

# Organoleptic Quality of Mutton Smoked with Sawdust Source and Different Smoking Duration

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## ABSTRAK

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Pengasapan adalah suatu metode pengolahan pangan dengan menggunakan limbah kayu untuk memperbaiki aroma, warna, citarasa, dan tekstur protein hewani, seperti daging kambing, yang memiliki tekstur alot dan feromon. Serbuk kayu dapat digunakan sebagai bahan pengasap untuk menurunkan ketersediaan sisa kayu pasca pemanenan. Penelitian ini bertujuan untuk menganalisa kualitas organoleptik kambing asap dengan menggunakan jenis serbuk kayu dan lama pengasapan yang berbeda. Penelitian ini menggunakan Rancangan Acak Lengkap (RAL) faktorial yang terdiri dari 4 jenis serbuk kayu (jati, sengon, meranti, dan damar) dan 3 lama pengasapan berbeda (2, 3, dan 4 jam). Parameter yang diperlukan dalam penelitian ini adalah warna, aroma, tekstur, keempukan, citarasa, kadar jus, dan penerimaan umum. Hasil penelitian ini menunjukkan bahwa penggunaan serbuk kayu dan lama pengasapan berbeda berpengaruh sangat nyata ( $P<0,01$ ) terhadap kualitas organoleptik kambing asap. Jenis serbuk kayu menunjukkan pengaruh sangat nyata ( $P<0,01$ ) dan lama pengasapan berpengaruh nyata ( $P<0,05$ ) terhadap kualitas organoleptik kambing asap. Kayu Meranti direkomendasikan sebagai bahan pengasapan daging baik karena memiliki daya pengawetan yang kaya dari berbagai senyawa kayu, seperti fenol dan etanol. Waktu pengasapan 3 dan 4 jam menunjukkan cukup suka daripada 2 jam karena jangka waktu produksi asap dapat melindungi kerusakan zat gizi dan mikrobiologi.

**Kata Kunci:** Kambing Asap, Kualitas Organoleptik, Serbuk Kayu, Lama Pengasapan

## ABSTRACT

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Smoking is a food processing method by preserving the food using timber to improve the flavor, colour, taste, and texture of the animal protein such as mutton, which has strong texture and pheromone flavor. Sawdust can be used as smoking material to decrease the wood wastes after logging. This study aimed to analyzed the organoleptic quality of smoked mutton based on the source of the sawdust and the smoking duration. This study used factorial complete random design with 4 sawdust sources (teak, chinese albizia, shorea, and dammar) and 3 different smoking durations (2, 3, and 4 hours). The measurement parameters used were colour, flavor, texture, tenderness, taste, juiciness, and general reception. The result of this study showed that the use of sawdust and the smoking duration had very significance ( $P<0.01$ ) towards the organoleptic quality of smoked mutton. The sawdust had very significance ( $P<0.01$ ) and the smoking duration had significance ( $P<0.05$ ) towards the organoleptic quality of smoked mutton. Shorea is the recommendation as good smoke material because it has preservation strength that rich from wood compounds, such as fenol and etanol. The smooking wood in 3 and 4 hours showed sufficient consumption than 2 hours because the period of smoke peoduction has been secured breakdown the nutrition and microbiology of mutton.

**Keywords:** Mutton Smoke, Organoleptic Quality, Sawdust, Smoke Duration

## INTRODUCTION

Mutton is a meat type of ruminant whose characteristics are darkness than cattle, having soft fibrous, strong texture as well as elastic, and cream visual. It contains 154 calories, 16.6% protein and 9.2% lipid. USDA classified mutton as a part of red meat that is a cholesterol source, but it contains the lowest compared the cholesterol value synthesized everyday in human body (Nugroho et al. 2018). General Directorate of Animal Husbandry and Veterinary (2020) explained

the annual consumption level of mutton per capita in 2015-2019 have not achieved the goal instead it needs a lot increase of its production, since in 2017 the production was only 0.001 kg. This issue due to the lack of attention of the community towards the mutton in traditional market which were slaughtered in many traditional slaughter houses, regarding quality aspect generally (Sriyani et al. 2018).

