https://doi.org/10.48048/tis.2022.4607

Physicochemical Properties and Functional Group Characteristics of Kacang Goat Meat

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Received: 11 September 2020, Revised: 24 September 2021, Accepted: 30 September 2021

Abstract

The characteristic of local quality goat meat in every country had been researched including in Indonesia. This research aimed to determine the properties of physical and chemical of Kacang goat meat as the character of goat meat and it could be a reference for comparison of the various quality goat meat in the world. Materials and methods: The study was conducted in Lamongan Regency, East Java, Indonesia on 40 male and female Kacang goat meat samples and at the loin and round section. The sampling was done by purposive random sampling methods. The research method was a laboratory exploratory. The observed variables were pH, Water Holding Capacity (WHC), cooking loss, shear force, Proximate and functional group characteristics with FTIR. The results: The range of physicochemical properties of Kacang goat meat covers: pH = 6.02 ± 0.09 to 6.13 ± 0.13, WHC = 35.22 ± 0.83 - 35.41 ± 0.88 %, Cooking Loss = 33.24 ± 0.85 - 35.40 ± 1.51 %, shear force = 5.50 ± 0.07 - 5.59 ± 0.1 kg/cm^2. The proximate value of Kacang goat meat were: Water content = 77.20 ± 0.19 - 77.35 ± 0.54 %, Protein = 18.60 ± 0.35 - 20.08 ± 0.19 %, Fat = 4.50 ± 0.41 - 4.69 ± 0.20 %, Energy = 749.71 ± 9.43 Kcal/kg - 762.18 ± 12.18 Kcal/kg, Ash = 1.81 ± 0.16 - 1.90 ± 0.04 %. FTIR spectroscopy of Kacang goat meat showed wavelengths at peak absorption ranging from 700.16 to 2,956.87 cm^{-1}. Conclusion: There was a variated of physicochemical and characteristics of the functional group Kacang goat meat in Indonesia, especially based on sex and section of meat.

Keywords: Physicochemical properties, FTIR, Functional groups, Kacang goat meat

Introduction

The goat meat is an important source of nutrition, especially for people in tropical countries [1]. These nutrients are essential components that the body needs for growth and maintenance for living [2]. The goat meat is content of saturated fatty acids and low cholesterol as well as high protein content and zinc, iron, selenium, magnesium, vitamin B-complex and folic acids, making the goat meat a healthy alternative to other red meat [1,2]. The goat population in Indonesia continues to increase from 17,906,000 in 2012 to 19,608,000 in 2016 [3]. The Kacang goat is a native Indonesian goat which has the characteristics of small size, flat nose, small ears, short fur and various colors ranging from brown to black and adaptive to environmental limitations [4].

The physical, chemical and functional quality of meat varies between countries in the world. This difference is caused by the production and genetic systems of livestock [5]. Studies on morphology and local goat production have been carried out, but there is still few research on the quality of its meat. The research on the effect of the calpastatin gene (CAST) on severe serum blood in goats and mutations of local goat individuals in Indonesia based on the GDF9 gene have been conducted by [6-8]. The local goats that are naturally born in dry areas cause the quality of meat to have a high protein content and lower fat than European breeds. They also have the potential to produce more diverse functional group characteristics. Fourier Transforms Infrared (FTIR) is a tool that can be used to characterize functional groups [9]. This study is important to explore the physicochemical properties and functional groups characteristic of Kacang goat meat in Indonesia. Thus, this research contributes a new finding about the

characteristics of Indonesian original germplasm functional groups and potentially known to the world community and global competitiveness. This will also produce new data on the characteristics of native Indonesian livestock meat as a reference for comparing various types of meat in the world. The objective of this study is to explore the physicochemical properties and characteristics of the functional group of Kacang goat meat.

Materials and methods

Ethical approval: The project was approved by The Institute of Research and Empowerment of The University of Islam Lamongan (LITBANG PEMAS-UNISLA) (Approval No./UN.V.95/ST/II/2019).

Raw material and sample preparation

The Kacang goat meat was taken in the loin and round sections obtained from 20 male goats and 20 female goats from breeders and slaughterhouses in the Lamongan district of East Java at Juny 2018 - Macrh 2019. The Kacang goat was kept intensively, feeding using cut and carry system that using 70 % of forage and 30 % of concentrate. The forage was consists of elephant grass and field grass and rice straw, and the concentrate was consist of 100 % rice bran. The method was using laboratory analysis and interview. The samples were put into a box containing dry ice with a temperature of 80 °C [10]. This research used exploratory laboratory methods. The determination of the sample was done by purposive random sampling in several areas where there were population of Kacang goats. The samples were divided separately based on analysis needs. For physicochemical analysis, the samples were stored in fresh and frozen forms. For FTIR analysis, the sample was dried by weighing (Mettler PM 200 Switzerland) 20 g of goat meat, then in the oven (Memert UN 30 - 32) at 60 °C for 24 h. The sample was blended with a dry blender (Panasonic), then sieved with the size of 60 mess. The statistical design used in this study was a completely randomized 2-stage nested pattern design using the ANOVA assumption test, homogeneity test of error variance, Levene test and the assumption of error freedom test with the help of SPSS software.

pH Measurements

pH (pH 45 min) were measured round using a digital pH meter (Spear Double Junction) paired with the penetration electrode. The measurements were repeated 3 times per sample. The probe was calibrated with pH 4 and 7 standard buffer solutions. The highest pH were taken after complete glycolysis at 24 h post mortem [11,12].

Temperature

Temperature (T 45 min, in Celcius) were measured at 2 muscle points on the loin. The temperature was measured by inserting a thermometer pointer into the muscle was recorded using a digital stegetermometer for meat. Before and after of each reading, the electrodes and thermometer point were thoroughly cleaned with distilled water and a cotton towel. The highest temperature were taken after complete glycolysis at 24 h post mortem [11,12].

Cooking loss measurements

Cooking loss were tested according to the methodology described by [13]. Initial weights from samples were obtained using semi-analytical balance (Marconi, AS 5500 °C). The samples were cooked in an electric oven (Eco, Gran Master Gourmet) at 180 °C until the internal temperature (geometric center) reached 72 °C [14], and reversed when the internal temperature reaches 36 °C. The control of individual temperature samples was carried out using thermopairs (Exacta) connected to the temperature indicator (Gulton). When at room temperature, the sample was weighed again and WLC was assessed using the following equation: WLC = [(initial weight-final weight)/initial weight)]×100. The results were presented in percentage.

