



Received: 20 July 2025; Accepted: 23 February 2026; Published: 28 February 2026

**THE PERCENTAGE OF INTERNAL ORGAN WEIGHTS AND BELLY FAT
THICKNESS IN BALI AND LANDRACE PIGS FOR USE AS BABI GULING**

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How to cite: Gutierrez, IKGA, Suada IK, Suardana IW. 2026. The Percentage of Internal Organ Weights and Belly Fat Thickness in Bali and Landrace Pigs for Use as *Babi Guling*. JVAS, 8(1): 33-42. DOI: <https://doi.org/10.24843/JVAS.2026.v08.i01.p05>

Abstract

Pigs are a livestock commodity with great potential for meat production due to their superior characteristics and capabilities. The percentage of organ weight and abdominal fat thickness of Balinese and Landrace pigs needs to be known to determine the most suitable pig breed for babi guling (Balinese roast pig). This study used an observational study design based on primary data on the weight of internal organs and abdominal fat thickness of pigs. The samples used included 32 hearts, 32 pairs of lungs, 32 livers, 32 spleens, 32 pairs of kidneys, 32 kidney fat, and 32 abdominal fat. Samples were taken from 32 pigs, consisting of 16 Bali pigs and 16 Landrace pigs. Sampling was carried out 16 times. The objective method used was quantitative descriptive, which presents data in the form of percentages, means, and standard deviations. This study concluded that the percentage of organ weight in Bali pigs is: heart 0.32%, lungs 0.89%, liver 1.79%, spleen 0.13%, kidney 0.27%, and kidney fat 0.12% of the live weight of Bali pigs. For Landrace pigs, the percentages are: heart 0.30%, lungs 0.83%, liver 1.88%, spleen 0.16%, kidney 0.36%, and kidney fat 0.15% of the live weight of Landrace pigs. The total thickness of abdominal fat in Bali pigs is 33 cm, while in Landrace pigs, the thickness is 28.9 cm. The fat content of Bali pig meat is significantly higher than that of Landrace pig meat. It is recommended that further research investigate the internal organs and abdominal fat in Balinese and Landrace pigs in more detail.

Keywords: Internal organs, belly fat, Bali pig, Landrace pig.

INTRODUCTION

Pigs have been domesticated and bred since ancient times to meet humanity's need for meat. Pigs are a meat-producing livestock commodity with significant potential for development due to their advantageous characteristics and capabilities. (Agustina *et al.*, 2017; Siagian, 1999). Pigs have great potential for development because they have characteristics and abilities including: fast growth rate, high number of children born (litter size), good ration efficiency (70-80%), and high carcass percentage (65-80%) (Sumardani *et al.*, 2020). One Balinese tradition is to use pork as the main ingredient in the roasted suckling pig dish. Bali pigs have several advantages, including high resilience to less-than-ideal environmental conditions, minimal water requirements, and the ability to survive on limited feed. However, a disadvantage of Bali pigs is their relatively slower growth rate compared to imported breed (Budaarsa *et al.*, 2016).

Balinese pork has a more savory flavor and is very suitable for use as suckling pig. In fact, in some regions, there is still a fanaticism in using Balinese pork for suckling pig (Sukanata *et al.*, 2018). Suckling pig is a Balinese culinary specialty that holds high cultural and economic value. The quality of suckling pig is greatly influenced by the pig's body composition, especially the percentage of internal organ weight and fat content in the belly (Sutama, 2015; Yanti *et al.*, 2023). Balinese pork has a more intense color, namely a dark pink red compared to Landrace pork, which is reddish pink (Ardiawan *et al.*, 2024).

Landrace pigs are superior pigs originating from Denmark. Landrace pigs are bred to increase meat production in Indonesia. These pigs are a high-quality meat (bacon) type of pig. Their advantageous traits include ease of maintenance, high adaptability, and better meat quality. The rearing system is also the reason why Bali pigs have a significantly lower slaughter weight than Landrace pigs. Landrace pigs are intensively raised with highly nutritious feed and housing conditions tailored to their needs (Sihombing, 1997).

