtained data is statistical analyzed with ANOVA and DMRT. The results showed that sie reuboh cooked with stainless steel pot is preferable in terms of color, aroma, flavor (P≤0,01) than one cooked with clay pot. Furthermore, the QDA showed that from ten examined attributes, brightness, sour and spicy aroma and umami flavor of sie reuboh cooked with stainless steel has higher notes (P≤0,01) than other treatment. As conclusion, it can be stated that stainless steel provides sie reuboh with better sensory properties and higher consumer liking.

1. Introduction
Sie reuboh is authentic traditional food from Aceh, which inherits the local wisdom of people [1]. Sie reuboh is commonly cooked during meugang tradition, as a welcoming event to celebrate religious moments such as Ramadhan, Idul Fitri and, Idul Adha. As a festive event, meugang always provides and serves huge numbers of food from read-meat, chickens, and lambs to be shared with the poor, orphanage, and close relatives [2]. Furthermore, sie reuboh called as a packed meal for Acehnese soldiers during the war. Siereruobh is made from red meat, which boiled together with the number of spices and palm vinegar, dried up, then fried [3]. The used ingredients together with a complex cooking process produce a cuisine which has a complex flavor and long shelf-life [4]. Suhairi [5] claimed that sie reuberohable to be keep for a month with repeated heating.

Hasni et al. [6] successfully mapped the formulation of up to date version of sie reuboh from eleven subdistricts in Aceh Besar. The findings showed that except this cuisine used a huge range of spices, a wide range of the amount of palm vinegar and beef tallow existed within these sample areas. Later 5% palm vinegar and 50% beef tallow from total red meat used produce better quality of sie reuboh than the less added amount. Then Erfiza et al. [7] also claimed that the mentioned combination produced better nutritional value than other treatments.
As a traditional cuisine, *sie reuboh* has a huge opportunity as a commercializing product. Its exquisite taste and appearance, long product usage as well as the indigenous knowledge behind the cuisine are consider as an ultimate selling point. However, several issues should be addressed properly to produce ready to sell *sie reuboh*, such as its cooking ware. This cuisine is originally cooked for 1 hour in convex (round) bottom clay pot or *beulanga tanah* with medium heat[6,7]. Unfortunately, this cooking ware is becoming rare nowadays since its hand-made. Its limited production, fragile, porous surface, cleaning difficulties, and slow-heat propagation are several reasonable conditions of why clay pot is left behind [8,9]. On the other hand, stainless steel pot is usual cooking ware in Indonesian domestic kitchen. Its comfy appliance, durability, and availability are the reason why stainless steel is more preferable [10].

Several studies have worked related to the implication of chosen cooking ware towards the quality of food, for examples its physical, sensory and nutritional quality. Xing et al. [11] reported that pea pastes, a traditional legume food in China and many Asia countries, cooked in with clay pot received higher sensory qualities while as using iron pot allowed the iron enrichment for this traditional dish. Later, a comparative study has done related the food shelf life cooked in an aluminum pot and clay pot, where total plate count of food cooked in an aluminum pot is higher than the clay pot [10]. Therefore, to assess detail information related to its sensory quality, a comparison between these two cooking wares should be made. Later the outcome of this research should be used as decision tool to choose the suitable cooking ware for commercial *sie reuboh*.

2. Materials and Methods
The research and scale productivity assessment done in Food Processing Technology Laboratory. Meanwhile the sensory quality was assessed in Sensory Evaluation Laboratory and safety assessment in Microbiology Industry Laboratory. All laboratories are part of Department of Agricultural Product Technology, Faculty of Agriculture – Universitas Syiah Kuala.

2.1 Materials
Red meat and tallow was from 3-year-old Aceh cow local breeding (female), thigh part meat (beef round) and solid tallow. The meat and tallow were freshly bought at Lambaro Kaphe traditional market, Aceh Besar district one day before cooking. The meat and tallow were prepared (cleaned from fat, well-trimmed), cut into square block bites (4 cm x 6 cm x 2 cm) with uniform weight 90-100 g per pieces, weighed for 1 kg, placed in a plastic vacuum then stored in freezer 0 to -5°C before cooking.