WHC measurements

For the determination of WHC, we adopted the methodology described by Hamm, quoted by Cirne *et al*. [12] 500 ± 20 mg meat samples were placed in the transverse direction of the fiber to filter paper between 2 acrylic plates, which weigh 10 kg placed for 5 min. The sample was weighed, and water loss was counted as a difference. The results were presented in percentage of water release with consideration to initial weight.

Shear force measurements

The texture value of the sample was determined using Shear Force Indicator with Zwick/Roell (22.5 German) equipped with Warner Bratzler (WB). Each sub-sample was cut 3 cubes 1.5 cm 1.5 cm, obtained from the Loin and round samples. This cube was then cut in the transverse direction of muscle fibers at speeds of about 3.3 mm/s by a texture analyzer (Brookfield Engineering) combined to WB. The values were presented as kg/cm^2. The average shear force for 3 sub-samples measured twice was calculated and recorded as the maximum tenderness value for the sample [11,12] and the results were presented in kg [15].

Proximate analysis

Proximate analysis of the composition of Kacang goat meat was carried out with direct analysis to determined water content, ash, crude protein fat and energy [16] using a laboratory in the Department of Veterinary Testing and Feed Analysis of the Faculty of Veterinary Medicine, Airlangga University of Surabaya.

FTIR spectroscopy

Samples were prepared with weighing 0.01 g and homogenized with 0.1 g of potassium bromide (KBr) anhydrous with mortar agate. Afterwards, they were vacuum pressed using a pressure of 1.2 psi until a transparent pellet was obtained which was ready to be analyzed by FTIR (Shimadzu) [17] using advanced Mineral and Materials Laboratory, Faculty of Mathematics and Natural Sciences, State University of Malang. The frequency, wavelength, or wave number where the sample absorbs IR radiation (x axis) and the corresponding intensity (both transmission or absorbance) (y axis) was recorded into the IR spectrum. For analytical purposes, the IR region is usually divided into 3 regions: The far IR is suitable for wave numbers ($1/\lambda$) measuring 400 - 10 cm^{-1}, the central IR region corresponds to $1/\lambda$ 4,000 - 400 cm^{-1}, and near the IR at $1/\lambda$ 14.285 - 4,000 cm^{-1}. Nevertheless, the difference between these regions varies depending on the type of instrumentation applied to measure the IR spectrum and also depends on the nature of the radiation. The IR spectrum is generally reconsidered as one of the characteristic properties of the sample, including meat [18].

Results and discussion

pH

The pH test of the Kacang goat sample was carried out in stages at different sexes and section of meat. The average of pH values are presented in **Table 1**.

Table 1 Average of pH value of Kacang goat meat.

Gender	Section of meat	Number of Samples	Mean pH value
Male	Loin	10	6.02 ± 0.09
	Round	10	6.03 ± 0.07
Female	Loin	10	6.10 ± 0.11
	Round	10	6.13 ± 0.13

Table 1 showed that the pH value ranged from 6.02 ± 0.09 to 6.13 ± 0.13. The range of pH values was normal. These results are similar to the previous studies conducted on chevon goats that the pH of goat meat ranged from 5.93 ± 0.14 to 6.54 ± 0.29 [19]. The low deviation rate 0.07 - 0.013 indicates the absence of high diversity in the degree of acidity of the Kacang goat meat in Lamongan Regency, East Java. The highest pH value was obtained from female goat meat, but there was no difference compared to the pH value of male goat meat. The pH value at the round section was also higher than at the loin section.

The sample that was taken less than 12 h showed similar pH value. This was not different from previous studies that there was no significant difference in the pH of goat meat based age group and type of goat [14]. As it was influenced by the same meat quality factors, the glycolysis process that occurred did not differ. The Kacang goat were breeded in a pasture management system (non-intensive) that

allowed the energy contained to be stable in temperature, not too high so that the process of glycolysis was not too fast and produced normal pH value.

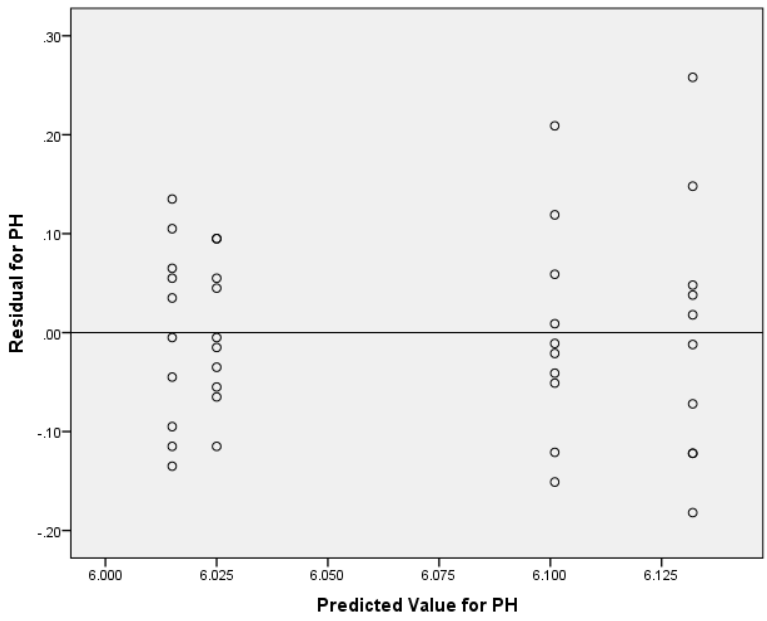
Tests of Between-Subjects Effects

Dependent Variable: PH

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.098[A]	3	0.033	3.030	0.042
Intercept	1472.946	1	1472.946	136051.488	.000
JK	0.093.006	1		8.601	0.093
Location (JK)	0.005	2	0.003	.245	.784
Error	0.390	36	0.011		
Total	1473.435	40			
Corrected Total	0.49	39			

a. R Squared = 0.202 (Adjusted R Squared = 0.135).

