The utilization of cassava by-products as complete feed on physical and chemical meat quality of weaning male crossbred Landrace pigs

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Abstract. The objective of this research is utilization of cassava by-products as complete ration on physical and chemical meat quality of weaning male of crossbred Landrace pigs. This research was conducted at Desa Rumah Mbacang Pancur Batu from April to June 2019. The research used completely randomized design (CRD) with 4 treatments and 2 replications. The treatments compose of P0 (without cassava by-products), P1 (with 20% cassava by-products), P2 (with 40% cassava by-products) and P3 (with 60% cassava by-products). The variables were observed consist of physical quality (pH value, water holding capacity, cooking loss and color) and chemical quality (water content, fat content and protein content). The results showed that the best pH value on P1 (5.00), the best water holding capacity on P1 (51.32%), best cooking loss on P1 (44.99%), the best color on P1 (1.50), the best water content on P1 (78.11%) , the best fat content on P1 (3.84%) and the best protein content on P1 (21.72%). It was concluded that the use of cassava by-products in complete feed for pigs should not exceed 20%.

1. Introduction
Cassava is a food crop that can replace other food crops such as rice and corn. Cassava plants can grow easily with many types of soil conditions and are resistant to pests. According to Statistics Indonesia [1], total cassava production in Indonesia is 21,801,415 tons with a harvest area of 949,916 hectares while cassava production in North Sumatra is 1,619,495 tons with a harvest area of 47,837 hectares. By-products of post-harvest processing of cassava such as cassava leaves that are not utilized after harvesting, as well as cassava peel and cassava pulp from cassava starch industry will become waste that can pollute the environment if not utilized properly. These wastes can be utilized as animal feed ingredients not only for monogastric livestock such as poultry and small ruminants but also large ruminants. Pigs in Indonesia are one of the sources of protein in the form of meat which is able to provide 10.43% of total meat production in Indonesia [2]. According to Riasari [3], the protein of pork is not much different from beef. As a meat-producing livestock, pigs do not require long maintenance. According to Anderson [4], the advantage of pig livestock is that they do growth, can produce many piglets (6-12 individuals), can give birth twice a year or even 5 times in 2 years. Pigs are also very efficient in converting leftovers and by-products of agriculture and factories. Meat quality is defined as the number of traits which determine the meat affect consumer acceptance. The purpose of this research is to find out research on the utilization of cassava by-products, especially cassava leaves, cassava peel and cassava pulp as a complete ration of the physical and chemical quality of meat weaning male of crossbred Landrace pigs.
2. Materials and methods

Materials used in this study were 8 weaning male of crossbred Landrace pigs which were taken from the flesh of the thighs in a fresh condition. The feed ingredients used in this study were cassava leaves, cassava peel, cassava pulp, corn flour, coconut meal, rice bran, soybean meal, minerals, and molasses. Test materials used were aquades, alcohol, label paper, plastic clips, H$_2$SO$_4$ concentrated, a mixture of selenium, H$_3$BO$_3$ 2%, 0.01% HCl and 30% NaOH. The tools used in this study are scales, animal feed and animal medicine. The tools used in testing the pH value, cooking loss, water holding capacity, color, water content, fat content and protein content of meat include digital scales, pH meters, knives, cutting boards, cooking utensils, meat color, ballast weighing 35 kg, waterbath, centrifuges, destructors, distillators, ovens and desiccators.

Making complete feed: cassava by-products consisting of cassava leaves, cassava peel and cassava pulp were dried first and then grounded using a grinder. After that it was mixed with other feed ingredients such as corn flour, rice bran, coconut meal, soybean meal, minerals and molasses until the homogenous complete feed was obtained. The homogenous complete then given to pigs.

The research method used was experimental using a completely randomized design (CRD) with 4 treatments and 2 replications. The treatments studied were as follows: P0 = Complete feed without cassava by-products; P1 = Complete feed with 20% cassava by-products; P2 = Complete feed with 40% cassava by-products; P3 = Complete feed with 60% cassava by-products.

2.1. Observed variables

2.1.1. Physical quality of pork. The physical quality of meat observed was pH value AOAC [5], water holding capacity with the HAM method according to instructions Soeparno [6], cooking loss according to instructions Soeparno [6] and color using the chart meat color (pork quality standards) from 6 colored photos of pig muscles made by the National Pork Board, calculated using the formula:

- pH value = pH value measurement done with a pH meter
- Water holding capacity = % Water Content -% Water Content Wet Area
- Cooking loss = \[
\frac{\text{Initial weight of meat} - \text{Final weight of meat}}{\text{Initial weight of meat}} \times 100\%
\]
- Color = Pieces of meat compared to six color scales: 1 (Pale pinkish gray to white); 2 (Grayish pink); 3 (Reddish pink); 4 (Dark reddish pink); 5 (Purplish red); and 6 (Dark purplish red).