According to research by Suandita (2016), the fat content of Balinese pork is significantly higher than that of Landrace pork. The high fat content of Balinese pork is due to the traditional way in which Bali pigs are raised, feeding them kitchen waste, which has a high fat content. This method is still widely used by Bali pig breeders. The low fat content of Landrace pork is due to the intensive farming and commercial feed intake of Landrace pigs. The feed consumed by these pigs has a high protein content that meets the body's needs, allowing fat to be utilized efficiently as energy. Bali pigs are known for their even and thick fat distribution, as well as proportional organ size, making them often considered more suitable for suckling pigs, which prioritize crispy skin and the savory flavor of the fat. On the other hand, Landrace pigs grow faster and more efficiently, but tend to have thinner subcutaneous fat and a different organ composition (Widyastuti *et al.*, 2020). The percentage of organ weight and thickness of pork belly fat determines the type of pig that is suitable for suckling pig, therefore this study aims to determine the percentage of organ weight and thickness of pork belly fat of Balinese and Landrace pigs to determine the most suitable breed of pig for suckling pig.

MATERIALS AND METHODS

The research design used in this study was observational based on primary data regarding the weight of internal organs and thickness of belly fat in Balinese and Landrace pigs after slaughter at Mr. Mangku's traditional slaughterhouse. The research results were analyzed quantitatively and descriptively in the form of tables and graphs. Data collection was carried out by removing internal organs and measuring belly fat thickness in Balinese and Landrace pigs.

Organ weight and belly fat thickness were measured by removing internal organs, including the heart, lungs, liver, spleen, kidneys, kidney fat, and belly fat from Balinese and Landrace pigs. The organs were then thoroughly washed and dried with tissue paper. Each organ was weighed using a digital scale, recorded, and then belly fat thickness was measured using a ruler.

Research Subjects

The samples used were 32 hearts, 32 pairs of lungs, 32 livers, 32 spleens, 32 pairs of kidneys, 32 kidney fat, and 32 belly fat. The samples came from 32 Balinese and Landrace pigs, consisting of 16 Balinese and 16 Landrace pigs, taken from a traditional slaughterhouse owned by Mr. Mangku in Banjar Ulapan 2, Blahkiuh Village, Abiansemal District, Badung Regency. Sampling was carried out 16 times. The tools used in the study included knives, cutting boards, buckets, digital scales, and rulers. The materials used in the study included water, tissue, hearts, lungs, livers, spleens, kidneys, kidney fat, and belly fat from Balinese and Landrace pigs.

Research Methods

The research design used in this study was observation based on primary data regarding the weight of internal organs and the thickness of belly fat in Balinese and Landrace pigs after slaughter at a traditional slaughterhouse owned by Mr. Mangku. The results were analyzed descriptively and quantitatively in the form of tables and graphs. Data collection was carried out by removing internal organs and measuring the thickness of belly fat in Balinese and Landrace pigs.

Data Analysis

Organ weight and belly fat thickness were measured by removing internal organs, including the heart, lungs, liver, spleen, kidneys, kidney fat, and belly fat from Balinese and Landrace pigs. The organs were then thoroughly washed and dried with tissue paper. Each organ was weighed using a digital scale, recorded, and then belly fat thickness was measured using a ruler. The results of the organ weight and belly fat thickness measurements were calculated as percentages, and the results were objectively described quantitatively in tables and graphs.

RESULTS AND DISCUSSION

Results

A total of 32 samples were used in this study, consisting of 16 Bali pigs and 16 Landrace pigs slaughtered at a traditional slaughterhouse owned by Mr. Mangku located in Banjar Ulapan 2, Blahkiuh Village, Abianseml District, Badung Regency. The parameters observed included the weight of internal organs (liver, heart, kidney, lungs, spleen, and kidney fat) and the thickness of belly fat measured after the slaughtering process. The data obtained are presented in tables and graphs to see the characteristics between the two types of pigs in the context of their use as traditional culinary ingredients.

Bali pig Organ Weight

Bali pig organ weights were obtained from 16 Bali pig samples used in the study. The weight of each organ can be seen in Table 1 below.