Based on the ANOVA table above, the *P*-value (Sig.) for Gender is 0.006 < 0.05 (α) so Reject H_0. This means that with a 95 % confidence level, it can be stated that gender can have a different effect on the PH value of goats. The *P*-value (Sig.) for the sample location (nested on gender) is 0.784 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that differences in sample locations (Loin and Rounds) cannot have a different effect on PH values in goats. The value of R Squared or Coefficient of Determination of 0.202 or 20.2 % indicates that 20.2 % of the total diversity in the model can be described/explained by independent variables. Because the number of treatments in the model is only 2, then to see which treatment is the best on the significant treatment, it is not necessary to carry out further tests so that it is enough to identify the average value of the descriptive statistics from the research data.



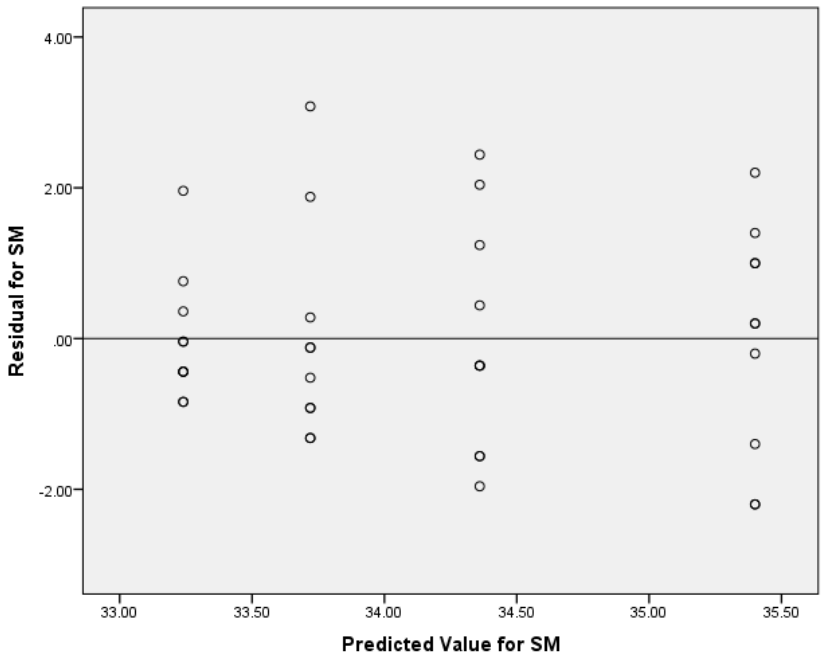
Based on the fitted value plot above, it can be seen that the data points do not form a certain pattern and are mostly near the horizontal line, so it can be concluded that the assumption of freedom of error is met.

Cooking loss measurements

Loss Tests of Between-Subjects Effects					
Dependent Variable: % CLM					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	26.160[a]	3	8,720	4,712	0.01
Intercept	46730.896	1	46730.896	25250.844	.000
JK	19.600	1	19.600	10,591	0.002
Location (JK)	6.560	2	3.280	1.772	.184
Error	66.624	36	1.851		
Total	46823.680	40			
Corrected Total	92.784	39			

a. R Squared = 0.282 (Adjusted R Squared = 0.222).

Based on the ANOVA table above, the *P*-value (Sig.) for Gender is 0.002 < 0.05 (α) so Reject H_0. This means that with a 95 % confidence level, it can be stated that gender can have a different effect on the value of % Cooking Loss in goats. The *P*-value (Sig.) for the sample location (nested on gender) is 0.184 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that differences in sample locations (Loin and Rounds) cannot have a different effect on the value of % Cooking Loss in Goats. The value of R Squared or Coefficient of Determination of 0.282 or 28.2 % indicates that 28.2 % of the total diversity in the model can be described/explained by independent variables. Because the number of treatments in the model is only 2, then to see which treatment is the best on the significant treatment, it is not necessary to carry out further tests so that it is enough to identify the average value of the descriptive statistics from the research data.



Based on the fitted value plot above, it can be seen that the data points do not form a certain pattern and are mostly near the horizontal line, so it can be concluded that the assumption of freedom of error is fulfilled.

Water Holding Capacity (WHC)

The average of WHC of Kacang goat meat obtained is presented in **Table 2**.

Table 2 Average WHC (%) Kacang goat meat.

Sex	Section	Number of Samples	Average WHC (%)			
			mg H2O	FWR	WB	WHC (%)
Male	Loin	10	125.93 ± 2.35	41.98 ± 0.78	77.20 ± 0.19	35.22 ± 0.83
	Round	10	125.68 ± 2.50	41.89 ± 0.83	77.30 ± 0.24	35.41 ± 0.88
Female	Loin	10	125.96 ± 1.67	41.99 ± 0.56	77.35 ± 0.54	35.36 ± 1.00
	Round	10	125.92 ± 1.98	41.97 ± 0.66	77.36 ± 0.49	35.39 ± 0.92

Description: FWR = Free Water Rates, WB = Water Bonded, WHC = Water Holding Capacity (%).

Table 2 showed that the WHC of Kacang goats in Lamongan district of East Java was 35.22 ± 0.83 - 35.41 ± 0.88 %. The value was quite similar with standard deviation 0.83 - 1.00 and in the normal meat WHC range. These results were difference with the study by [14] which ranged from 60.5 to 63.0 %. The WHC percentage in each sample was not difference, but the highest number was showed in meat samples taken at the round section. WHC value in male goat meat does not difference compared to female goat meat. The WHC value would be related to the pH of the meat. At the round section, it is usually used as a goat livestock activity. Thus, the thickness and magnification of the size of myoglobin occur at that section. This allows the WHC at these sections to be higher.

Shear force

Texture values was measurement with shear force test. Data were obtained from 40 samples of Kacang goat meat in Lamongan district, East Java are presented in **Table 3**.

Table 3 Average shear force (kg/cm^2) Kacang goat meat.