Mutton contains many essentsial amino acids needed by human being. The dominant essentsial amino acids contained in mutton are leucine, lysine, isoleucine

and valine, while arginine is a non essential amino acids for the body. There are two amino acid groups which have role in the mechanism of decreasing the blood pressure, those are GSH-glutamate, arginine, cystein, and leucine group. The first group descreases the blood pressure by improving the insuline resistance, modulating the angiotensin renin system, and improving the function of kidney. The second group decreases the body fat, improve insuline resistance, and protect the muscle weight by increasing protein synthetic (Mirdhayati 2015). However, this issue was inversed by Afid & Nurmasitoh (2016) that compound of saturated fat in mutton is known trigger to increase the body weight, so that it also increases the risk of blood pressure, atherosklerosis accumulation, and hypertension by 7 times.

The incisive and less-preferred heavy smell comes from soluble protein component and high lipid content (Hastuti & Suparman 2018). Meanwhile, the precursor compound which is responsible to sheep flavor is found in adipose tissue. The flavor source of lipid acid chain is 4-methyloktanoat and 4-methyloktanoanoic. The cholesterol was synthetized by steroid on all body cells that were launched by animal metabolism. Its function as the former the cell membrane, brain myelin structure, stimulate system centre, and vitamin D. The compound of meat cholesterol is determined by many factors, while in mutton compounds it contains high cholesterol and saturated acid that caused heart contraction disease (Wati et al. 2019).

Smoking is a food preserving methode using heater and smoke through wood burning which does not need the heat sear or burn out the food. After drying, the meat is usually marinated in salt solution, then hanged in smoking area with chimney (Ariawan et al, 2021). The aim of smoking it to bring damp from wood burning to enter the food ingredient to extend the shelf life of meat, as well as to create the taste and a unique visual. In this case, smoke is produced from wood forest products or other biomass, like coconut powder, sawdust or coconut

shell (Mekarsari et al. 2017). Smoking at high temperature of 80-90°C and short time of 2-8 hours caused ripe and does not need to be process further. If it is high, it determines the inactive enzyme to prevent decomposition. Many people does not use smoking because its smokes scatters and lost on the air, different from using stove which has the possibility to determine the cycle for taste and rise into chimney (Sudirman 2016).

The fiber dimension has a role in a complex correlation and in determining the physical properties of pulp, paper and other fiber production. The fiber cell wall that is very thick will be flat easily while very long fibers will crop the weaving power strongly (Lempang 2017; Lempang 2018). Fiber length significantly determines the weaving power to have a better length. Fiber diameter is determined to form leaves, fiber bonds and fiber strength (Herlina et al. 2018).

It requires the assurance that food received is fresh and can be stored until it change to efficient spot appropriate by the food charatheristic. The ingredient formula cooking spices preparation, food processing, and cook priority have been done by steps and hygiene quality. Compatible appearance will contribute to separate every food serves (Kustiyoasih et al. 2016).

## MATERIALS AND METHODS

The ingradient to uses in this study were PE mutton, sawdust (teak, chinese albizia, shorea, and dammar), salt, water, and lemon, while the tools used were smoked drum, basin, pan, knife, smoked iron, food box, match, hand towel, plate, cutting board, meat temperature internal tool, bucket, sack, spoon, label and smoked hanger.

Every wood have component structural and fire points as sawdust for smoke production support. The component structurals and fire points of wood shown in Table 1.

**Table 1.** Structural component of wood and fire point for sawdust as the smoke production support

No.	Wood Materials	Cellulose (%)	Lignin (%)	Hemi/Holocellulose (%)	Fire Point (°C)
1.	Teak	46,70 <sup>+</sup>	30,07 <sup>+</sup>	14,26 <sup>+</sup> (Hemi)	360 <sup>&amp;</sup>
2.	Chinese Albinzia	41,1 <sup>++</sup>	17,51 <sup>++</sup>	22,26 <sup>+</sup> (Hemi)	330 <sup>^</sup>
3.	Shorea	54,01 <sup>§</sup>	32,75 <sup>§</sup>	38,00 <sup>&gt;</sup> (Hemi)	462 <sup>=</sup>
4.	Agathis	50,52 <sup>@</sup>	32,47 <sup>”</sup>	57,52 <sup>”</sup> (Holo)	Not specified. Generally, it started the pyrolysis with 150 and ended at 400 <sup>!</sup>

