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Chapter 5

Meat Quality of Indonesian Local Cattle and Buffalo

Henny Nuraini, Edit Lesa Aditia and
Bram Brahmantiyo

Additional information is available at the end of the chapter

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Abstract

Indonesia have alot of indigenous of cattle breed that already adapted with local condition like bali cattle, madura cattle, ongole crossbred cattle, sumba ongole, aceh cattle and other. The purpose of this review was to determine the quality of meat from local cattle and buffalo in Indonesia. Livestock products in Indonesia must follow ASUH rules that are Aman (safe), Sehat (healthy), Utuh (Wholesomeness) and Halal. Halal food is food that is free from any components that Muslims are prohibited to consuming. The critical point of halal to the product of animal origin is the animal species, the slaughtering process, the distribution until the process of preparing the product for the consumer. Local beef cattle and buffalo meats were more red, tough (warner bratzler shear force > 4.6 $kgcm^{-2}$), low flavor (marbling, texture and juiceness) than imported meat. Some of the circumstances causing the low quality of meat in Indonesia are most of the breeders employing cattle and buffalo, low quality of feeding, older slaughter age and handling before and at the time of slaughtering process that does not pay attention to aspects of animal welfare. Efforts to improve livestock management, selection and crosses with *Bos taurus* breeds.

Keywords: meat quality, local cattle, buffalo, meat tenderness, muscle microstructure

1. Introduction

Local livestock is crossing cattle or introduction from outside that has been bred in Indonesia until the fifth or more generation has adapted to the local environment and/or management (the Law No. 18/2009 on Husbandry and Animal Health). Indonesian local cattle include bali cattle, ongole crossbreed cattle, madura cattle, sumba ongole, aceh cattle and others, as well as buffalo marshes and river buffalo. The main source of meat in Indonesia comes from local

cattle and buffalo, and beef is a livestock commodity that became the main source of animal protein and became one of the main foodstuffs in Indonesia.

The population of cattle in 2017 is 16,599,247 head and buffalo only about 1,395,191 head. Bali cattle is the breed cattle with the highest population when compared with other cattle such as ongole cattle, ongole crossbreed (PO) cattle, aceh cattle, pasundan and madura cattle. Farmer's demand on bali cattle are great because they have many benefits, such as having high reproduction efficiency, fast breeding, potential in producing meat with high carcass percentage and also have a good adaptability to the environment.

Ref. [1] reported that Kebumen district is feasible to be a source of PO cattle breeding because the reproduction of PO cattle in this area is good enough and its population dynamics are expected to increase from 2015 to 2019. Local ciamis cattle have carcass percentage which is not different from Bali cattle, PO and crosses cattle. Local ciamis cattle have a closer genetic distance to PO cattle [2]. Each area has a specific cattle breed, such as Aceh, West Sumatra (pesisir cattle), West Java (pasundan cattle), and the breed's wider spread is a bali cattle and ongole cross breed cattle. In addition, the potential of buffalo in several regions of Indonesia, such as Banten, West Sumatra, Demak, West Nusa Tenggara also make this livestock as a source of meat in Indonesia [3].

The diversity of local feeds in Indonesia also creates different feed quality between regions. Agricultural areas produce agricultural waste that can be used as a source of feed [4]. The use of sorghum silage in cattle fattening could increase meat production by 12.7% with the best growth response achieved by ongole crossbreed cattle. Several other studies also suggest that local cattle provide a rapid growth response through the fattening process [5–7]. The research results showed that local cattle (sumba ongole) with high energy rations have a weight of life and value higher marbling, and more efficient use of ration compared to low energy and medium energy ration. Production performance and quality of local beef can be improved through fattening with rations high energy [6]. To meet the needs of meat and improve the quality of local beef, Indonesia also imports several breeds such as brahman cross, simmental, limousine and angus. The imported cattle have adapted well, even crossed with local cattle in order to improve the quality of meat [8].

Indonesia with a variety of ethnic, cultural and custom has a variety of cuisine based on meat cooked by the method of wet cooking. Wet cooking methods in Indonesia are grouped into several techniques that used the basic ingredients of water to cook it. Wet cooking techniques are boiling, poaching, braising, stewing, simmering, and steaming. This cooking technique actually adjusts to the quality of meat in the market. Beef or buffalo derived from local livestock is generally less tender so it is suitable with wet cooking techniques.

Application of the concept of quality at this time is very important, so that the resulting product can compete in domestic and foreign trade. The term quality means fitness for use [9]. The definition is universal that can be applied to all types of goods and services. The concept is oriented to the assessment or views of consumers as users of goods or services. If the goods

produced by the manufacturer match or in accordance with the wishes of consumers, then the goods or services have a good sale value. According to [10] the definition of meat quality is a measure of the characteristics or characteristics of meat assessed by consumers.