Others materials are palm vinegar from circa three months of fermentation process, with pH range 3.56-3.62, was bought at Ulee Kareeng traditional market Banda Aceh. The utensils were used *beulanga tanah*, a traditional Acehnese clay pot with round bottom with diameter 28±1.15 cm and height 8,5±0,57 cm, also a round stainless steel pot with diameter±34 cm and height ± 8 cm as can be seen in Figure 1. Digital scales, blender, wood stirrer, basins, gas stove, plastic vacuum container, vacuum sealer were also used. For sensory quality assessment, score sheet based on AMSA guidelines [12] and glassware were used. pH meter, TPC, oven were used for others products assessments.

![Figure 1. Stainless steel and clay pots](image-url)
2.2 Methods

2.2.1 Experimental Design. This study was designed with Randomized Block Design with cooking ware ($B = beulanga/earthen clay pot$ and $S = stainless steel pot$) as independent variable. Specific for rendemen and cooking loss assessment, with four times repetition. For other treatments such as sensory quality, pH, total plate count, the repetition was done three times. All combination experiments were statistically measured by Analysis of Variance and Duncan Multiple Range Test. The statistical analysis ran with Microsoft Excell 2013.

2.2.2 Sie reuboh preparation. *Sie reuboh* cooking procedures and the recipes taken from the best experiment from previous study [6]. Amount of used red meat was a basis percentage of all ingredients used in the recipes. The frozen meat and 50% tallow were thawed 3 hours before cooking. Then meat and tallow were mixed with lime extract (2%) and salt (1%) in cooking ware, then rest for 15 minutes. Dried spices named as cayenne pepper (1%), ground red chilies (5%), garlic (1%), galangal (5%), ginger (1%), turmeric (0.3%)were coarsely blended with a spoon, mixed well with meat and tallow. Then all materials were cooked with medium heat for 60 minutes uncovered, then 5% vinegar were added while the cooking was continued for others 30 minutes. Next, *sie reuboh* was cooled and placed in a plastic vacuum container before analysis, stored in room temperature (25°C).

The measured parameters were sensory quality both hedonically (color, aroma, flavor, and texture) and descriptively (color, aromasour, aroma spicy and aroma meaty, flavor sour, spicy, salty and umami, tenderness and chewiness).

2.2.3 Sensory analysis. *Sie reuboh* was prepared based on AMSA [12] that stated that sensory evaluation of meat product should be done based on common practice. Homogenizing dan reducing the differences within the treatments, each piece of sample of *sie reuboh* cut into cubes in measurement 1.27x1.27x1.27 cm, and well-mixed. Furthermore, *sie reuboh* is reheated for 10-15 minutes and then placed in glass bowl. The panelists received three or four cubes for each sample of meat together with the sauces.

Acceptance test was done to measure hedonic quality of *sie reuboh*. Thirty panelists were invited to take the test. Panelists were selected by their adequate knowledge about *sie reuboh* and frequent consumption (self-cooked or buy). Panelists were seated individually in personal booth and received the six samples randomly. The responses were noted in score sheet, where the 1-5 hedonic score were used (1=very unlikely to 5=like it very much) [13].

The sensory quality of *sie reuboh* was examined with Qualitative Descriptive Analysis (QDA) method with the help of 8 trained panelists. Panellist was chosen based on their knowledge and frequent consumption (heavy users) of *sie reuboh*. Prior testing, the panellist received three times probation to allow adaptation towards testing procedures and products. QDA examined intensity of ten attributes of *sie reuboh*, named color (brightness), aroma (sour, spicy and meaty), flavor (sour, spicy, salty and umami) and texture (tenderness and chewiness) with 1-5 scale (very weak to very strong) [14]. In between of sample testing, panelists and trained panelists were urged to clear their palate with mineral water and unsalted crackers. During the test, panelists were asked to test the color, aroma, flavor, and texture of each sample sequentially without any repetition or reexamination [13;14]. Then the assessed score is tabulated and calculated based on SNI 01-2346-2006 with 95% standard deviation [15], where the average score was obtained. Average data was used as data sources for Analysis of Variance and DMRT.