Sex	Section	Number of Samples	Shear Force (kg/cm^2)			
			1	2	3	Average (kg/cm^2)
Male	Loin	10	5.52 ± 0.05	5.52 ± 0.03	5.50 ± 0.05	5.51 ± 0.04
	Round	10	5.55 ± 0.07	5.55 ± 0.06	5.54 ± 0.08	5.55 ± 0.07
Female	Loin	10	5.50 ± 0.07	5.50 ± 0.07	5.48 ± 0.06	5.50 ± 0.07
	Round	10	5.59 ± 0.09	5.59 ± 0.10	5.58 ± 0.10	5.59 ± 0.10

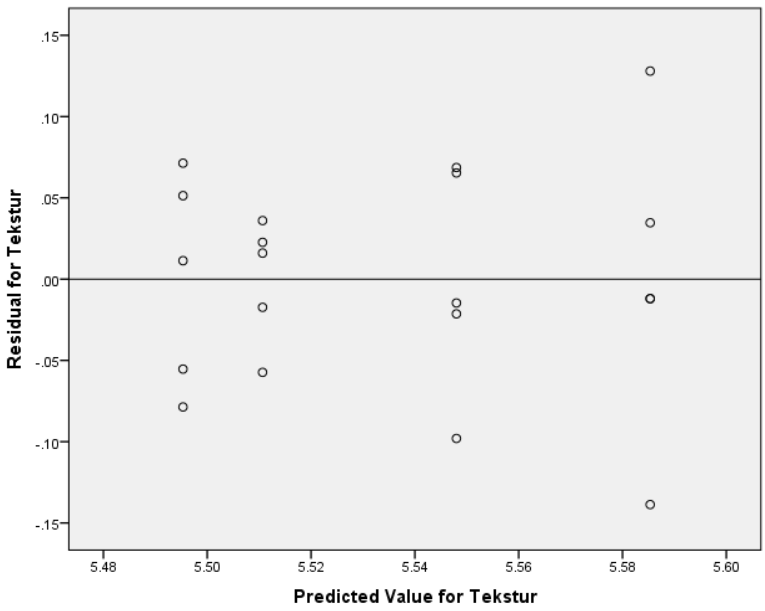
Table 3 showed the range of shear force was 5.50 ± 0.07 - 5.59 ± 0.1 kg/cm^2. The shear force of the female goat meat at the loin section was softer than the male goat meat. But the round section was higher 5.59 ± 0.10 kg/cm^2. This was due to the enlargement of the myoglobin muscle in the round section, mainly on female goats. That part was the goat's spill when pregnant, giving birth and breastfeeding.

The range of shear force showed that the texture of Kacang goat meat was quite soft and not tough, but still higher than the tenderness of lamb. The study by Cirne *et al*. [12] showed that the share force of sheep meat ranges from 2.43 to 2.76 kg/cm^2. The meat ingestion was influenced by environmental, genetic, age, sex and section of the meat. The Kacang goat is a breed that has a relatively small body and is adaptable to feed and environmental constraints. Thus, the formation of connective tissue is lesser compared with other goats. Nevertheless, the texture of Kacang goat meat is better.

Tests of Between-Subjects Effects					
Dependent Variable: texture					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	0.024[a]	3	0.01	1.641	0.220
Intercept	612.688	1	612,688	123907.394	.000
JK	0.001	1	0.001	.122	.731
Location (JK)	0.024	2	.012	2.400	.123
Error	0.079	16	0.005		
Total	612.791	20			
Corrected Total	0.103	19			

a. R Squared = 0.235 (Adjusted R Squared = 0.092).

Based on the ANOVA table above, the *P*-value (Sig.) for Gender is 0.731 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that gender does not have a different effect on the texture value of goats. The value of P (Sig.) for the location of the sample (nested on gender) is 0.123 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that differences in sample locations (Loin and Rounds) cannot have a different effect on texture values in goats. The value of R Squared or Coefficient of Determination of 0.235 or 23.5 % indicates that 23.5 % of the total diversity in the model can be described/explained by independent variables. Because there were no significant or significantly different treatments, the average value of each treatment was of course almost the same.



Based on the fitted value plot above, it can be seen that the data points do not form a certain pattern and are mostly near the horizontal line, so it can be concluded that the assumption of freedom of error is met.

Proximate

Proximate test of Kacang goat meat was done to determine water content, protein, fat, energy and ash content. The average of proximate values is presented in **Table 4**.

Table 4 Proximate value (%) of Kacang goat meat.

Sex	Section	Number of Samples	Proximate Value (%)				
			Water Content	Protein	Fat	Energy (Kcal/kg)	Ash
Male	Loin	10	77.20 ± 0.19	20.08 ± 0.19	4.60 ± 0.36	753.19 ± 17.11	1.81 ± 0.16
	Round	10	77.30 ± 0.24	19.98 ± 0.19	4.50 ± 0.41	762.18 ± 12.18	1.87 ± 0.18
Female	Loin	10	77.35 ± 0.54	18.96 ± 0.68	4.69 ± 0.20	749.71 ± 9.43	1.89 ± 0.04
	Round	10	77.36 ± 0.49	18.60 ± 0.35	4.51 ± 0.24	760.63 ± 10.59	1.90 ± 0.04

Table 4 showed the average range of water content is 77.20 ± 0.19 - 77.35 ± 0.54 %. It is normal and included in the standard. Similar result have also been published by [20], the water content of goat meat that is kept in the grain and pasture system, the water content ranges from 75.5 - 77.46 %. The diversity of water content of the Kacang goat meat in this study is low with deviation standard 0.19 - 0.54, that means the samples taken are quite homogeneous both in terms of age and farm management system. The sex and section of meat also does not make any difference in water content.

Table 4 showed the range of crude protein is 18.60 ± 0.35 - 20.08 ± 0.19 %. The crude protein content of the sample in this study shows considerable diversity with standard deviation 0.19 - 0.68. The protein diversity of this studies is similar to the research that have been conducted [20] that in different cultivation systems the crude protein content ranges from 14.9 to 20.9 %. The highest protein content is obtained from male goat meat in the loin section. This indicates that the formation of protein in myoglobin in male goats is more optimal than in female goats. Similarly, the formation of protein in myoglobin at the loin section was more optimal than at the round section. **Table 4** also shows that the fat content of Kacang goat meat ranged from 4.50 ± 0.41 to 4.69 ± 0.20 %. Fat carcass content of animals varies from 8 - 20 % including in pigs [2]. The standard deviation ranged from 0.20 to 0.41. Fat content is marbling not lard (fat deposits). The highest fat was obtained from female goat meat at the loin section. whereas fat deposits will likely be more at the round section. The fat content varies depending on breed, sex, location of meat and grazing environment [21].