2.1.2. Chemical quality of pork. The chemical quality of meat observed was water content, fat content and protein content analysed using the method AOAC [5] with the formula:

\[
\% \text{ Water content } = \frac{(B - A) - (C - A)}{(B - A)} \times 100
\]
\[
\% \text{ Fat content } = \frac{(C - A) - (D - A)}{B - A} \times 100
\]
\[
\% \text{ Protein content } = N \times Fp
\]

Specification:
A = Weight of porcelain cup/filter paper (g)
B = Weight of porcelain cup/filter paper containing sample before heating (g)
C = Weight of porcelain cup/filter paper containing sample after heating (g)
D = Weight of filter paper containing residues after heating (g)
N = nitrogen content (%)
Fp = protein factor (vegetable value of 6.25; animal of 5.56).
Data obtained will be analysed using variance (Anova). If there are significant differences, it will be continued with the Duncan Multiple Range Test [7].

2.2. Implementation of research

2.2.1. Preparation of cage and equipment. The cages used were individual units of 100x100x80 cm as many as 16 units. The cage floor was made of iron and between the cage units with one another separated by a partition. Cages were prepared a week before pigs enter the cage so that the cage was free of pests. The cage equipment was cleaned and disinfected using rodalon. The selected pigs must be healthy and normal (not disabled) pigs. The pigs were put into a cage randomly.

2.2.2. Research ration composition. The complete feed arrangement and nutritional content in the feed prepared for this study can be seen in Table 1.

| No | Materials          | Treatment |
|----|-------------------|-----------|
|    |                   | P0 | P1 | P2 | P3 |
| 1  | Cassava by-products | 0  | 20 | 40 | 60 |
| 2  | Corn Flour        | 42 | 30 | 19 | 7 |
| 3  | Rice Bran         | 18.8| 12 | 7.8| 5 |
| 4  | Coconut Meal      | 12.2| 13 | 9.2| 5 |
| 5  | Soybean Meal      | 20 | 18 | 17 | 16|
| 6  | Mineral           | 2  | 2  | 2  | 2 |
| 7  | Molasses          | 5  | 5  | 5  | 5 |
|    | TOTAL             | 100| 100| 100| 100|

| Nutritional content |
|---------------------|
| 1 Water content (%) | 36.02 | 36.32 | 41.37 | 43.69 |
| 2 Ash content (%)   | 7.25  | 12.41 | 7.45  | 7.94  |
| 3 Crude protein (%) | 17.44 | 18.12 | 16.06 | 14.00 |
| 4 Crude fiber (%)   | 6.48  | 8.49  | 9.60  | 10.58 |
| 5 Crude fat (%)     | 7.72  | 5.97  | 5.21  | 4.12  |
| 6 NFE (%)           | 25.09 | 18.69 | 20.31 | 19.67 |

2.2.3. Treatment and maintenance. Before pigs were given treatment, the initial weight of the pig was weighed and then weighing the pig was done once a week. Feed was given twice a day at 08.00 AM and 16.00 PM. For prevention of disease, all pigs were vaccinated with SE vaccines at a dose of 1 cc per head carried out a week before the study began. Besides that, pigs were also given combinatin® with a dose of 1 tablet recorder given through rations. Feed containers were cleaned every day in the morning and the cages were cleaned in the morning and evening.

2.2.4. Slaughtering of pigs. Before the pigs were slaughtered, pigs were fasted for 10 hours, then they were weighed. Cutting is done by stabbing the neck right in front of the tip of the sternum, with the aim of cutting the jugular vein. After removing the blood, the hair is cleaned and the pig is grilled again using fire from a gas cylinder and then the internal organs were taken, the toenails and head were separated. Pigs were cut horizontally. Furthermore, the necessary research data is taken.

2.2.5. Sampling of pork. Sampling of pork is as follows: taking meat of thing; weighing the pork sample of each portion by 1 kg; conducting physical testing of pork samples; and conducting chemical testing of pork samples.
3. Results and discussion

3.1. Physical quality of pork

The pH value, water holding capacity, cooking loss and color of pigs Landrace fed cassava by-products can be seen in Table 2.