3. Results and Discussion

3.1 Consumer Acceptance

Table 1 showed the average score given by panelists during acceptance test for *sie reuboh* based on its used cooking ware. Panelists examined four attributes of *sie reuboh* due their liking, which are color(brightness), aroma, flavor, and texture. It can be seen from the Table 1 that stainless steel pot produce *sie reuboh* which is more preferable by panelists than the clay pot, especially for color, aroma.
and flavor attributes \((P<0.01)\). For color, panelists were asked to examine the brightness due to their liking. Panelists tend to like sie reuboh from the stainless steel pot than clay pot, but both of the cooking ware produced sie reuboh which valued in similar range of hedonic scale (just right). Color or brightness is a result of Maillard reaction during cooking process, where Maillard reaction produced melanoidin and causes the product darker [16]. For aroma, sie reuboh cooked with clay pot is scored as dislike \((2.15)\) whereas sie reuboh cooked with stainless steel pot achieves just right score \((3.48)\). Aroma is a result of lipid oxidation and releasing volatile compounds from the used spices during cooking process [17]. The other attribute which has a significant influence of types of cooking ware is flavor of sie reuboh. Stainless steel pot produced sie reuboh with higher flavor notes than the claypot.

Flavor perceived by panelists as a combination between odor and taste, with tongue bud and nasal cavity as receptors [18]. The liking of these attributes hedonically by panelists occur since stainless steel pot absorbed heat quicker than claypot [10]. As it occurs, the Maillard reactions considers as one of important routes of flavor compounds in thermal process food. During cooking, carbonyl group of reducing sugars interacts with an amino compound of protein, then they condense and degrades into different oxygenated compounds. Later these oxygenated compounds interact with other reactive components such as aldehydes, hydrogen sulfide, and ammonia and produce flavor compounds such as furans, pyrazines, pyrroles [19]. Therefore it might be possible that Maillard reaction and lipid oxidation releasing the volatile compounds might be occurred more sufficient in stainless steel than in earth claypot. Later this insufficient heat absorption causes how many flavor compounds formed during the cooking process for flavor formation, which give impact towards the color, aroma, and flavor perceived by panelists hedonically and descriptively. This assumption also supported by the fact that umami and sour flavor of sie reuboh cooked with stainless steel also has higher notes.

### Table 1. The effect of types of cooking ware used in sie reuboh cooking process towards consumer’s liking by acceptance test

| Types of cooking ware     | Consumer Acceptance with Hedonic Scale1  |
|---------------------------|------------------------------------------|
|                           | Color \((P<0.01)\) | Aroma \((P<0.01)\) | Flavor \((P<0.01)\) | Texture \((P>0.05)\) |
| Earth Clay pot            | 2.15 ±0.16a | 2.71 ±0.14a2 | 2.68 ±0.44a | 3.16 ±0.19 |
| Stainless steel pot       | 3.48 ±0.09b | 3.21 ±0.20b | 3.14 ±0.33b | 3.14 ±0.40 |
| DMRT \((t)\) 0.05         | 0.48 | 0.49 | 0.32 | ns3 |

1Hedonic scale \((1=dislike it very much, 2=dislike it, 3=neutral/just right, 4=like it and 5=like it very much)\)
2Different letters \((a,b)\) in the same row indicate significant differences by DMRT
3ns= no significant differences statistically

### 3.2 Sensory Profile of Sie Reuboh

Sensory profile of sie reuboh assessed in this research based on its ten attributes, which placed on four general sensory attributes, which are color, aroma, flavor, and texture. The attributes were examined individually by eight trained panelists. Brightness or color of sie reuboh produced with two variations of cooking ware is between 1.62 (very pale to pale) and 3.56 (bright to very bright). ANOVA showed that types of cooking ware used has a significant influence towards the color of sie reuboh. From DMRT it can be shown that the difference between treatments are significant, where stainless steel pot produced brighter sie reuboh than claypot. This brightness also influenced the consumer acceptance (Table 1).