The energy content of Kacang goat meat is quite large, ranged from 749.71 ± 9.43 Kcal/kg to 762.18 ± 12.18 Kcal/kg. Male goat meat has a higher energy compared to female goat meat. The energy at the round section is also higher than at the loin section. Meat is not an energy source, the energy content of sheep meat generally reaches 122 Kcal/kg [2]. **Table 4** have also shows average ranged of ash content of Kacang goat meat was 1.81 ± 0.16 - 1.90 ± 0.04 %. Ash diversity values occur in different sexes and meat section. The diversity is also likely due to differences in pasture fields and different cultivation patterns at the farmer level. Similar result have also been published by [20], that the ash content of goat meat cultivated with grains and pastures ranged from 3.6 to 12.5 %. The chemical composition of meat is quite diverse. Not only meat, the chemical composition of the milk also varies. The chemical composition of goat milk depends on the breed and each individual [22]. The chemical composition of goat meat is influenced by age, sex, breed and environment and maintenance management [20]. The nutritional value is useful for determining consumption levels according to the needs of the human physiology phase [23].

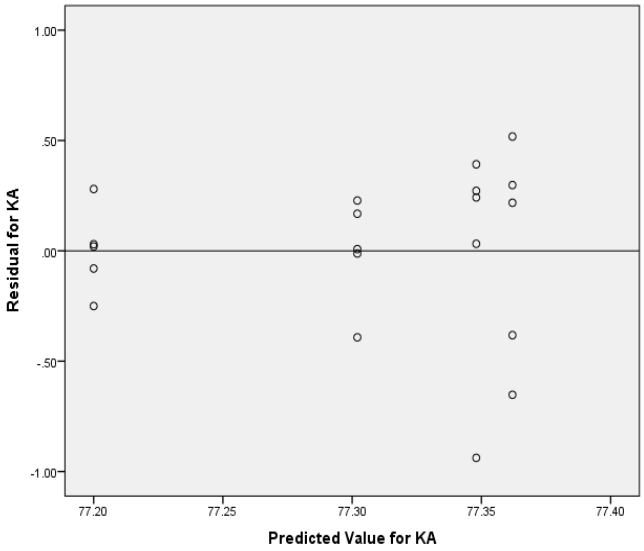
Tests of Between-Subjects Effects

Dependent Variable: Water Content

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.081[a]	3	0.027	0.170	0.915
Intercept	119515.076	1	119515.076	757191.309	.000
JK	.054	1	0.054	.343	.566
Location (JK)	0.027	2	.013	.084	.920
Error	2,525	16	0.158		
Total	119517.682	20			
Corrected Total	2.606	19			

a. R Squared = 0.031 (Adjusted R Squared = –0.151).

Based on the ANOVA table above, the *P*-value (Sig.) for Gender is 0.566 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that gender does not have a different effect on the KA value in goats. The *P*-value (Sig.) for the sample location (nested on gender) is 0.924 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that the difference in sample locations (Loin and Rounds) cannot have a different effect on the KA value in Goats. The value of R Squared or Coefficient of Determination of 0.031 or 3.1 % indicates that 3.1 % of the total diversity in the model can be described/explained by the independent variable. Because there were no significant or significantly different treatments, the average value of each treatment was of course almost the same.



Based on the fitted value plot above, it can be seen that the data points do not form a certain pattern and are mostly near the horizontal line, so it can be concluded that the assumption of freedom of error is met.

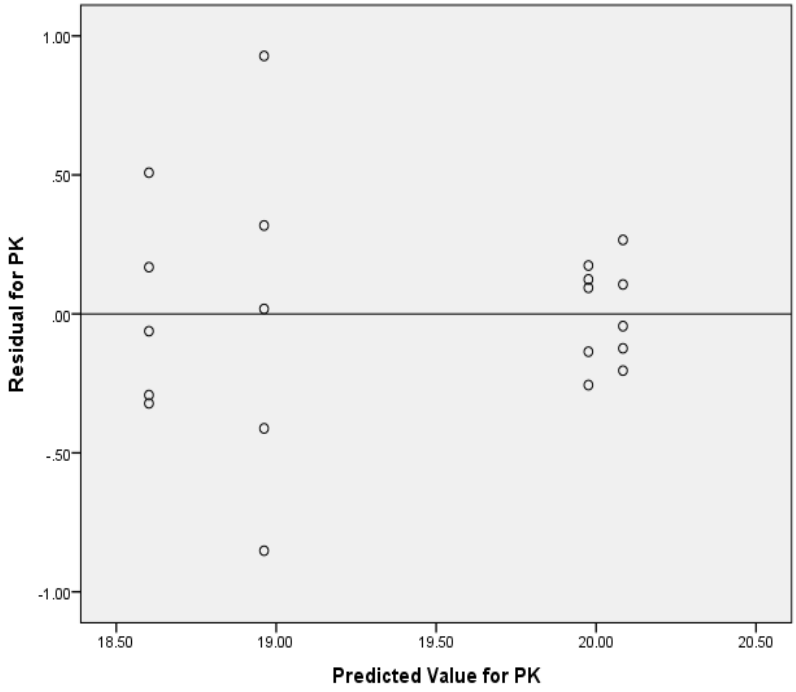
Tests of Between-Subjects Effects

Dependent Variable: Protein

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8141[a]	3	2.714	16.592	0.00
Intercept	7531.857	1	7531.857	46052.319	0.00
JK	7.788	1	7.788	47.616	0.00
Location (JK)	.353	2	.177	1.080	.363
Error	2.617	16	0.164		
Total	7542.614	20			
Corrected Total	10 757	19			

a. R Squared = 0.757 (Adjusted R Squared = 0.711).

Based on the ANOVA table above, the *P*-value (Sig.) for Gender is 0.000 < 0.05 (α) so Reject H_0. This means that with a 95 % confidence level, it can be stated that gender can have a different effect on the PK value in goats. The *P*-value (Sig.) for the sample location (nested on gender) is 0.363 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that differences in sample locations (Loin and Rounds) cannot have a different effect on PK values in goats. The value of R Squared or Coefficient of Determination of 0.757 or 75.7 % indicates that 75.7 % of the total diversity in the model can be described/explained by independent variables. Because the number of treatments in the model is only 2, then to see which treatment is the best on the significant treatment, it is not necessary to carry out further tests so that it is enough to identify the average value of the descriptive statistics from the research data.