Table 1. Bali pig Organ Weight

Organ	Live Weight (Kg)	Average	Standard Deviation	Organ Weight (%)
Liver	39.31	832.5	370.84	2.12
Heart	39.31	148.44	72.68	0.38
Lungs	39.31	414.81	204.29	1.06
Kidneys	39.31	127.63	65.30	0.32
Spleen	39.31	62.75	42.77	0.16
Renal Fat	39.31	54.69	26.80	0.14

Table 1 shows the results of organ weight measurements from 16 Bali pigs with an average live weight of 39.31 kg. The organs analyzed included the liver, heart, lungs, kidneys, spleen, and kidney fat. The data presented includes the mean, standard deviation, and percentage of organ weight relative to live weight. The organ with the highest average weight was the liver, at 832.5 grams. The standard deviation for this organ was also quite large, at 370.84 grams. The liver contributed approximately 2.12 percent of total live weight. This finding aligns with the liver's function as a major metabolic organ with a relatively large volume and mass in the mammalian body.

The lungs ranked second with an average weight of 414.81 grams, equivalent to 1.06 percent of live weight. The heart had an average weight of 148.44 grams, representing a percentage of 0.38 percent of live weight. The kidneys had an average weight of 127.63 grams, contributing 0.32 percent. The spleen weighed an average of 62.75 grams and kidney fat 54.69 grams, accounting for 0.16 percent and 0.14 percent of live weight, respectively. The relatively high standard deviations, particularly for the liver and lungs, indicate significant individual variation among the samples. This may be influenced by genetic factors, nutrition, health status, and the rearing environment. Differences in the weight of each Bali pig organ can be seen in Graph 1 below.

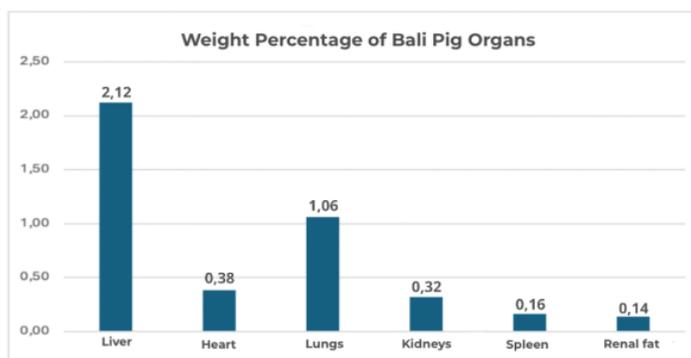


Figure 1. Graph of Bali pig Organ Weight Percentage

Weight of Landrace Pig Organs

Landrace pig organ weights were obtained from 16 samples of landrace pigs used in the study. The weight of each organ can be seen in Table 2 below.

Table 2. Weight of Landrace Pig Organs

Organ	Live Weight (Kg)	Average	Standard Deviation	Organ Weight (%)
Liver	46.62	877.56	152.88	1.88
Heart	46.62	141.13	59.42	0.30
Lungs	46.62	385.25	109.22	0.83
Kidneys	46.62	168.38	48.60	0.36
Spleen	46.62	72.50	25.60	0.16
Renal Fat	46.62	71.31	41.90	0.15

Table 2 presents organ weight data from 16 Landrace pigs with an average live weight of 46.62 kg. The organs observed included the liver, heart, lungs, kidneys, spleen, and kidney fat. The mean weight, standard deviation, and percentage of live weight were recorded for each organ. The liver had the highest average weight, at 877.56 grams, with a standard deviation of 152.88 grams, and a percentage of live weight of 1.88 percent. This value indicates that although the live weight of Landrace pigs is higher than that of Bali pigs, the proportion of the liver to body weight is slightly smaller.

The lungs weighed an average of 385.25 grams, equivalent to 0.83 percent of the live weight. The heart weighed an average of 141.13 grams and contributed 0.30 percent of the live weight. The kidneys weighed an average of 168.38 grams and accounted for 0.36 percent of the live weight. The spleen and kidney fat weighed an average of 72.50 grams and 71.31 grams, respectively, with a percentage of the live weight of 0.16 percent and 0.15 percent, respectively.