Addition palm vinegar which has high acidity level \((pH 3.6)\) might be prevent meat oxidation during cooking process, which enable to stabilize the brighter color during cooking [1]. However, since the raw material of stainless steel is from combination of various metal such as chromium, nickel, and mangan [20]. It has function as an active heat conductor. On the other hand, clay pot is from earth soil which make it has pores and acts as inactive conductor. By doing this, heat propagation of stainless steel is faster and more stable than clay pot [21]. This stable heat might provoke the occurrence of meat oxidation and Maillard reaction more often than the clay pot one. Therefore it
produced more darker *sie reuboh* than claypot. By comparing the two dishes, *sie reuboh* from stainless steel might appear brighter than the pale *sie reuboh* from clay pot.

For aroma attributes, the examination was done for sour, spicy, and meaty aroma. The types of cooking ware used statistically have any influenced towards all of three aroma attributes perceived by trained panelists. Eventhough, based on the given score, earth clay pot seems to have lower intensity than stainless steel for all aroma attributes. Sour aroma is an identical sensory properties of *sie reuboh* as an outcome of palm vinegar addition [1]. Stainless steel pot produced *sie reuboh* with just right scale aroma than claypot.

Furthermore, spicy aroma is manifestation of all spices used, where *sie reuboh* from stainless steel pot perceived higher intensity than claypot. As both of spices and palm vinegar have volatile compounds, it can be said that rapid heat propagation of stainless steel pot enable many volatile compounds to release and produce a strong sour and spicy aroma. Gray et al. [22] and Khan et al. [23] reported that meaty aromadescribed as aroma of fresh raw meat, fishy and bloody. The used of 5% of palm vinegar reported to press over this meaty aroma [1] since the acetic acid in palm vinegar is diffused within the meat cells during cooking, denaturated the protein cells, and released the volatile compounds which elevated the sour aroma and decreased the meaty aroma.

**Table 2.** Color and aroma of *sie reuboh* based on its cooking ware

| Types of cooking ware | Sensory Properties of *Sie Reuboh* with intensity scale¹ | Aroma |
|-----------------------|---------------------------------------------------------|-------|
|                       | Colour (P≤0.01)  | Sour Aroma | Spicy Aroma | Meaty Aroma |
| Earth Claypot         | 1.62 ±0.15a²    | 2.47 ±0.50 | 2.22 ±0.55 | 2.79 ±0.27 |
| Stainless steel pot   | 3.56 ±0.10b     | 2.99 ±0.19 | 3.16 ±0.28 | 2.83 ±0.30 |

1Intensity scale (1=very pale/weak, 2=pale/weak; 3=neutral/just right, 4=bright/strong and 5=very bright/strong)
2Different letters (a,b) in the same row indicate significant differences by DMRT
3ns= no significant differences statistically

Flavor of *sie reuboh* were described onto four attributes, which are hot-spicy flavor, sour flavor, salty and umami flavor. Amongst these four attributes, only sour and umami flavor of produced *sie reuboh* have been influenced significantly by types of cooking ware. It is due to the evaporation of palm vinegar during cooking. Sour flavor of both of *sie reuboh* are in the range of weak intensity (2.01-2.25), where stainless steel pot produced weaker sour flavor than claypot. It might be occurred due to stainless steel is more reactive to acid than claypot. The metal component of stainless steel are leached and reduce the acidity level. Tomato sauce cooked in stainless steel reported to have higher pH than sauces made with other cookware [24].

On the other hand, clay pot has pores and tight surfaces which enables slower heat absorption and evaporation [9;11]. This finding is quite different with previous study that described *sie reuboh* with 5% addition of palm vinegar perceived by panelists with just right to strong intensity scale (3.56). For umami, DMRT showed that both treatments are significantly differentiated, where *sie reuboh* with higher umami tensity (just right scale) perceived by panelists from cooking with stainless steel pot. Umami is taste of salty-sweet and savory cooked meat, as a manifestation of lipid oxidation from 50% beef tallow addition. Beef tallow is a derivative of volatiles and plays significant role in flavor formation in Maillard reaction and lipid oxidation during a thermal processing [25]. As stainless steel absorbed heat quicker, the oxidation is more rapid than clay pot which elevates the intensity of umami flavor. The other two attributes in flavor are hot spicy and salty. These two attributes are not influenced by types of cooking ware used. It is becausethe salt and chilies are given in same percentage for all variables and also since salt is mineral, the absorption is not influenced by how rapid the heat propagation for each cooking ware.
Table 3. Flavor of *sie reuboh* based on its cooking ware