Based on the fitted value plot above, it can be seen that the data points do not form a certain pattern and are mostly near the horizontal line, so it can be concluded that the assumption of freedom of error is met.

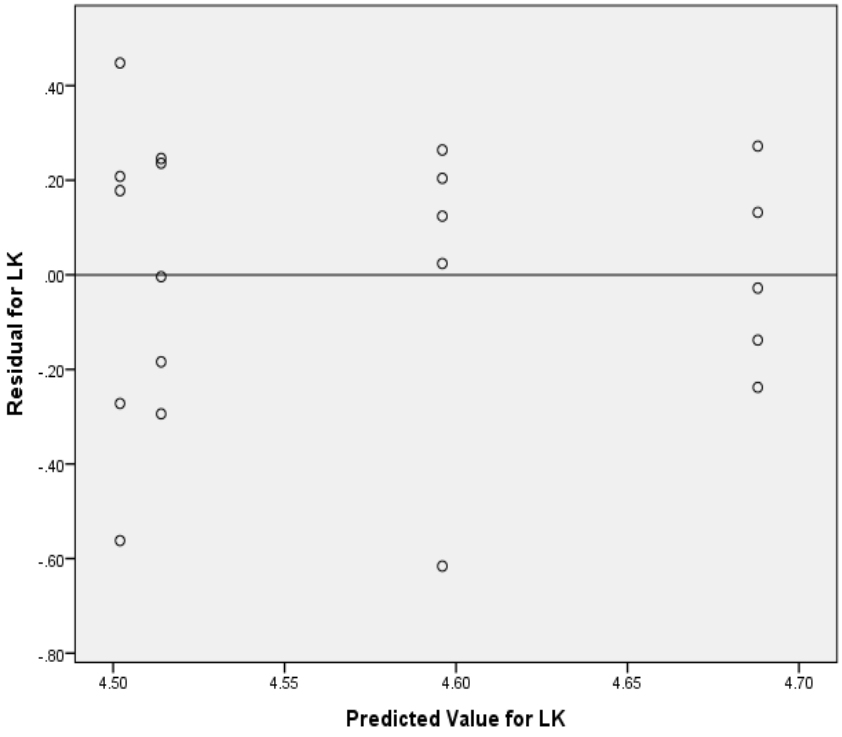
Tests of Between-Subjects Effects

Dependent Variable: Fat

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.111[a]	3	0.037	0.377	0.771
Intercept	418.612	1	418.612	4248.256	0.000
JK	0.014	1	0.014	0.137	0.716
Location (JK)	.098	2	.049	.496	0.618
Error	1.577	16	0.099		
Total	420.300	20			
Corrected Total	1.688	19			

a. R Squared = 0.066 (Adjusted R Squared = –0.109).

Based on the ANOVA table above, the *P*-value (Sig.) for Gender is 0.716 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that gender does not have a different effect on the LK value in goats. The value of *P* (Sig.) for the location of the sample (nested on gender) is 0.618 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that the difference in sample locations (Loin and Rounds) cannot have a different effect on the LK value in Goats. The value of R Squared or Coefficient of Determination of 0.066 or 6.6 % indicates that 6.6 % of the total diversity in the model can be described/explained by independent variables. Because there were no significant or significantly different treatments, the average value of each treatment was of course almost the same.



Based on the fitted value plot above, it can be seen that the data points do not form a certain pattern and are mostly near the horizontal line, so it can be concluded that the assumption of freedom of error is met.

Tests of Between-Subjects Effects

Dependent Variable: Energy (Kcal/Kg)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	520.796[a]	3	173 599	1.081	0.385
Intercept	11446223.25	1	11446223.25	71301.132	.000
JK	35,992	1	35,992	0.224	.642
Location (JK)	484.804	2	242.402	1.510	.251
Error	2568.537	16	160.534		
Total	11449312.59	20			
Corrected Total	3089.333	19			

a. R Squared = 0.169 (Adjusted R Squared = 0.013).

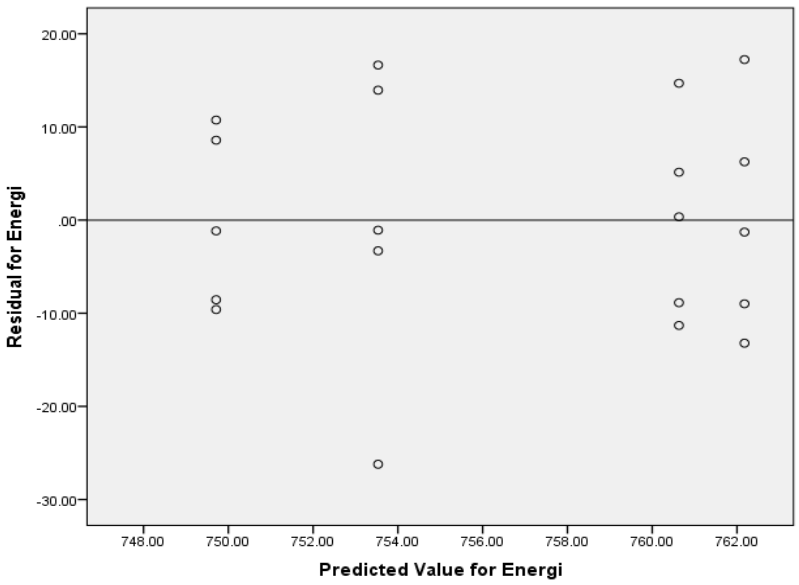
Based on the ANOVA table above, the *P*-value (Sig.) for Gender is 0.642 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that gender does not have a different effect on energy (Kcal/Kg) in goats. The *P*-value (Sig.) for the sample location (nested on gender) is 0.251 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that differences in sample locations (Loin and Rounds) cannot have a different effect on the Energy value (Kcal/Kg) in Goats. The value of R Squared or Coefficient of Determination of 0.169 or 16.9 % indicates that 16.9 % of the total diversity in the model can be described/explained by independent variables. Because there were no significant or significantly different treatments, the average value of each treatment was of course almost the same.