Source: <sup>+</sup>Syahidah et al. (2007), <sup>++</sup>Trisanti et al. (2018), <sup>§</sup>Jasni et al. (2016), <sup>></sup>Tajalla et al. (2019), <sup>@</sup>Lempang (2017), <sup>=</sup>Pari and Hudaya (1992), <sup>&</sup>Sulistyo et al. (2020), <sup>!</sup>Sugiyatno (2020)

**Product procedural**

The use of closed drum is to produce smoke during the food processing. The appointment of sample were separated by smoking duration. The mutton was then washed to minimalize the microorganism. Afterwards, the water was thrown out from washing residue. The distribution of lemon is accordance with Konuti et al. (2018) by smearing and idle during 30 minutes. Furthermore, curing was done in accordance with PATPI (2020) modification by salt marinade by 6% for 10 minutes. The procedure of smoking was started from entering the sawdust treatment to under the drum. Sawdust sack was pondered to ease the powder weight taken in smoke drum. The heat was flame up after fulfilling the smoker. It was burned until hot steam comes out in 80°C. The mutton was cured to take soaking by salt and hanged up in smoker. During the mid of the smoking, the sawdust was added when it becomes charcoal and there was a little bit smoke left. The smoking duration

was determined according to study design. The mutton can ripe in 50-60°C.

**Organoleptic parameters**

This organoleptic test is used semi trained panelists of 15 people, consisting of student from Faculty of Animal Science of Universitas Halu Oleo. Every panelist have organoleptic test sheet individually and used the treatments to determine the colour, flavor, tenderness, taste, texture, juiciness and general acceptance. The hedonic scale for this study is shown in Table 2.

**Research design**

This study is employed Completely Random Design (CRD) factorial 4 x 3, included smoking media (Teak, sengon, meranti and damar sawdusts) and smoking durations (2, 3 and 4 hours) (Sudibya 2013).

**Tabel 2.** Hedonic Score of Smoked Mutton

Parameter	Score	Annotation
Tenderness	1	Very tough
	2	Tough
	3	Medium
	4	Tender
	5	Very tender
Colour	1	Dark brown
	2	Brown
	3	Yellowish brown
	4	Golden yellow
	5	Yellow
Flavor	1	Rather nasty
	2	Nasty
	3	Rather smoked
	4	Smoked
	5	Very smoked
Taste	1	Very dislike
	2	Dislike
	3	Rather like
	4	Like
	5	Very like
Juiciness	1	Dry
	2	Rather juicy
	3	Enough juicy
	4	Juicy
	5	Very juicy
Texture	1	Very rough
	2	Rough

Parameter	Score	Annotation
General Acceptance	3	Rather soft
	4	Soft
	5	Very soft
	1	Very like
	2	Like
	3	Rather like
	4	Dislike
	5	Very dislike

Source: Modification of Buntu et al. (2020), Hafid et al. (2021, 2024), Patriani et al. (2019)

## RESULTS AND DISCUSSION

### Colour

The result of variance analysis showed that the use of sawdust and the smoking duration had significance ( $P < 0.05$ ) on the smoked mutton colour. Based on the average of wood treatment, the panelists liked brown color the most since it looks like the original colour of smoked mutton with the highest was shorea than teak, chinese albinzia and dammar which did not have any significance ( $P > 0.05$ ).

In addition, regarding the average of smoking duration, the panelists also liked the same colour with the highest to 2 hours, compared to 3 and 4 hours which did not have any significance. Regarding interaction, further testing showed that K2A4 has a significance interaction with K1A4, K1A4 interacted with K1A3 dan K4A3, K1A3 interacted with K4A3, K4A2 and K2A3, and K4A2 interacted with K2A3 and K3A2. The result of smoked mutton colour is shown in Tabel 3.

This issue is caused by phenol and ethanol which have a role to change the colour stabilization on the drum media. The normal burning condition with water encouraged smoke production that Shorea has burning easier in high temperature. The fiber is very congested and thight (Zara 2024) and it tends with smooth. The wood compounds could caramelize from phenol and methanol to determine the enzymatic activity. Furthermore, phenol also forms the smoked product. Buntu et al. (2020) claimed that the brown smoked is produced from carbonyl which burned cellulose and hemicellulose. The structural component of Shorea are cellulose 54.01%, lignin 32.75% and hemicellulose 38% (Jasni et al. 2016; Tajalla et al. 2019), so that the high cellulose generated the optimal smoke.

