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Nutritional Content and Sensory Properties of Sere Kedele from Various Producers in Gianyar Regency, Bali

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Abstract---*Sere kedele is a traditional food from fermented soybeans produced by people on the southeast coast of Bali. The purpose of this study was to determine the nutritional content and sensory properties of sere kedele from various producers in Gianyar Regency. The survey results showed that in Gianyar Regency there are 4 producers of sere kedele, namely 2 producers in Blabatuh Village (Banjar Pokas and Banjar Teruna), 1 producer in Sukawati Village, and 1 producer in Buruan Village. Sere kedele products were sampled from all producers and then analyzed for its nutritional content and sensory properties. The design used was a Completely Randomized Design (CRD) with 4 replications. The results of the analysis showed that the water content of sere kedele ranged from 57.68% to 60.84%, ash content from 2.24% to 3.06%, fat content from 7.84% to 12.40%, dissolved protein content from 2.18% to 4.30%, carbohydrate content from 22.77% to 26.51%, glutamic acid content from 0.52 % to 6.97 %, total microbes from 10.78 log cfu/ml to 11.50 log cfu/ml, total lactic acid bacteria from 10.54 log cfu/ml to 10.77 log cfu/ml. Sensory properties of sere kedele for color ranged from yellow to yellowish brown with criteria liked, aroma from disliked to liked, taste from fair to savory with criteria from disliked to very much like, and overall acceptance ranged from dislike to very much like. Sere kedele in Banjar Teruna, Blahbatuh Village, had the best nutritional content and sensory properties, with water content of 57.68%, ash content of 2.85%, fat content of 12.40%, soluble protein content of 4.30%, carbohydrate content of 22.77%, glutamic acid of 6.79 %, total microbes of 10.78 log cfu/g, total lactic acid bacteria of 10.77 log cfu/g, had a yellowish-brown color with criteria like, like for aroma, very much like for its savory taste and very much like for the overall acceptance.*
Keywords---*Gianyar Regency, nutritional content, sensory properties, sere kedele.*

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Introduction

One of the traditional Balinese food made from soybeans through spontaneous fermentation is *sere kedele*. *Sere kedele* is still found in several regencies in Bali, such as in Gianyar and Klungkung regencies. *Sere kedele* as a traditional food plays an important role in the fulfillment of nutrition for the community, since soybean is a nutrient-dense food. Soybeans contain amino acids and isoflavone aglycones compounds which are beneficial for health. Isoflavones can reduce DNA damage caused by cyclophosphamide (Ribeiro et al., 2007), suppress lipoprotein oxidation (Takahashi et al., 2005), and reduce the risk of cardiovascular disease (Rimbach et al., 2008). *Sere kedele* is derived from the word *sere* which means shrimp paste and *kedele* which means soybeans. Balinese people generally recognize *terasi* as *sere*, where the word *sere* is used due to the aroma produced from the mixture of fermented soybeans and the spices resemble the aroma of shrimp paste (Widyantari et al., 2017). *Sere kedele* is generally produced by home industries traditionally which is consumed as a complement or substitute for side dishes and *sere kedele* is mixed with rice to obtain a menu combination to improve protein quality and digestibility (Sutiari et al., 2011; Widyantari et al., 2017).

The fermentation process in *sere kedele* is carried out spontaneously because there is no addition of other ingredients which trigger the fermentation process. Fermentation time varies from producer to manufacturer. Generally, fermentation is carried out for 2 days in a closed or slightly open container. After the fermentation is complete, the spices are added and the *sere kedele* is ready to be consumed. *Sere kedele* photo can be seen in Figure 1.

Figure 1. *Sere kedele* (private collection)

Sere kedele is like fermented soy products. Fermented soybean products include tempeh, soy sauce, miso, and natto. Making *sere kedele* is almost similar to making natto in Japan. The process of making natto goes through the stages of cleaning and sorting dry soybeans, soaking, sorting wet soybeans, steaming, inoculating the *Bacillus subtilis* natto, transferring into containers, then continuing with the fermentation process and sorting the products. Usually, natto is eaten for breakfast along with rice (Sahirman, 2019; Chan et al., 2021). Both products have a slightly slippery (sticky) texture and have a distinctive and strong flavor (Liu et al., 2021). The difference is that the *sere kedele* undergoes spontaneous fermentation, while *Bacillus subtilis* natto is added to the process of making natto. Koswara (1997), reported that the microbes that play a role in the fermentation process of *sere kedele* spontaneously come from the air, containers or leaves used as a cover. The containers commonly used in the manufacture of *sere kedele* can be in the form of *besek* or winnower made of bamboo that is not covered or covered with leaves.