The standard deviations for these organs were generally smaller than those of the Bali pig, particularly for the liver and lungs, which may indicate lower individual variation within this sample group. A comparison of the weights of each organ in Landrace pigs can be seen in Graph 2 below.

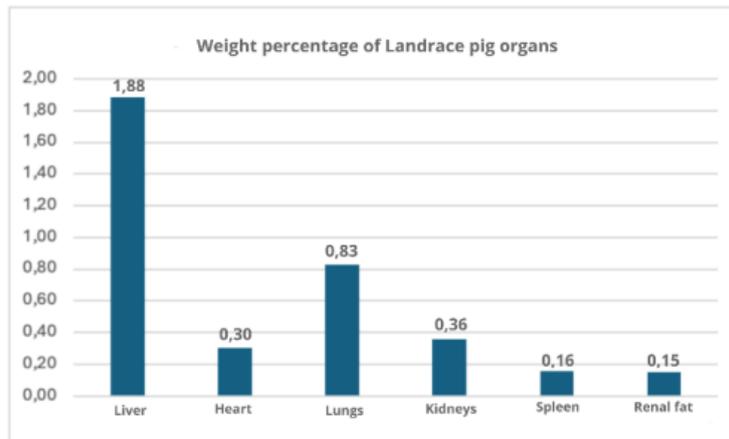


Figure 2. Graph of Landrace Pig Organ Weight Percentage

Thickness of Belly Fat

The thickness of belly fat from landrace pigs and Bali pigs can be seen in table 3 below

Table 3. Belly Fat Thickness of Landrace Pigs and Bali Pigs

Types of Pigs	Belly thickness (cm)		
	Total	Average	Standard Deviation
Landrace Pig	28.9	1.81	0.5
Bali pig	33	2.06	0.68

Table 3 presents a comparison of belly fat thickness between Landrace and Bali pigs. Measurements show that Bali pigs have a higher belly fat thickness, with a total of 33 cm, a mean of 2.06 cm, and a standard deviation of 0.68 cm. Meanwhile, Landrace pigs have a total thickness of 28.9 cm, with a mean of 1.81 cm and a standard deviation of 0.50 cm.

This difference in mean values indicates that Bali pigs tend to have a thicker belly fat layer than landrace pigs. Furthermore, the slightly higher standard deviation value in Bali pigs indicates greater variation in belly fat thickness between individual Bali pigs compared to landrace pigs. A comparison of belly fat between landrace and Bali pigs can be seen in Graph 3 below.

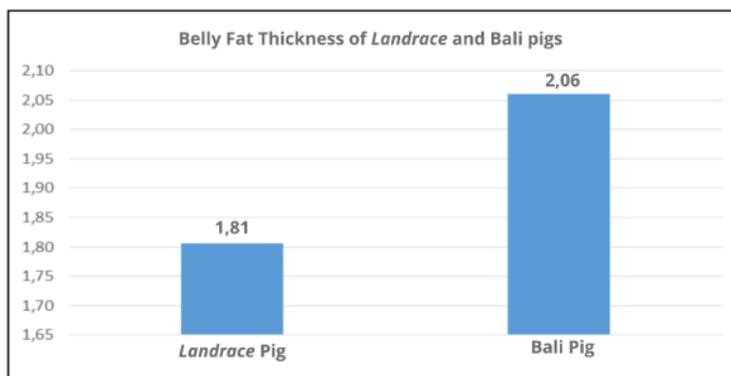


Figure 3. Belly Fat Thickness Graph for Bali Pigs and Landrace Pigs

Discussion

Weight of Balinese Pig Organs

Based on the data in Table 4.1, the results obtained regarding the weight of internal organs of Balinese pigs from 16 samples analyzed. The liver was the organ with the highest weight, both absolutely and relative to body weight, with an average of 832.5 grams and a standard deviation of 370.84 grams. This organ contributed 2.12% to total body weight. The liver is known to be a major metabolic organ that plays a vital role in detoxification, carbohydrate, protein, and fat metabolism, as well as glycogen and vitamin storage (Frandsen, Wilke, & Fails, 2009). Therefore, the high proportion of liver reflects its dominant function in the physiological system of the pig body.