Smoking duration supported the change of the smoked mutton colour through brown reaction and make an enzymatic. Myoglobin is a sarcoplasmic protein which is more heat resistance, but it is almost denaturated in 80-85°C totally or completely. The heat mutton is not the source of foodborne disease of the virus that live in it. The determination of actin proportion, which is

aminated, can also encourage severity size or heat treatment intensity that was experienced by red meat (Patriani et al. 2019). The appropriate marinade is by using 6% of salt since it can influence mutton to form smoked colour. The curing of 30 minutes will determine the smoked mutton from different wood types. The salt will diffuse in mutton fibrous that starch actin out. The direct replacement effort as removal of nitrite and nitrate from curing system induced a bit of colour by 2-14 ppm depends by species completely (Saputro et al. 2016).

### Flavor

The result of variance analysis showed that the use of sawdust and smoking duration had significance ( $P < 0.05$ ) on the flavor of smoked mutton. It means that the panelists quite like to flavor of the smoked mutton. Based on the average score, chinese albinzia wood is the highest compared to shorea, teak and dammar wood, while concering the smoking duration, the highest was obtained at 4 hours compared to 3 and 2 hours. Interaction of further testing showed that K4A2 has significant interaction with K3A2, K3A3, K3A4, and K4A4. and K1A4 has significant interaction with K2A4. The result of flavor the mutton smoked can show in Tabel 4.

The fiber is more functionate to wood strength. It has smaller cell wall and lumen (Woesono et al. 2022). Generally, the bulky of wood cell wall generated to strength (Priadi & Novianto 2019). Smoking duration gives cellulose and lignin the opportunity to change the ring structural into typical smoked compounds which created new flavor of mutton by pheromone. The cellulose and lignin compound of Chinese Albinzia are 41,1% and 17.51% (Trisanti et al. 2018).

Cellulose is a fiber, clayey, not soluble in water, and discovered as plant protector cell, particularly stalk, stem and branch. It is included non-soluble polysaccharide and former the plant skin, found more 50% of wood that it was white and big pull skin (Octaviana 2017). Cellulose polymer aggregated the crystalline, the fibrous structure is known as micro fibril to appropriate thermal stabilization to cellulose (Mansor et al. 2019).

## Texture

The result of variance analysis showed that the use of sawdust and the smoking duration had significance ( $P < 0.05$ ) to the texture of smoked mutton. It means that the panelists like a rather soft smoked mutton. Based the average score, shorea wood was the highest compared to teak, chinese albinzia and dammar wood, while regarding the smoking duration 3 and 2 hours were the highest compared to 4 hours. Interaction of further testing showed that K2A4 has interacted by K4A4 and K2A2, K4A3 has significance by K1A4 and K3A4, and K3A3 is more significance than K1A3. The result of texture of the smoked mutton is show in Table 5.

This issue is caused by the mutton texture which nears soft level after stretching fiber and myofibril out from smoked compounds. Smoking duration can also change the meat fibers through various metabolism steps which change the hard structure into sluggish. Diptiroceae produce many variant of chemistry substances, such as terpenoid, steroid, flavanoid, and oligostillbenoid, that have many biological activities (Matinahoru 2023). It induced to playing an important role to create smoke texture for mutton in medium cooking. The extractive substance has the big impact and role in differences of wood types characteristics. It produced 3 parts, are aliphatic (lipid and wax), terpene, terpenoid, and phenolic (Putra et al. 2018). Component amount and structural substance are different between

and intra species, between parts in the same tree, even on cell wall structural tissue (Agustina et al. 2021).

Smoking duration can also change the meat fibers through various metabolism steps which change the hard structure into sluggish. This issue is supported by Pangestu et al. (2016) that texture is the most important to find meat quality product by many factors, including smoked interaction and food component, age, animal activity, sex and feed. The meat tenderness and quality after the cooking is scored by simple mastication without loss of physics and proper tissue. The meat components which are proper to tenderness are bond tissue, muscle fibers and adipose with differences.