Based on previous surveys and studies conducted by Widyantari et al. (2017), reported that there were differences in the boiling time made by producers in the manufacture of *sere kedele* in Gianyar Regency, which ranged from 3 to 7 hours while the fermentation time was between 1 to 3 days with the condition of the fermentation container used was *besek* either closed or slightly open. Soybeans that have been fermented spontaneously are then added with fine spices. At the stage of adding this seasoning, there are variations that are carried out before the fermentation process and after and whether or not there is the addition of oil. The spices used in making *sere kedele* vary including garlic, galangal, turmeric, aromatic ginger, chili, salt and a little of cooking oil. The differences in the production process of *sere kedele* in Gianyar Regency will affect the nutritional content and sensory properties of *sere kedele*, thus further research needs to be done. This study aimed to determine the nutritional content and sensory properties of *sere kedele* from various producers in the Gianyar Regency (Adeyemo & Onilude, 2013; Mielenz et al., 2009; Yadnya et al., 2016).

Research Methods

Sere kedele sampling in Gianyar Regency was carried out using a saturated sampling technique, which is a sampling technique in which all members of the population are used as samples (Sugiyono, 2017). Based on the survey results, there are 4 producers in Gianyar Regency including 2 producers in Blahbatuh Village, precisely in Banjar Teruna and Banjar Pokas, 1 producer in Sukawati Village and 1 producer in Buruan Village. The design used was a Completely Randomized Design (CRD) with 4 replications to obtain 16 experimental units. *Sere kedele* purchased from various producers were brought to the laboratory using a cool box and ready to be analyzed.

Analysis of water content was carried out using the drying method (Sudarmadji & Haryono, 1997), ash content using the oven method (Sudarmadji & Haryono, 1997), fat content using the Soxhlet method, soluble protein content based on the Lowry method with a spectrophotometer (Apriyantono et al., 1989), carbohydrate content using Carbohydrate by different analysis (BeMiller, 2017), glutamic acid (Lawal et al., 2011), modified total microbes (Mailoa et al., 2017), and total lactic acid bacteria (Hidayat et al., 2013). Sensory testing of color was carried out with score and hedonic tests and aroma, taste and overall acceptance were carried out by hedonic tests. The data obtained were analyzed by variance and if the treatment had an effect on the observed parameters, then the analysis was continued with Duncan's test (Gomez & Gomez, 2010).

Results and Discussion

Based on the results of a survey conducted in 2021, it was found that in Gianyar regency there are 4 producers of *sere kedele*, including 2 producers in Blahbatuh Village, namely in Banjar Pokas and Teruna, 1 producer in Sukawati Village and 1 producer in Buruan Village. Each producer has differences in the duration of boiling the soybeans, and the amount and type of seasoning added, while the fermentation time for each producer is the same, which is 2 days. The addition of spices in all manufacturers is done after the fermentation process is complete. The process of making *sere kedele* in various producers in Gianyar Regency can be seen in Table 1.

Table 1
Sere kedele production process in several producers in Gianyar Regency

Stages of the Process	Sukawati Village	Blahbatuh Village (Banjar Teruna)	Blahbatuh Village (Banjar Pokas)	Buruan Village
Boiling time soya bean	6 hours	4 hours	4 hours	5 hours
Fermentation time	2 days (anaerobic at room temperature)	2 days (anaerobic at room temperature)	2 days (anaerobic at room temperature)	2 days (anaerobic at room temperature)
Fermentation Container	Closed Besek	Closed Besek	Closed Besek	Closed Besek
Added seasoning	Seasoned after fermentation without oil	Seasoned after fermentation with oil	Seasoned after fermentation with oil	Seasoned after fermentation without oil

Table 1 showed that the two producers in Blahbatuh Village (Banjar Teruna and Banjar Pokas) have the same boiling time of soybeans and the addition of coconut oil at the final stage, while in Sukawati Village, they boiled it for about 6 hours and in Buruan Village they boiled it for about 5 hours and both did not add coconut oil. Boiling of *sere kedele* in various producers in Gianyar Regency varies from 4 to 6 hours, while the duration of fermentation, the time of adding spices and the fermentation container used by each village had similarities, where it took 2 days of fermentation and the time of adding spices after fermentation using a closed besek. The spices added in the manufacture of *sere kedele* differ in number and type. The spices in making *sere kedele* can be seen in Table 2.