Descriptive Statistics

Dependent Variable: Energy (Kcal/Kg)

Gender	Location	Mean	Std. Deviation	N
Male	Loin	753.53	17.11	5
	Round	762.18	12.18	5
	Total	757.85	14.72	10
Females	Loin	749.71	9.43	5
	Round	760.63	10.59	5
	Total	755.17	11.07	10
Total	Dada	751.62	13.18	10
	Round	761.40	10.79	10
	Total	756.51	12.75	20

According to the table above shows that the average value Energy (Kcal/Kg) in Sex and in the location of the sample nested in each sex has almost the same value.

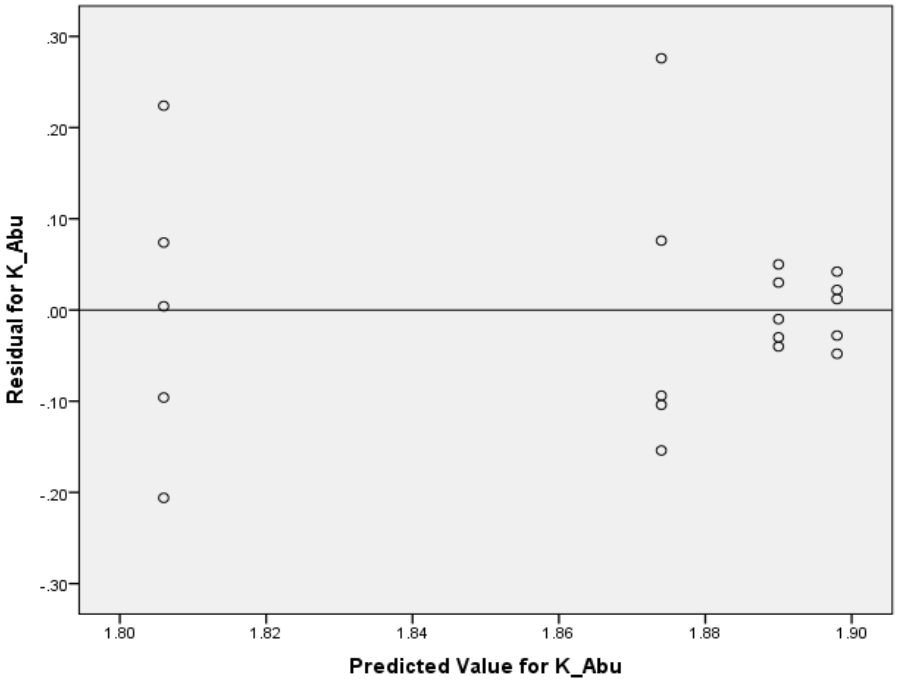


Based on the fitted value plot above, it can be seen that the data points do not form a certain pattern and are mostly near the horizontal line, so it can be concluded that the assumption of freedom of error is met.

Tests of Between-Subjects Effects					
Dependent Variable: K. Abu					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	0.026[a]	3	0.009	0.575	0.640
Intercept	69.714	1	69.714	4569.148	0.000
JK	0.015	1	0.015	0.956	0.343
Location (JK)	0.012	2	0.006	0.384	0.687
Error	0.244	16	0.015		
Total	69.984	20			
Corrected Total	0.270	19			

a. R Squared = 0.097 (Adjusted R Squared = –0.072).

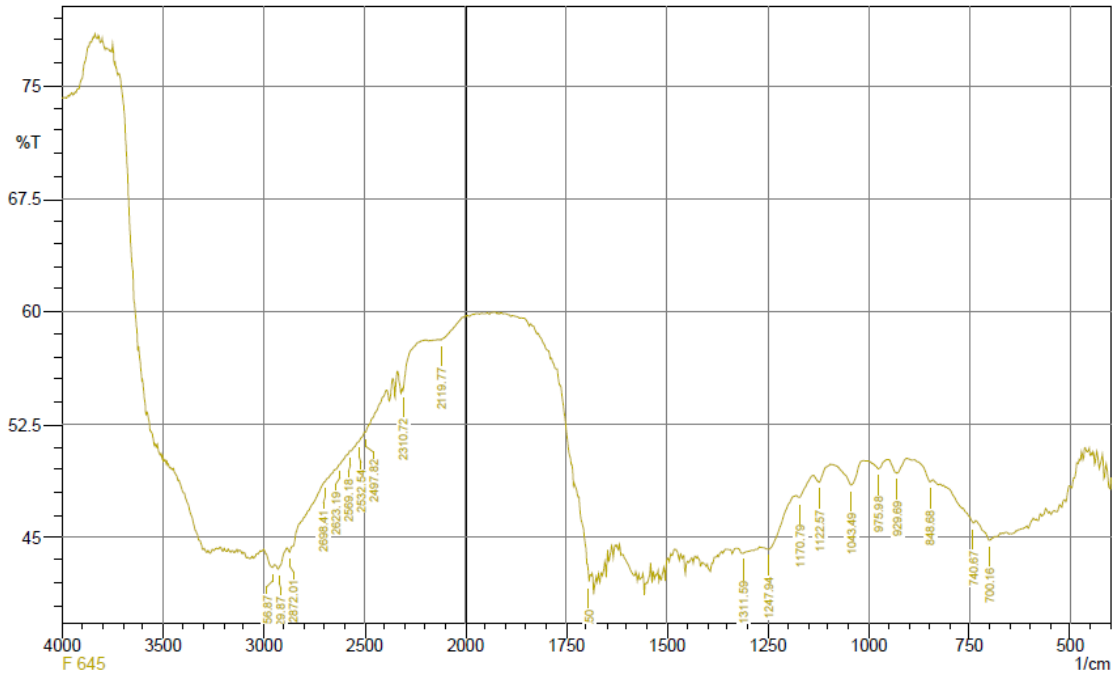
Based on the ANOVA table above, the *P*-value (Sig.) for Gender is 0.343 > 0.05 (α) so that Accept H_0. This means that with a 95 % confidence level, it can be stated that gender does not have a different effect on K. Ash in goats. The *P*-value (Sig.) for the sample location (nested on gender) is 0.687 > 0.05 (α) so Accept H_0. This means that with a 95 % confidence level, it can be stated that differences in sample locations (Loin and Rounds) cannot have a different effect on the value of K. Ash in Goats. The value of R Squared or the Coefficient of Determination of 0.097 or 9.7 % indicates that 9.7 % of the total diversity in the model can be described/explained by independent variables. Because there were no significant or significantly different treatments, the average value of each treatment was of course almost the same.