The increasing size of muscle fibers with the age caused the meat texture from oldest animal is rougher and less tender (Harahap 2017).

## Tenderness

The result of variance analysis showed that the use of sawdust and the smoking duration had significance ( $P < 0.05$ ) on the tenderness of smoked mutton. Based the average score, shorea wood had the highest score compare to dammar, teak, and chinese albinzia, while teak and chinese albinzia wood did not have real significance that showed the panelists medium than tender. The highest score on the smoking duration obtained at 3 hours compare to 2 and 4 hours, while the smoking duration of 2 obtained lower score than 3 and 4

**Table 3.** Colour of smoked mutton using sawdust sources and smoking duration

Smoking Duration (A)	Sawdust Type (K)				Average
	Teak	Chinese Albinzia	Shorea	Danmar	
2 hours	2.33 <sup>e</sup> ± 0.16	2.43 <sup>e</sup> ± 0.18	2.28 <sup>de</sup> ± 0.09	2.16 <sup>cde</sup> ± 0.08	2.30 <sup>B</sup> ± 0.05
3 hours	1.95 <sup>bc</sup> ± 0.10	2.24 <sup>cdc</sup> ± 0.22	2.37 <sup>e</sup> ± 0.10	1.99 <sup>bcd</sup> ± 0.55	2.14 <sup>A</sup> ± 0.05
4 hours	1.79 <sup>ab</sup> ± 0.14	1.64 <sup>a</sup> ± 0.15	2.73 <sup>f</sup> ± 0.08	2.32 <sup>e</sup> ± 0.30	2.12 <sup>A</sup> ± 0.05
Average	2.02 <sup>A</sup> ± 0.06	2.10 <sup>A</sup> ± 0.06	2.46 <sup>B</sup> ± 0.06	2.16 <sup>A</sup> ± 0.06	

Average score with different superscript showed significance ( $P < 0.05$ ); the average score with the same superscript showed not significance ( $P > 0.05$ )

**Table 4.** Flavor score of smoked mutton using different sawdust types and smoking duration

Smoking Duration (A)	Sawdust Type (K)				Average
	Teak	Chinese Albinzia	Shorea	Danmar	
2 hours	2.87 <sup>a</sup> ± 0.12	3.07 <sup>ab</sup> ± 0.23	3.03 <sup>ab</sup> ± 0.04	3.03 <sup>ab</sup> ± 0.14	3.00 <sup>A</sup> ± 0.04
3 hours	3.07 <sup>a</sup> ± 0.23	3.40 <sup>c</sup> ± 0.15	3.05 <sup>ab</sup> ± 0.13	2.89 <sup>a</sup> ± 0.03	3.07 <sup>AB</sup> ± 0.04
4 hours	3.20 <sup>bc</sup> ± 0.30	3.21 <sup>bc</sup> ± 0.06	3.05 <sup>ab</sup> ± 0.15	3.08 <sup>ab</sup> ± 0.15	3.14 <sup>B</sup> ± 0.04
Average	3.00 <sup>A</sup> ± 0.04	3.23 <sup>B</sup> ± 0.04	3.05 <sup>A</sup> ± 0.04	3.00 <sup>A</sup> ± 0.04	

Average score with different superscript showed significance ( $P < 0.05$ ); the average score with the same superscript showed not insignificance ( $P > 0.05$ )

**Table 5.** The texture score of smoked mutton using sawdust types and different smoking duration

Smoking Duration (A)	Sawdust Type (K)				Average
	Teak	Chinese Albinzia	Shorea	Dammar	
2 hours	2.88 <sup>a</sup> ± 0.12	3.07 <sup>abcd</sup> ± 0.20	3.60 <sup>f</sup> ± 0.70	3.27 <sup>de</sup> ± 0.11	3.20 <sup>B</sup> ± 0.03
3 hours	3.41 <sup>ef</sup> ± 0.11	3.24 <sup>cde</sup> ± 0.06	3.40 <sup>ef</sup> ± 0.10	3.15 <sup>bcd</sup> ± 0.10	3.30 <sup>B</sup> ± 0.03
4 hours	3.16 <sup>bcd</sup> ± 0.37	3.00 <sup>bc</sup> ± 0.11	3.20 <sup>bcd</sup> ± 0.16	3.03 <sup>abc</sup> ± 0.16	3.09 <sup>A</sup> ± 0.03
Average	3.15 <sup>A</sup> ± 0.04	3.10 <sup>A</sup> ± 0.04	3.40 <sup>B</sup> ± 0.04	3.15 <sup>A</sup> ± 0.04	