Table 2
Seasonings in making Sere kedele per 5 Kg Soybeans

Name of Material	Sukawati Village	Blahbatuh Village (Banjar Teruna)	Blahbatuh Village (Banjar Pokas)	Buruan Village
Garlic (g)	300	250	300	300
Galangal (g)	200	150	200	200
Turmeric (g)	200	250	200	200
Aromatic ginger (g)	150	100	150	150
Chili (g)	200	200	250	200
Salt (g)	250	150	200	250
Coconut oil (ml)	-	60	50	-
Lemongrass (g)	300	-	-	-

The results of the analysis of the nutritional content of *sere kedele* including water content, ash content, fat content, protein content, and carbohydrate content from various producers in Gianyar Regency can be seen in Table 3.

Table 3
The nutritional content of *Sere kedele* from various producers in Gianyar Regency

Name of Village/Banjar	Water Content (%)	Ash Content (%)	Fat Content (%)	Protein Content (%)	Carbohydrate Content (%)
Sukawati Village	60.52 a	2.24 c	8.54 c	2.18 d	26.51 a
Blahbatuh Village (Banjar Teruna)	57.68 c	2.85 b	12.40 a	4.30 a	22.77 c
Blahbatuh Village (Banjar Pokas)	58.57 b	3.06 a	9.56 b	3.17 b	25.64 b
Buruan Village	60.84 a	2.79 b	7.84 d	2.73 c	25.78 b

The average value followed by different letters in the same column shows a very significant difference (P<0.01)

The results of the analysis of glutamic acid, total microbes and total LAB of *sere kedele* from several producers in Gianyar Regency can be seen in Table 4.

Table 4
Content of glutamate acid, total microbes and total lactic acid bacteria (LAB) in *Sere Kedele* from several producers in Gianyar Regency

Name of Village/Banjar	Glutamate Acid (%)	Total microbes (log cfu/g)	Total LAB (log cfu/g)
Sukawati Village	0.52 d	11.50 a	10.54 d
Blahbatuh Village Banjar Teruna	6.97 a	10.78 d	10.77 a
Blahbatuh Village Banjar Pokas	5.33 b	10.80 c	10.76 b
Buruan Village	2.09 c	10.99 b	10.73 c

The mean value followed by different letters in the same column shows a very significant difference (P<0.01)

The results of the analysis of variance showed that the *sere kedele* produced by each producer in Gianyar Regency had a very significant effect (P<0.01) on the water content. The highest water content in *sere kedele* samples produced in Buruan Village while the lowest water content in *sere kedele* samples in Banjar Teruna, Blahbatuh Village. Based on the results of the survey, it is known that *sere kedele* produced by producers in Buruan Village has a boiling time of about 5 hours and *sere kedele* produced by producers in Banjar Teruna, Blahbatuh Village, boils soybeans for about 4 hours. The longer the boiling time of soybeans, the higher the water content of *sere kedele*. This is due to differences in water absorption into soybean seeds and differences in seed development in each soybean boiling treatment. At the time of boiling soybeans, water will enter the soybean seeds so that it will increase the weight of the water in it and the water content will increase (Banobe et al., 2019). Lola (2009), stated that the increase in water content occurred due to the absorption of water by the material. This also happened in the study

reported by Putri et al. (2021), that the boiling time of soybeans had a very significant effect on the water content of fermented soybeans. Soybeans boiled for 180 minutes had a higher water content of 35.45% than soybeans boiled for 60 minutes, which was 21.45%.