Table 2. pH value, water holding capacity, cooking loss, and color in pigs fed rations containing cassava by-products

| Parameters               | Treatment | P0   | P1   | P2   | P3   | Mean ± SD |
|--------------------------|-----------|------|------|------|------|-----------|
| pH value                 |           | 5.25 | 5.00 | 5.25 | 5.50 | 5.25 ± 0.20 |
| Water holding capacity (%) |          | 46.34 | 51.32 | 41.52 | 34.81 | 43.50 ± 7.04 |
| Cooking loss (%)         |           | 40.65 | 44.99 | 46.64 | 43.99 | 44.07 ± 2.53 |
| Color                    |           | 1.50 | 1.50 | 2.00 | 2.00 | 1.75 ± 0.29 |

Note: *) Different superscripts on the same line had significant difference (P<0.05)

3.1.1. pH value. The pH value in pork Landrace ranges from 5.00-5.50. This is not much different from the research of Kristiawan et al. [8] on the pH value of pork, Landrace which is 5.18-6.30. Based on the analysis of variance that the giving of cassava by-products to pigs Landrace showed no significant effect (P<0.05).

According to Soeparno [6], factors that can affect variations in pH values included stress before cutting, giving of hormonal injections or certain drugs, species, muscle types, enzyme activity that affects glycolysis and states that pork pH values are not usually measured after cutting (usually within 45 minutes) to find out the initial pH. Subsequent measurements are usually done at least after 24 hours to determine the final pH of the pork or carcass. The value of pH muscle (transverse or skeletal muscle or so-called meat) in livestock is around 7.0-7.2 (neutral pH). Septinova et al. [9] adding acidic pH will cause the water holding capacity decrease, conversely when the final pH is high it will provide a higher water holding capacity.

In the treatment P1, the pH obtained was 5.00 and the color obtained was 1.50. This is in accordance with statement Buckle et al. [10] which reported that the final pH value achieved has a significant effect on pork quality, ie at a low pH (± 5.1) causing a bright red color favored by consumers, having an open structure that is highly desirable for salting meat, flavor are preferred under cooked or salted conditions and have better stability against damage by microorganisms.

3.1.2. Water holding capacity. The water holding capacity given by cassava by-products ranges from 34.81 to 51.32%. The highest water holding capacity was in the P1 treatment that was 51.32% and the lowest in the P3 treatment was 34.81%. The average water holding capacity Landrace pork is 43.50%. This result is not much different from research Satriani et al. [11] on the water holding capacity pork in pigs Landrace which is 59.48%. The water holding capacity by pork protein is defined as the ability of the pork to retain its water or water added as long as there is an influence of strength, such as cutting meat, heating, grinding, and pressure. Pork also has the ability to absorb water spontaneously from a liquid-containing environment. According to Lawrie [12] pork protein plays a role in the holding of pork water. High levels of pork protein cause increased ability to hold meat water there by reducing free water content and on the contrary. The higher the amount of water that comes out, the lower the power of water holding capacity.

Based on analysis of variance the effect of cassava by-products fed on male Landrace pigs was significantly different (P < 0.05). This difference can be caused by factors varying water holding capacity by pork protein. According to Soeparno [13] the factors that cause variations in the holding capacity of water by pork include: pH factors, maturation treatment factors, cooking or heating, biological factors such as muscle type, livestock type, sex and age of livestock. Likewise, the factors that affect feed were
3.1.3. **Cooking loss.** Based on Table 2, the value cooking loss of pork in pigs Landrace ranges from 40.65-46.64%. This result is not much different from the research of Kristiawan et al. [8] on cooking loss of pork Landrace which ranges from 37.04 to 45.14%. Based on the analysis of variance that the fed of cassava by-products to pigs Landrace showed no significant effect (P>0.05).

According to Soeparno [6], that in general the value of cooking loss varies between 1.5-54.5%. Pork of cooking loss low has good quality compared to meat of cooking loss large, so the risk of losing nutrients during cooking is less. Cooking loss is an indicator of meat nutrition, which is the amount of water that is bound in and between muscles. From the results of the study in Table 2 show that the higher the cooking loss, the lower the water holding capacity and on the contrary.

3.1.4. **Color.** The general average color score of pigs Landrace fed by cassava by-products is 1.75. These results are not much different from studied of Sriyani et al. [11] on the color of the pigs Landrace crossing which is 2.3. Based on analysis of variance of pork color scores in pigs Landrace showed no significant effect. This might be caused by the pH of the pork which the pH of the pork is getting lower the color of the pork will turn pale. This is consistent with the statement Forrest et al. [14] which states that the lower the pH, the color of the pork will become paler. The rapid and extensive rate of decrease in muscle pH will result in the color of the flesh becoming pale, the binding capacity of the pork protein to the liquid is low and the surface of the pork slices will become wet due to the discharge of the surface of the porkpieces (drip or weep).