The average score with different superscript showed significance (P<0.05); the average score with the same superscript showed not significance (P>0.05)

**Table 6.** The Tenderness Score of Smoked Mutton Using Sawdust Types and Smoking Duration

Smoking Duration (A)	Sawdust Type (K)				Average
	Teak	Chinese Albinzia	Shorea	Dammar	
2 hours	2.49 <sup>a</sup> ± 0.06	2.48 <sup>a</sup> ± 0.11	3.44 <sup>d</sup> ± 0.14	3.04 <sup>bcd</sup> ± 0.06	2.86 <sup>A</sup> ± 0.04
3 hours	3.37 <sup>d</sup> ± 0.15	2.87 <sup>b</sup> ± 0.19	3.40 <sup>d</sup> ± 0.91	3.40 <sup>d</sup> ± 0.05	3.26 <sup>C</sup> ± 0.04
4 hours	2.92 <sup>bc</sup> ± 0.36	3.15 <sup>d</sup> ± 0.17	3.15 <sup>d</sup> ± 0.17	3.12 <sup>cd</sup> ± 0.12	3.08 <sup>B</sup> ± 0.04
Average	2.93 <sup>A</sup> ± 0.04	2.83 <sup>A</sup> ± 0.04	3.33 <sup>C</sup> ± 0.04	3.19 <sup>B</sup> ± 0.04	

Average score with different superscript showed significance (P<0.05); the average score with the same superscript showed not significance (P>0.05)

hours. Interaction of further testing by lowercase superscript showed that K1A4 had interaction with K4A2. The result of the tenderness of the smoked mutton is shown in Tabel 6.

This issue is caused by the mutton texture nears soft level after stretching the fiber and myofibril out from the smoked compounds. The tenderness became medium by moderate fibers between tender and hard, although tender characteristic changed significantly. The wood structural cells has been obtaining hot influence, so that it is hard natural (Iskandar et al. 2021), as well as the texture of Chinese Albinzia (Ma’ruf 2023). It induced the tenderness direct with texture to create smoke mutton in medium cooking.

Furthermore, smoking duration also changed the tenderness level from hard to rather soft through the improvement of actin and myosin. Susanti et al. (2020) stated that the meat texture built through protolithic reaction whose broke peptide bond become plain protein molecules. Salt is osmotic that pulled water out from meat bones and decrease the water activity.

**Taste**

The result of variance analysis showed that the use of sawdust and the smoking duration had significance (P<0.05) on the taste of smoked mutton. Based on the average score, shorea wood has higher score than teak, dammar, and chinese albinzia which did not have any significance. However, dammar and teak woods has real

interaction effect that showed the panelists rather like the smoked mutton. Smoking duration showed that 4 and 3 hours are better than 2 hours. Interaction of further testing lowercase superscript showed that K3A2 has more significance interaction than K3A3. The result of the taste of the smoked mutton is presented in Tabel 7.

This issue occurs because every wood have different cellulose compound to create the taste of smoked mutton that has different smoking duration and burning level. Furthermore, smoke mutton also has enough acidity and salt because the lemon and salt curing is sufficient to form repair fibrous and internal myosin. The teak tree has smooth fiber cum erect and combine (Mufid et al. 2018), as well as the texture of Chinese Albinzia (Ma’ruf 2023). The free cluster of OH on surface cellulose chain allowed to absorb by forming hydrogen bond. Wood cellulose is more isolate to it than cutton in the same humidty (Leto 2021). Lignin and cellulose are very connect about cell wall structural by every layers and between cells on wood (Wibisono et al. 2018). Hemicellulose and lignin were being tendered the matrix by increasing temperature to saturated wood and it functionate as the structural unit of holocellulose (Meiganati et al. 2020).