The lungs weigh an average of 414.81 grams and a standard deviation of 204.28 grams, accounting for 1.06% of body weight. The lungs play a role in gas exchange and maintaining the body's acid-base balance, making their size an important indicator of respiratory capacity and respiratory health (Dyce, Sack, & Wensing, 2010). The heart, as the center of the circulatory system, weighs an average of 148.43 grams and contributes 0.38% to body weight. According to Swatland (1994), heart size and weight are closely related to the animal's activity level and blood circulation needs, with healthy and active animals tending to have hearts that are more proportional to their body mass.

The organs with the smallest contribution are kidney fat and spleen fat, with percentages of 0.14% and 0.16%, respectively. Kidney fat has an average weight of 54.68 grams, while the spleen weighs 62.75 grams. Kidney fat functions as an energy reserve and organ protection, but its amount is influenced by genetic factors, age, diet, and the animal's physiological status (Pond, Mersmann, & Woodliff, 1992). The spleen, as part of the lymphatic and immune systems, has a relatively small mass but is important in blood filtration and lymphocyte production.

The organ weight distribution of Balinese pigs in this study showed a general pattern consistent with veterinary physiology literature, with vital organs such as the liver, lungs, and heart having a larger proportion than other organs. These results provide insight into the physiological condition and carcass potential of Balinese pigs for consumption, particularly in traditional processed forms such as suckling pig.

Landrace Pig Organ Weight

Based on the data in Table 2, the organ with the highest total weight and percentage in Landrace pigs is the liver, with a total weight of 14,041 grams, a mean of 877.56 grams, and a standard deviation of 152.88 grams. This organ contributes 1.88% of total body weight. Physiologically, this indicates that the liver in Landrace pigs plays a dominant role in metabolic activities, including detoxification, protein, carbohydrate, and fat metabolism, and glycogen and vitamin storage. The relatively large and consistent liver size indicates high metabolic activity in this breed (Frandsen *et al.*, 2022).

The next organ with a large proportion is the lungs, with a total weight of 6,164 grams, a mean of 385.25 grams, and a standard deviation of 109.22 grams. The lungs contribute approximately 0.83% of body weight. This relatively large lung size reflects adequate respiratory capacity, which is necessary to support the high metabolism in intensively reared Landrace pigs (Dyce *et al.*, 2020).

The heart has an average weight of 141.12 grams, contributing 0.30% to body weight. Although relatively small, the heart plays a vital role as the center of the circulatory system, and its work

capacity is closely related to the animal's circulatory needs and metabolic activity. A proportional heart weight indicates an efficient circulatory system (Konig *et al.*, 2021).

Meanwhile, the kidneys weighed a total of 2,694 grams, with an average of 168.37 grams and a percentage of body weight of 0.36%. The kidneys function in excreting metabolic waste products and maintaining body fluid balance. The relatively stable average kidney weight reflects the efficient functioning of the excretory organs in Landrace breeds.

The organs with the lowest proportions to body weight are the spleen and kidney fat, at 0.16% and 0.15%, respectively. The spleen has an average weight of 72.5 grams, while kidney fat weighs 71.31 grams. The spleen plays a role in the immune system and red blood cell filtration, while kidney fat serves as an energy reserve and protects internal organs. The low kidney fat content in Landrace pigs may be attributed to the intensive rearing system and high-protein feeding, which leads to metabolic efficiency and low visceral fat deposition (Tobing *et al.*, 2020; Suparno, 2022).