Sere kedele produced by each producer in Gianyar Regency had a very significant effect (P<0.01) on the ash content. The highest ash content was found in *sere kedele* samples produced in Banjar Pokas, Blahbatuh Village, while the lowest ash content was in *sere kedele* samples produced in Sukawati Village. *Sere kedele* in Buruan Village and *sere kedele* in Banjar Teruna, Blahbatuh Village, had almost the same ash content. The decrease in ash content was caused by the long boiling factor of soybeans such as sere kedele produced in Sukawati Village, which was 6 hours. The longer the soybeans are boiled, the more minerals will dissolve into the water and make the ash content of the soybeans decrease. This is reinforced by the statement from Fennema (1996), which states that the mineral content in food cannot be damaged by light, oxidizing agents, and extreme pH. However, the loss of minerals is caused by washing or heating processes. This opinion is supported by Lola (2009), which states that the reduction in ash content may be caused by the leaching of mineral compounds into boiling water. In the study of Putri et al. (2021), there was also a decrease in the ash content of fermented soybeans with the longer boiling treatment which indicated that the minerals contained in soybeans were abundant in the soybean epidermis.

The results of the analysis of variance showed that the *sere kedele* produced by each producer in Gianyar Regency had a very significant effect (P<0.01) on fat content. The highest fat content was found in the *sere kedele* samples produced in Banjar Teruna, Blahbatuh Village, while the lowest fat content was in the *sere kedele* samples produced in Buruan Village. Based on the survey results, it is known that the increase in fat content in *sere kedele* produced in Banjar Teruna, Blahbatuh Village, is probably caused by the addition of oil to the spices used, while *sere kedele* produced in Buruan Village there is no addition of oil. Boiling also causes fat to melt into boiling water causing a reduction in fat content (Lola, 2009). This is in accordance with the results of the survey and analysis that in Buruan Village with 5 hours of boiling time, the fat content is lower than in Banjar Teruna, Blahbatuh Village, with 4 hours of boiling.

Sere kedele produced by each producer in Gianyar Regency had a very significant effect (P<0.01) on the dissolved protein content. The highest soluble protein content was in *sere kedele* samples produced in Banjar Teruna, Blahbatuh Village, while the lowest soluble protein content was in *sere kedele* samples in Sukawati Village. *Sere kedele* produced in Buruan Village and *sere kedele* in Banjar Pokas, Blahbatuh Village, had almost the same dissolved protein content. Based on the results obtained, it showed that the decrease in protein content was affected by the boiling time. The longer the boiling or steaming, the more protein is lost (Kristiningrum & Susanto, 2016). Boiling treatment causes protein to be denatured, resulting in protein damage. The more denatured protein causes a decrease in protein content (Komolafe & Obayanju, 2003).

The results of the analysis of variance showed that the *sere kedele* produced by each producer in Gianyar Regency had a very significant effect (P<0.01) on the carbohydrate content. The highest carbohydrate content was found in the *sere kedele* samples produced in Sukawati Village, while the lowest carbohydrate content was in the *sere kedele* samples from Banjar Teruna, Blahbatuh Village. *Sere kedele* in Buruan Village and *sere kedele* in Banjar Pokas, Blahbatuh Village have almost carbohydrate content. The increase in carbohydrate content occurs with the longer boiling. Boiling time in Sukawati Village for 6 hours causes carbohydrate levels to increase while boiling time in Blahbatuh Village for 4 hours causes carbohydrate levels to decrease. Ikanone & Oyekan (2014), stated that boiling can maintain the value of carbohydrate content more. Amon et al. (2014), reported an increase in carbohydrate content with longer boiling time in taro flour research. The carbohydrate content by the difference in the proximate test is strongly influenced by the content of other nutrients (Pratama et al., 2014).

Sere kedele produced by each producer in Gianyar Regency had a very significant (P<0.01) effect on glutamic acid. The highest glutamic acid content was found in the *sere kedele* sample produced in Blahbatuh Banjar Teruna Village, namely 6.97%, while the lowest glutamic acid content was in the *sere kedele* sample in Sukawati Village, namely 0.52%. According to Fauzy et al. (2016), glutamic acid is part of the main framework of various types of protein molecules found in food. The decrease in the value of glutamic acid is caused by protein denaturation due to too high heating. Denaturation occurs in structural changes because there are broken bonds. This is in accordance with the results of the study, namely the *sere kedele* produced in Sukawati Village has less glutamic acid, namely 0.52%, due to boiling which was carried out for 6 hours (Tomaschunas et al., 2012; Jayachandran & Xu, 2019; Dai et al., 2017).