The longer smoking duration is the more increase the taste through the combination curing and ingredient. The lemon has stronger antibacterial, that the short time can impede optimal bacterial growth. The acidity of lemon is also determined by high concentration of organic acid, saponin and flavonoid. The mechanism of saponin as an antibacterial decrease the tension surface,

that it increases the permeability or leaking bacteria cell and came intracellular compound out. Saponin hampers the growth or kills the microbe by sterol membrane. Furthermore, the mechanism of flavonoid forms complex compound by protein extracellular and soluble that breaks the cell membrane. Flavanoid also breaks the cell membrane through macromollecule synthesis, depolarize cell membrane and impair DNA, RNA nor protein synthesis, impair the function of cytoplasm membrane and bacteria energy methabolism (Berlian et al. 2016).

### Juiciness

The result of variance analysis showed that the use of sawdust and the smoking duration had significance ( $P<0.05$ ) the juiciness of smoked mutton. Based on the average score, shorea wood has the highest score than teak, dammar, and chinese albinzia which has not significance. However, dammar and teak woods have real interaction effect that showed the panelists rather like the taste of smoked mutton. Smoking duration showed that 4 and 3 hours were better than 2 hours. Interaction of further testing by lowercase superscript showed that K1A3 has more significant interaction than K3A4 and K1A4. The result of juiciness of the smoked mutton is shown in Tabel 8.

This issue is caused by shorea which causes cooking loss by 26.67%, so that enough juiciness was obtained

based on temperature and cooking condition. If the temperature is optimal, the water supply in meat fibers will become rather to needed more juice of mutton. Wood substance and juiciness are interact to maximalize produce rich nutrient in smoke process. Diptiroceace produce many variant of chemistry substances, such as terpenoid, steroid, flavanoid, and oligostillbenoid, that have many biological activities (Matinahoru 2023).

The shorter the smoking duration produced maximal juiciness which kill the microba after processing. This issue is supported by Tahir et al (2017) that the increasing microbe during storage hooked water supply on ingredient generally.

### General acceptance

The result of variance analysis showed that the use of sawdust and the smoking duration had significance ( $P<0.05$ ) on the acceptance of smoked mutton. Based on the average score, shorea wood has the higher score than chinese albinzia and dammar which showed rather like, and dammar showed dislike of the smoked mutton. Furthermore, smoking of 3 and 4 hours had the highest score that it showed rather like than 2 hours that showed dislike. Interaction of further testing by lowercase superscript showed K2A2 has interacted with K3A4, K4A3 has interacted with K2A3, and K2A4 has intercted with K3A2. The result of acceptance the smoked mutton is show in Tabel 9.

**Table 7.** The Taste Score of Smoked Mutton Using Different Sawdust Types and Smoking Durations

Smoking Duration (A)	Sawdust Type (K)				Average
	Teak	Chinese Albinzia	Shorea	Danmar	
2 jam	2.83 <sup>a</sup> ±0.15	2.80 <sup>a</sup> ±0.14	3.13 <sup>bc</sup> ±0.05	2.80 <sup>a</sup> ±0.05	2.90 <sup>A</sup> ±0.04
3 jam	3.04 <sup>b</sup> ±0.29	3.08 <sup>b</sup> ±0.05	3.28 <sup>bcd</sup> ±0.14	3.09 <sup>b</sup> ±0.03	3.12 <sup>B</sup> ±0.04
4 jam	3.40 <sup>d</sup> ±0.35	3.08 <sup>b</sup> ±0.05	3.09 <sup>b</sup> ±0.18	3.35 <sup>cd</sup> ±0.07	3.34 <sup>C</sup> ±0.04
Average	3.09 <sup>AB</sup> ±0.04	3.00 <sup>A</sup> ±0.04	3.17 <sup>B</sup> ±0.04	3.08 <sup>AB</sup> ±0.04	

Average score with different superscript showed significance ( $P<0.05$ ); the average score with the same superscript showed not significance ( $P>0.05$ )