According to Lawrie [12] the factors that influence the color of pork are nutrition, species, nationality, age of sex, stress and oxygen. The main determining factor that affects the color of the pork is the concentration of pork pigment, namely myoglobin. Myoglobin concentrations differ by species, nation and location of muscles. Myoglobin molecular type and chemical status, chemical and physical status of other components in pork have big roles in determining the color of pork.

### 3.2. **Chemical quality of pork**

Water content, fat content and protein content of pigs Landrace given cassava by-products can be seen in Table 3.

| Table 3. Nutritional content of pork fed rations containing cassava by products |
| Parameters | Treatment          | P0     | P1     | P2     | P3     | Mean ± SD   |
|-------------|-------------------|--------|--------|--------|--------|-------------|
| Water content (%) |                   | 79.81a | 78.11a | 79.61a | 76.40a | 78.48 ± 1.58 |
| Fat content (%) ** |                  | 8.57a  | 9.80a  | 7.72a  | 3.84b  | 7.48 ± 2.57  |
| Protein content (%) |                  | 21.62a | 22.53a | 19.33a | 21.72a | 21.30 ± 1.37 |

Note: **) Different superscripts on the same line had significant difference (P<0.01)

3.2.1. **Water content.** Based on the results of the study, the water content of pork from pigs Landrace fed cassava by-products ranged from 76.40 to 78.91%. This result is not much different from the study of Armini et al. [15] which stated that the water content of pork from the pigs Landrace crossing of that were given a concentrate of 68.90% and statistically the water content of pork from each treatment was not significantly different. Winarno et al. [16] states that the water content available in pork is 60-70% and if pork has water content that is not too high or not too low, then the meat can last a long time during storage. The high water content in pork causes the protein to dissolve a little water so that the water holding capacity by pork protein will decrease. Pork moisture content is affected by intermuscular fat and feed given to livestock, high-energy feed content will accumulate intramuscular fat faster than cattle.
that are fed low-energy feed, so that there will be an increasing in the percentage of intramuscular fat and a decreasing in the percentage of water content Soeparno [6].

Vance et al. [17] reported pork water content in the thigh muscles of 53.99%. The difference in pork water content can be influenced by intramuscular fat content. If the fat content of the meat increases, the water level can decrease. Moisture content in pork muscle often has a significant negative relationship with pork fat content Soeparno [13]. According to Rosydi et al. [18], high water levels can be caused by the age of young animals, due to the formation of protein and pork fat that has not been perfect.

3.2.2. Fat content. Based on the results of studies of fat content in pigs Landrace fed cassava by-products ranged from 3.84-9.80%. This illustrates that the fat in pigs Landrace is still in the normal range. According to Soeparno [16] the content of muscle fat can vary greatly between 1.5-13%. Armini et al. [15] also stated that the fat content in pigs Landrace ranges from 3.77 to 4.14%.

From the results of the study (Table 3) showed that the lowest fat content was at P3 (3.84%). This is closely related to the use of cassava by-products, it can reduce the fat content of the feed. This is in accordance with the statement of Soeparno [6] which stated the nation, age, species, location, muscles, and feed are factors that can affect the level of meat fat. Buckle et al. [10] also added that the chemical composition of muscle (meat) is not the same for each animal, diversity occurs due to differences in age, breed, nationality, sex, condition of livestock, muscle type and animal feed. According to Soeparno [6], meat fat content is negatively correlated with pork water content and pork protein content, the higher the fat content, the lower the meat water content.

3.2.3. Protein content. Based on the results of research on protein content in pigs Landrace fed cassava by-products ranged from 19.33 to 22.53%. The results of this study are not much different from research Armini et al. [15] which stated that the protein content in pigs Landrace ranges from 16-22%. This result is still within the normal range of pork protein. Based on statistical protein content in pigs Landrace does not differ from each treatment. According to Judge et al. [19] differences in protein composition in pork can be caused by differences in growth, nation, age, muscle location and feed. Cattle fed concentrated feeds have high protein content when compared to animals that only consume plants Soeparno [13].