The four samples of *sere kedele* produced by each producer in Gianyar Regency had a very significant (P<0.01) effect on total microbes. The highest microbial total was found in the sample of *sere kedele* produced in Sukawati Village, namely 11.50 log cfu/g, while the lowest total microbial count was in the sample of *sere kedele* in Blahbatuh Village, Banjar Teruna, namely 10.78 log cfu/g. Microbes are organisms that are able to adapt and live in various

types of environments. One of the places where the microbial environment lives is water (Mudatsir, 2007). *Sere kedele* produced in Sukawati Village has a higher moisture content of 60.52% compared to *sere kedele* produced in Blahbatuh Village, Banjar Teruna, 57.68%, so the total microbes are higher.

The results of the analysis of variance showed that the four samples of *sere kedele* produced by each producer in Gianyar Regency had a very significant (P<0.01) effect on the total LAB. The highest total LAB was found in the *sere kedele* sample produced in Blahbatuh Village, Banjar Teruna, namely 10.77 log cfu/g, while the lowest total LAB was in the *sere kedele* sample in Sukawati Village, namely 10.54 log cfu/g. According to Zakaria et al. (2013), high heating causes contaminant bacteria to be destroyed, so that the proliferation of lactic acid bacteria is not hampered and can multiply optimally. This is in accordance with the results of the study, namely the *sere kedele* produced in Sukawati Village had a smaller total LAB of 10.54 log cfu/g due to boiling which was carried out for 6 hours. Sensory properties of *sere kedele* produced by each producer in Gianyar Regency were carried out by scoring tests on color and taste and hedonic level tests on color, flavor, taste, and overall acceptance. The average value of the results of the analysis of the color, flavor, taste, and overall acceptance of *sere kedele* can be seen in Table 5.

Table 5
Average score and hedonic test values on color, flavor, taste and overall acceptance of *Sere kedele*

Name of Village/Banjar	Color		Flavor	Taste		Overall Acceptance
	Score *	Hedonic ***	Hedonic ***	Score **	Hedonic ***	Hedonic ***
Sukawati Village	4.13 a	3.60 a	2.07 c	2.00 c	2.27 d	2.47 d
Blahbatuh Village (Banjar Teruna)	4.20 a	4.07 a	4.00 a	4.40 a	4.53 a	4.67 a
Blahbatuh Village (Banjar Pokas)	4.47 a	3.73 a	3.27 b	3.20 b	3.73 b	3.73 b
Buruan Village	3.27 b	3.67 a	3.40 b	2,60 bc	3.00 c	3.20 c

The average value followed by different letters in the same column shows a significant difference (P<0.05)
* 1 = clear, 2 = light yellow, 3 = yellow, 4 = yellowish brown, 5 = brown
** 1 = not savory, 2 = normal, 3 = slightly savory, 4 = savory, 5 = very savory
*** 1 = dislike very much, 2 = dislike, 3 = normal, 4 = like, 5 = very much like

The results of the analysis of variance from the scoring test on color, the four samples of *sere kedele* produced by each producer showed that the effect was very significant (P < 0.01). The highest average value in the sample of *sere kedele* produced in Banjar Pokas Blahbatuh Village, which was 4.47 (yellowish brown) had no significant effect on *sere kedele* in Banjar Teruna, Blahbatuh Village, which was 4.20 (yellowish brown) and *sere kedele* in Sukawati Village with value 4.13 (yellowish brown). The lowest average value was found in the *sere kedele* sample produced in Buruan Village with a value of 3.27 (yellow). *Sere kedele* from various producers in Gianyar Regency has a yellow to yellowish brown color. Research Putri et al. (2021), reported that prolonged boiling treatment resulted in the color of fermented soybeans becoming yellow to light brown. Boiling time can cause color changes in soybeans because the pigments contained in soybeans are increasingly damaged and the color of soybeans becomes pale with increasing of boiling time. Mulyatiningsih (2007), stated that foodstuffs will look less attractive if the boiling process is too long because the pigments in foodstuffs are unstable during the cooking process.