**Table 8.** Juice score of smoked mutton using sawdust type and different smoking duration

Smoking Duration (A)	Sawdust Type (K)				Average
	Teak	Chinese Albinzia	Shorea	Danmar	
2 hours	2.83 <sup>cd</sup> ±0.12	2.60 <sup>b</sup> ±0.15	3.29 <sup>f</sup> ±0.06	3.32 <sup>f</sup> ±0.05	3.01 <sup>C</sup> ±0.03
3 hours	2.77 <sup>cd</sup> ±0.08	2.68 <sup>bc</sup> ±0.11	3.12 <sup>e</sup> ±0.18	1.93 <sup>a</sup> ±0.05	2.63 <sup>A</sup> ±0.03
4 hours	2.57 <sup>b</sup> ±0.24	2.60 <sup>b</sup> ±0.12	2.83 <sup>cd</sup> ±0.04	2.91 <sup>d</sup> ±0.09	2.73 <sup>B</sup> ±0.03
Average	2.73 <sup>B</sup> ±0.03	2.63 <sup>A</sup> ±0.03	3.08 <sup>C</sup> ±0.03	2.72 <sup>B</sup> ±0.03	

Average score with different superscript showed significance ( $P<0.05$ ); the average score with the same superscript showed not significance ( $P>0.05$ )

This issue is caused by shorea wood quality which is the highest in producing the best smoked mutton because it has good preservation strength. The exhausted retention to white shorea had 6.82 kg/m<sup>3</sup>, while all woods penetration was 65-85%. Two woods had second preservation class or medium level based on SNI 01-5010-1999.

Smoking duration can be accepted because smoke mutton preservation is very good than short duration, this includes the wood chemical process, smoking temperature and smoking production time. In smoked liquid, the big hydrocarbon biomass molecule was ruptured become smaller which making pyrolysis phase: Hemicellulose on 180-300°C, cellulose on 200-330°C, and lignin on 300-500°C (Rizal et al. 2020).

The meat protein can change because the interaction between smoke component and nutrients. Phenolic is responded by sulfhydryl groups in meat or fish, whereas carbonyl group is responded by amino groups. Smoke can decrease lysine until 12% by formaldehyd effect in smoke. Smoking of 10 hours increased lysine until 44%. The impartial condensate evoked the highest increased lysine. Lysine lost usually occurs due to high heat. The damage of riboflavin and niacin around 2-3% of relative smoked caused by vitamin was protected by antioxidant effect from many smoke compounds. The smoked after salting evoked the highest thiamin losses by 15-20%, increasing the salt volume and decrease the water volume (Sulistijowati et al. 2015). Guaiacol gives more response to specific aroma (Akabebe et al. 2006; Janairo & Amalin 2018).

**Table 9.** acceptance score of mutton smoked with sawdust type and different smoking duration

Smoking Duration (A)	Sawdust Type (K)				Average
	Teak	Chinese Albinzia	Shorea	Dammar	
2 hours	2.65 <sup>a</sup> ±0.16	2.92 <sup>bc</sup> ±0.21	3.18 <sup>cdef</sup> ±0.10	2.66 <sup>a</sup> ±0.03	2.85 <sup>A</sup> ±0.03
3 hours	2.81 <sup>ab</sup> ±0.17	3.08 <sup>cde</sup> ±0.11	3.35 <sup>f</sup> ±0.07	3.06 <sup>cde</sup> ±0.03	3.07 <sup>B</sup> ±0.03
4 hours	3.23 <sup>def</sup> ±0.34	3.13 <sup>cde</sup> ±0.05	3.00 <sup>bcd</sup> ±0.07	3.30 <sup>ef</sup> ±0.06	3.17 <sup>B</sup> ±0.03
Average	2.90 <sup>A</sup> ±0.04	3.04 <sup>B</sup> ±0.04	3.18 <sup>C</sup> ±0.04	3.01 <sup>B</sup> ±0.04	

Average score with different superscript showed significance (P<0.05); the average score with the same superscript showed not significance (P>0.05)

### CONCLUSION

The use of various sawdust types with different smoking duration had significance (P<0.05) to organoleptic of smoked mutton. The sawdust had very significance (P<0.01) and the smoking duration had significance (P<0.05) towards the organoleptic quality of smoked mutton. Shorea is the recommendation as good smoke material because it has preservation strength that rich from wood compounds, such as fenol and etanol. The smooking wood in 3 and 4 hours showed sufficient consumption than 2 hours because the period of smoke peoduction has been secured breakdown the nutrition and microbiology of mutton.

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