According to Lawrie [12], meat protein levels vary between different muscles and are inversely proportional to their fat content. Lawrie [12] also added that there are differences in connective tissue protein between different muscles, therefore the level of active muscle protein is higher when compared to the level of passive muscle protein. The activity of muscle protein enzymes might also affect differences in protein values in the muscles Nurwantoro et al. [20].

4. Conclusions
The results showed that the best pH value on P1 (5.00), the best water holding capacity on P1 (51.32%), best cooking loss on P1 (44.99%), the best color on P1 (1.50), the best water content on P1 (78.11%) , the best fat content on P1 (3.84%) and the best protein content on P1 (21.72%). It was concluded that the use of cassava by-products in complete feed for pigs should not exceed 20%.

5. References
[1] Statistics Indonesia 2015 Cassava production and harvest area productivity of cassava in all provinces http://www.bps.go.id January 15, 2019
[2] Directorate General of Livestock and Animal Health 2014 Strategic Plan http://ditjenpkh.pertanian.go.id/userfiles/download/Renstra_Ditjen_PKH_(2010-2014).pdf?time=1484186785022 July 30, 2019
[3] Riasari JR 2015 Differences in characteristics of beef and pork Paper I Meat Hygiene (IPH 711) (Bogor: Faculty of Animal Science, Bogor Agricultural University)
[4] Anderson LL 2000 Pigs In: Hafez ESE and Hafez B (Eds) Reproduction in Farm Animals 7th Ed. (USA: Williams & Wilkins) p 182-191
[5] AOAC 2005 Official Methods of Analysis Association of Official Analytical Chemist
[6] Soeparno 2009 Meat Science and Technology 5th Edition (Yogyakarta: Faculty of Animal Science, University of Gadjah Mada)

[7] Steel R G D and J H Torrie 1995 Principles and Procedures of Statistics 2nd Edition (London: McGraw-Hill International Book Company)

[8] Kristiawan I M, N L P Sriyani and I N T Ariana 2019 The Physical Quality of Pigs Landrace Traditionally Crossed Crosses. Journal of Tropical Animal Husbandry (Denpasar, Bali: Faculty of Animal Husbandry, Udayana University)

[9] Septinova D, Riyanti, V Wanniatie 2016 Basic Technology for Animal Products Textbooks. (Bandar Lampung: University of Lampung)

[10] Buckle K A, R A Edwards, G H Fleet and M Wooton 1987 Food Science Translation: Purnomo and Adiono (Jakarta: Universitas of Indonesia Press)

[11] Sriyani N L P, R N M Artiningsih, S A Lindawati and A A Oka 2015 Comparative Study of the Physical Quality of Balinese Pork Meat with Pigs Landrace Cross-Cutat Traditional Slaughterhouses. Animal Husbandry Scientific Papers (Denpasar, Bali: Faculty of Animal Husbandry, Udayana University)

[12] Lawrie R A 1995 Meat Science 5th Edition Translation Aminudin Parakasi (Jakarta: Universitas of Indonesia Press)

[13] Soeparno 2011 Science of Nutrition and Nutrition for Meat (Yogyakarta: Gajah Mada University Press)

[14] Forrest J C, E B Aberle, H B Hedrick, M D Judge and R A Merkel 1975 Principles of Meat Science (San Francisco, CA: WH Freeman and Company)

[15] Armini N M A, N L P Srilani and T I Putri 2019 Chemical Quality of Pork Landrace Crosses Traditionally Connected at Different Times. Journal of Tropical Animal Husbandry. (Denpasar, Bali: Faculty of Animal Husbandry, Udayana University)

[16] Winarno F G, S Fardiaz and D Fardiaz 1994 Introduction to Food Technology (Jakarta: PT Gramedia)

[17] Vance R D, H W Ockerman, V R Cahill and R S F Plinpton 1971 In beef carcass evaluation of chemical composition, as related to selective measurements used. J Anim Sci 33: 744-749.

[18] Rosyidi D, A Susilo and R Muhbianto 2009 Effect of Addition of Aspergillus niger Fermented Shrimp Waste to Feed on Physical Quality of Broiler Chicken Meat. Journal of Animal Product Science and Technology Vol 4 (1): 1-10.

[19] Judge M D, H B Aberle, J C Forrest, E D Hendrick and R A Merkel 2001 Principle of Meat Science 4th Edition (Lowa: Kenda/Hunt Publishing)

[20] Nurwantoro V P, Bintoro, A M Legowo, A Purnomoadi 2012 Meat Processing with a Marinated System to Increase Food Safety and Added Value (Semarang: Faculty of Animal Husbandry, Dipenogoro University).