Based on the fitted value plot above, it can be seen that the data points do not form a certain pattern and are mostly near the horizontal line, so it can be concluded that the assumption of freedom of error is met.

Characteristics of functional groups

In this study, FTIR testing was carried out on 1 selected sample. The FTIR spectra obtained in the measurement of the Kacang goat meat is presented in **Figure 1**.



	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	700.16	44.815	0.517	732.95	688.59	15.257	0.108
2	740.67	45.965	0.336	806.25	734.88	23.377	0.103
3	848.68	48.68	0.336	875.68	842.89	10.073	0.028
4	929.69	49.277	0.935	950.91	906.54	13.46	0.189
5	975.98	49.555	0.575	1001.06	952.84	14.564	0.103
6	1043.49	48.475	1.52	1087.85	1012.63	23.085	0.423
7	1122.57	48.665	0.705	1136.07	1095.57	12.463	0.097
8	1170.79	47.656	0.381	1178.51	1138	12.781	0.05
9	1247.94	44.209	0.658	1259.52	1188.15	24.308	0.261
10	1311.59	43.93	0.302	1325.1	1290.38	12.356	0.05
11	1693.5	42.072	1.73	1718.58	1685.79	11.625	0.23
12	2119.77	58.135	0.043	2121.7	2017.54	24.017	0.072
13	2310.72	54.739	0.143	2312.65	2233.57	19.305	0.005
14	2497.82	52.006	0.05	2499.75	2391.73	29.465	0.043
15	2532.54	51.314	0.044	2534.46	2499.75	9.967	0.014
16	2569.18	50.734	0.074	2573.04	2536.39	10.723	0.021
17	2623.19	49.846	0.035	2625.12	2590.4	10.403	0.006
18	2698.41	48.674	0.036	2700.34	2646.34	16.682	0.007
19	2872.01	44.015	0.554	2883.58	2700.34	61.095	0.17
20	2929.87	42.886	0.624	2947.23	2885.51	22.337	0.187
21	2956.87	43.001	0.329	2987.74	2949.16	14.038	0.103

Figure 1 FTIR spectra of "Kacang" goat meat.

Figure 1 shows there are differences in the absorption of wave numbers in each infrared (IR) region. This shows that the diversity of functional groups does exist in Kacang goat meat. Based on the existing FTIR spectra, the functional groups of the sample can be estimated by looking at the wave number at the peak of absorption then adjusted to the source of previous research. The forecast is presented in **Table 5**.

Table 5 Forecast of functional group of Kacang goat meat.

Wave Number at Absorption Peak (cm^{-1})	Functional Group Forecast	References
2956.87 - 2497.82	N-CH_2 stretching	Issa (2017)
2310.72	Overlapping C-H stretching on chain CH2-, -CH3	Issa (2017)
2119.77	Aromatic isonitrile -N=C stretching	Stuart (2010)
1693.5	C=O stretch hydrogen bond paired with COO-, Deformation NH2, CH2 bending	Jeevithan *et al.* (2014)
1311.59	Aromatic C-N stretching, C-O-C antisimetric stretching	Stuart (2010) and Jeevithan *et al.* (2014)
1247.94	Aliphatic C-N stretching	Issa (2017)
1170.79 - 1043.49	Free amino group -NH2	Jeevithan *et al.* (2014)
975.98 - 848.68	NH2 wagging and twisting, bridge C-O-C	Issa (2017)
740.67 - 700.16	NH2 wagging, groups of N-H wagging on secondary amide, -OH bending	Issa (2017) and Jeevithan *et al.* (2014)

Table 5 showed the IR spectra that appears was the wave number at the absorption peak of 700.16 – 2,956.87 cm^{-1}. This is consistent with the opinion that FTIR is optimal for reading organic material in the wavelength range of 800 - 2,500 cm^{-1} [27].

The wavelength of peak absorption > 3,000 cm^{-1} does not appear in IR spectra, that means the sample of Kacang goat meat is relatively pure, without collagen fibers or connective tissue. This is different from previous studies conducted on chicken claw samples with different pH and temperature treatments [28]. The absorption peak > 3,000 cm^{-1} indicates the presence of NH2 symmetric stretching in the primary amide group which is an imide residue from the ß-sheet structure [25] which is a typical collagen group.

The wavelength of 2,119.77 cm^{-1} indicates the presence of Aromatic Isonitrile -N=C stretching groups that are very easy to bind with other atoms, mainly carbon atoms. The Isonitrile group -N=C is an isomer whose molecules have the same structure but different functions. The group is effortlessly easy to interact and release the hydrogen ions it binds [29].

The wavelengths 1,170.79 - 1,043.49 cm^{-1} indicate the presence of a free amino group - NH2. In this sample there is also a C=O stretch bond, a hydrogen bond paired with COO-, NH2 deformation, and CH2 bending which indicates the presence of peptides which are likely to consist of hydrophobic amino acids [30]. There are also NH2 wagging bonds, N-H wagging groups in secondary amides and -OH bending. The presence of NH2 wagging and twisting groups and C-O-C bridges make this peptide easy to spin and wobble, so that it reacts with other atoms [29].

The primary amide group of 1 nitrogen atom is connected to 1 carbon atom, whereas in the secondary amide group 1 nitrogen atom is connected to 2 carbon atoms. Amides are formed when the Hydroxyl group of Carboxylic acids (C (O) OH) is replaced by compounds such as Ammonia (NH3) or Amines [31]. Therefore, the hydrophobicity is low and less water soluble. Based on the diversity of wavelengths at different peak absorption, it indicates that the functional group in Kacang goat meat is dominated by active peptides. This opens up further research opportunities to find out, specifically the bioactive peptide and its function in supporting body health. The use of FTIR with Chemometrics is a technique of analyzing functional groups of meat that is powerful and faster [18]. Thus, further research is needed to characterize functional groups of "Kacang" goat meat by combining the 2 analyzes.

Conclusions

Gender can have a different effect on the value of pH, cooking loss measurements, protein in goats. However, gender did not have a different effect on shear force, water content, fat, energy and ash content in goats. The difference in sample locations (loin and rounds) cannot give different effects on the value of pH, cooking loss measurements, shear force, water content, protein, fat, energy and ash content in goats.

Acknowledgment

The authors would like their gratitude to DRPM-Kemenristek DIKTI Republic of Indonesia for giving the basic research grant in 2019.

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