| Types of cooking ware | Sensory Properties of *Sie Reuboh* with intensity scale¹ | Flavor |   |   |   |
|-----------------------|--------------------------------------------------------|--------|---|---|---|
|                       |                                                        | Hot spicy Flavor | Sour Flavor | Salty Flavor | Umami |
| Earth Claypot         |                                                        | 1.62 ±0.15       | 2.25 ±0.35b² | 2.31 ±0.41   | 2.53 ±0.21a|
| Stainless steel pot   |                                                        | 1.96 ±0.51       | 2.01 ±0.38a | 2.20 ±0.27   | 2.94 ±0.18b|
| DMRT t (α) 0.05       |                                                        | Ns               | 0.17         | ns³          | 0.16   |

¹Intensity scale (1=very pale/weak, 2=pale/weak; 3=neutral/just right, 4=bright/strong and 5=very bright/strong)
²Different letters (a,b) in the same row indicate significant differences by DMRT
³ns= no significant differences statistically

Texture of *sie reuboh* were assessed by its tenderness and chewiness. Tenderness measures the easy gustation of meat and chewiness refers to hardness to chew the meat during gustation in mouth. Based on ANOVA, types of cooking ware does not influence the tenderness and chewiness of produced *sie reuboh*. Both of cooking ware produces *sie reuboh* with just right tenderness (3.01-3.13) and weak to just right chewiness (1.68-1.79). Chewiness and tenderness are revised attributes to each others. The thermal processing up to 95 minutes and intervention of palm vinegar able to hydrolize protein muscles of meat, loosen up the connective tissue and binding water of meat muscles [26; 27]

Table 4. Texture of *sie reuboh* based on its cooking ware

| Types of cooking ware | Sensory Properties of *Sie Reuboh* with intensity scale¹ | Texture |   |   |
|-----------------------|--------------------------------------------------------|---------|---|---|
|                       |                                                        | Tenderness | Chewiness |
| Earth Claypot         |                                                        | 3.13 ±0.21 | 1.68 ±0.41 |
| Stainless steel pot   |                                                        | 3.01 ±0.31 | 1.79 ±0.01 |
| DMRT t (α) 0.05       |                                                        | Ns       | ns²       |

¹Intensity scale (1=very pale/weak, 2=pale/weak; 3=neutral/just right, 4=bright/strong and 5=very bright/strong)
²ns= no significant differences statistically

Figure 2. Sensory profile of *sie reuboh* based on its cooking ware

Figure 2 below showed sensory profile of *sie reuboh* based on its cooking ware used. It can be seen that stainless steel produced *sie reuboh* with better sensory properties, especially for color, sour and spicy aroma and also umami flavor. However the texture are perceived in similar intensity. This finding might be different with previous studies which have done before. By having this information, it can be stated that it is highly possible to cook *sie reuboh* with stainless steel pot since it produces...
good sensory profile. Using stainless steel as cooking ware in commercial production is common practice since it has rigid forms, long shelf usage, and multi-functioning.

4. Conclusions
Taking everything into consideration, it can be stated that cooking ware significantly influences sensory quality of sie reuboh. Its heat propagation system tends to influence the thermal reaction during cooking. Stainless steel as good heat conductor might be elevate the process of lipid oxidation, water evaporation, aroma formation through releasing the volatile compounds and Maillard reaction than the claypot. The finding showed that sie reuboh cooked with stainless steel pot is more preferable in terms of color, aroma, and flavor (P≤0,01) than one cooked with clay pot. Furthermore, the QDA showed that from ten examined attributes, brightness, sour and spicy aroma and umami flavor of sie reuboh cooked with stainless steel has higher notes (P≤0,01) than other treatment. By having this information, it can be stated that stainless steel is highly possible to use as cooking ware in commercial production. However several study is required to be done in order to have comprehensive understanding related other quality aspects of sie reuboh based on its cooking ware.

Acknowledgment
The researchers and all involved parties acknowledge Ministry of Research and Higher Education of Republic Indonesia, in the name of Syiah Kuala University, who funded and supported this research through “Penelitian Lektor 2019” with contract number 141/UN11.2/PP/PNBP/SP3/2019.

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