In general, the distribution of internal organ weight in Landrace pigs shows a pattern consistent with the physiological characteristics of bacon-type breeds, namely efficient meat production with low visceral fat. These results provide important insights into the carcass quality of Landrace pigs, which have high potential for commercial meat production. Based on the data in Table 2, it is known that the organ with the highest total weight and percentage in Landrace pigs is the liver, with a total weight of 14,041 grams, a mean of 877.56 grams, and a standard deviation of 152.88 grams. This organ contributes 1.88% of total body weight. Physiologically, this indicates that the liver in Landrace pigs plays a dominant role in metabolic activities, including detoxification, protein, carbohydrate, and fat metabolism, and glycogen and vitamin storage. The relatively large and consistent liver size indicates high metabolic activity in this breed (Frandsen *et al.*, 2022).

The next organ with the largest proportions is the lungs, which have a total weight of 6,164 grams, a mean of 385.25 grams, and a standard deviation of 109.22 grams. The lungs contribute approximately 0.83% of body weight. This substantial lung size reflects adequate respiratory capacity, which is necessary to support the high metabolism of intensively raised Landrace pigs (Dyce *et al.*, 2020).

The heart weighs an average of 141.12 grams, contributing 0.30% to body weight. Despite its relatively small size, the heart plays a vital role as the center of the circulatory system, and its work capacity is closely related to the animal's circulatory needs and metabolic activity. A proportional heart weight indicates an efficient circulatory system (Konig *et al.*, 2021).

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Belly Fat Thickness in Balinese and Landrace Pigs

Research data shows that belly fat thickness in Balinese pigs is statistically higher than in Landrace pigs. This is related to genetic differences between the two pigs: Balinese pigs are lard-type (tend to store fat), while Landrace pigs are bacon-type, which are more focused on producing lean meat (Razmaitè *et al.*, 2024). Modern research confirms that back fat and belly fat thickness are strongly influenced by genetics, and fatty breeds like local pigs have higher fat accumulation than modern breeds like Landrace or Large White, which adapt high-protein rations to increase muscle efficiency and reduce fat.

Physiologically, belly fat thickness can be considered an indirect indicator of carcass composition, particularly the proportion of fat to muscle. Studies show that increasing belly fat thickness negatively correlates with lean meat yield, as the volume of the carcass filled with fat reduces the space for muscle tissue. Therefore, high belly fat thickness in Balinese pigs can result in a lower meat yield percentage, which impacts the economic value of the carcass due to the generally higher market demand for lean meat. Husbandry practices are also a key determinant. Landrace pigs are generally intensively raised and fed commercial feeds high in protein but with a high energy ratio, supporting efficient muscle growth and encouraging fat utilization for metabolic energy, thus reducing belly fat accumulation.

Genetically, heritability for belly traits, including belly thickness and weight, is reported to be moderate (~0.23–0.34), indicating the potential for genetic selection to modify fat content without compromising meat sensory quality (Lee *et al.*, 2023). Feeding with different compositions will result in different meat chemical compositions. High-energy feed consumed by livestock can result in high body fat deposition and decreased protein and water content (Sriyani & Ariana, 2018)

CONCLUSIONS AND SUGGESTIONS

Conclusions

1. The percentage weight of organs in Balinese pigs used for suckling pigs is 0.38% heart, 1.06% lungs, 2.12% liver, 0.16% spleen, 0.32% kidney, and 0.14% kidney fat of the live weight of Balinese pigs.
2. The percentage weight of organs in Landrace pigs used for suckling pigs is 0.30% heart, 0.83% lungs, 1.88% liver, 0.16% spleen, 0.36% kidney, and 0.15% kidney fat of the live weight of Landrace pigs.
3. The total thickness of belly fat in Balinese pigs is 2,06 cm, while in Landrace pigs it is 1,81 cm

Suggestions

1. The results of this study can be used as a baseline data reference regarding the morphometric comparison of Bali pigs and Landrace pigs used for *babi guling* (roasted suckling pig).
2. The results of this study can be used as a reference for fulfilling nutritional values derived from specific organ types.

3. The belly fat thickness can be used as a reference for assessing the flavor of the *babi guling* produced.
4. Further studies are needed regarding consumer acceptance of the quality of *babi guling* originating from Bali pigs and Landrace pigs.

ACKNOWLEDGMENTS

The author would like to express his gratitude to all parties who have helped in completing this research.

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