The results of the analysis of hedonic test variance on color, the four samples of *sere kedele* showed that the effect was not significant (P> 0.05). The average value of the lowest to highest *sere kedele* ranged from 3.60 (normal to like) to 4.07 (like). The highest average value in succession to the lowest was obtained in the sample of *sere kedele* in Banjar Teruna, Blahbatuh Village with a value of 4.07 (like), *sere kedele* in Banjar Pokas, Blahbatuh Village, the value of 3.73 (normal to like), *sere kedele* in Blahbatuh Village). Panelists liked the color of *sere kedele* between yellow to yellowish brown.

Hedonic test on flavor, the four samples of *sere kedele* produced by each producer showed a very significant effect (P < 0.01). The highest average value was found in the *sere kedele* sample produced in Banjar Teruna, Blahbatuh Village, which was 4.00 (like) while the lowest was in the *sere kedele* sample in Sukawati Village, namely 2.07 (dislike). The panelists gave the usual assessment on the sample of *sere kedele* produced in Buruan Village, namely 3.40 and *sere kedele* in Banjar Pokas, Blahbatuh Village, which was 3.27. This is different from the study by Sipayung et al. (2019), which stated that the panelists gave an assessment of the aroma of *sere kedele* given the

duration of fermentation as the treatment with the help of *Bacillus subtilis*, resulting in the aroma criteria of neither like nor dislike to like.

The results of the analysis of the variance from scoring test on taste, the four samples of *sere kedele* produced by each producer showed that the effect was very significant ($P < 0.01$). The highest average value for the *sere kedele* sample produced in Banjar Teruna, Blahbatuh Village, was 4.40 (savory) and the lowest average value for the *sere kedele* sample in Sukawati Village was 2.00 (normal). The panelists gave a score of 2.60 with the criteria of ordinary to slightly savory on samples of *sere kedele* produced in Buruan Village and slightly savory on *sere kedele* in Banjar Pokas, Blahbatuh Village, which was 3.20. In relation to the taste of food, in Indonesia, it is known that there is a savory taste response that reveals its own taste impression. Several studies mentioned that the savory taste in tempe, soy sauce, moromi products (Setyaningsih, 1998; Ikasanti, 2001; Martoyo, 2001; Saleha, 2003). Boiling can cause a more intense savory taste (Shi et al., 2020). Hedonic test on taste, the four samples of *sere kedele* showed a very significant effect ($P < 0.01$). The highest average value is found in the *sere kedele* sample produced in Banjar Teruna, Blahbatuh Village, which is 4.53 (like to very like) and the lowest average value in the *sere kedele* sample in Sukawati Village is 2.27 (dislike). The panelists gave a normal assessment of the *sere kedele* sample in Buruan Village, namely 3.00 and a normal rating to liking the *sere kedele* sample produced in Banjar Pokas, Blahbatuh Village, which was 3.73 (Wang et al., 2019; Eshak, 2016; Endrizzi et al., 2015; Kusfriyadi & Nabilah, 2022).

Hedonic test on overall acceptance, the four samples of *sere kedele* produced by each producer showed a very significant effect ($P < 0.01$). Table 5 shows that the average value of *sere kedele* ranged from 2.47 (dislike) to 4.67 (like to very much like). The highest average value is found in the *sere kedele* sample produced in Banjar Teruna, Blahbatuh Village, which is 4.67 (like to very much like) and the lowest average value in the *sere kedele* sample in Sukawati Village was 2.47 (dislike). The panelists gave a normal assessment of the *sere kedele* sample produced in Buruan Village, namely 3.20 and a normal rating to liking the *sere kedele* sample in Banjar Pokas, Blahbatuh Village, which was 3.73. Overall acceptance showed how much a product can be accepted by the panelists. Overall acceptance assessment is generally a combination of all aspects such as color, aroma, taste and texture (Purwandari et al., 2021).

Conclusion

Sere kedele in Banjar Teruna, Blahbatuh Village, had the best nutritional content and sensory properties. *Sere kedele* in Banjar Teruna, Blahbatuh Village, had the best nutritional content and sensory properties, with water content of 57.68%, ash content of 2.85%, fat content of 12.40%, soluble protein content of 4.30%, carbohydrate content of 22.77%, glutamic acid of 6.79 %, total microbes of 10.78 log cfu/g, total lactic acid bacteria of 10.77 log cfu/g , had a yellowish-brown color with criteria like, like for aroma, very much like for its savory taste and very much like for the overall acceptance.

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