The quality of the meat is a special part of the quality of production (production quality) and should clearly be distinguished from the quality of production. The assessment of carcass composition is one part of the quality of production, although it may be a factor influencing the quality of meat. The ecological and animal welfare aspects are part of the quality of production [11]. Furthermore, these factors can be categorized into factors prior to slaughter and factors after slaughter. The assessment of meat quality is an attempt to predict the nature of palatability, processing and cooking of meat. The nature of palatability of meat means acceptable ingredients of meat (fits) with the senses of the eyes, nose and ears [12]. Indonesia's condition with tropical climate, unstable feed quality and traditional rearing management caused the quality of beef and buffalo not to compete in the international market [13]. This situation creates two different meat markets in Indonesia, that is, traditional markets and specific markets (for hotel, restaurant and catering).

The purpose of this review was to determine the quality of local beef and buffalo meat in Indonesia.

2. Meat quality

The quality of meat is a special part of a product quality that is a combination of several important factors when it comes to using the product. When described in an equation, the quality of meat [11] is:

$$Q = \Sigma fi \, . \, xi \tag{1}$$

where: Q = quality; f = weighting of the assessed factors from 0 to 1; x = the factor itself.

What matters is the assessment and determining factors are different for each person and also depend on the purpose of performing a quality assessment.

The quality of production will affect the quality of the product such as the occurrence of DFD (dark, firm, dry), hygiene of the slaughter process and aging after the post mortem process. Production quality also affects judgments, for example, from ecological aspects, such as religion, ethnicity and ethics, are currently receiving much attention from consumers. Indonesia has the largest Muslim consumer, so the religious aspect of halal meat is very important.

Assessment of nutritional aspects, as part of hygiene indicators and some technological factors such as pH or myofibril protein content can be measured by chemical analysis. Microbiological aspects as part of hygiene indicators can be evaluated by indicators such as ATP and pyruvate detection or cell differentiation and cell counting. Technological characteristics can be measured physically such as water holding capacity and shear force to measure

tenderness. Sensory assessment is a very difficult part to measure in meat quality assessment, this is because it involves the factor of subjectivity in the assessment.

Briefly it can be mentioned that the quality of production and product quality consists of several factors that can be described and measured objectively, where the quality of production affects product quality. While the assessment is a subjective illustration to determine the likes or dislikes by consumers. The description illustrates that the quality of meat is a combination of several assessments and could be divided into:

1. religious aspect
2. sensory quality
3. nutritional quality
4. hygienic and toxicological quality
5. technological quality

Factors affecting of meat quality characteristics can be classified on the physical and chemical properties of meat (called internal factors = internal determinants/IDs) and external factors of meat or livestock. Some internal factors have a direct influence on the characteristics of meat quality (e.g. the concentration of myoglobin affects the color of the meat). However, for some of its indirect effects. For example, two important livestock characteristics, namely genotype and sex are internal factors, but their effect on quality through indirect media.

Internal factors that affect the quality of meat can be divided into primary and secondary internal factors, depend on direct or indirect influence. Primary internal factors such as connective tissue, muscle fiber size, mixed muscle fiber types, concentration and muscle glycogen content, degree of fat and adipose tissue composition. Secondary internal factors include solubility and collagen concentration, metabolic characteristics, muscle ultimate pH, myoglobin form, degree of muscle contraction, fat pigment level, fatty acid proportion. But in reality, the relationship between these factors can occur more than two or three aspects. Changes in meat quality patterns can be estimated due to the growth process. Besides, the influence of other factors such as genotype and nutrition will also affect the pattern of change.

Other factors that affect the quality of meat are external factors. External factors are technical factors as how to handle livestock before, during and after the slaughtering process. Handling or treatment before livestock is slaughter, duration of resting and fasting of livestock. Furthermore, the process of slaughter, electrical stimulation and aging/chilling process will have a lot of effect on the quality of meat.

3. Quality of Indonesian local meat

In this section we will describe the quality of Indonesian local cattle and buffalo, both qualitative and quantitative. Livestock products in Indonesia must follow ASUH rules that are Aman (safe),

Sehat (healthy), Utuh (Wholesomeness) and Halal. To meet the needs of domestic meat, local beef and buffalo showed the same quality as beef crossbreed cattle [14]. The results showed that physical and chemical quality of local beef cattle (ongole grade) was not different from crossbreed cattle. Independent *t* test was no different for the variable: water content, protein content, fat content, pH, WHC and texture. However, other researchers reported that the slaughter weight of the Bali cattle and Madura cattle are generally below average (270.30 ± 63.07 kg) of optimal slaughter weight, so the productivity of cattle with this small frame size is still low, preferably small frame size beef cattle is slaughter if the level of body fatness is fat [15]. Slaughter weight of Madura cattle to meet the traditional market demand is 338.07 kg [13] and Bali cattle which is intensively fattened, able to achieve slaughter weight 343.017 kg [5].

3.1. Religion aspects

Islam as religion has a quality criterion for a very important product that is halal. Halal food is food that is free from any components that Muslims are prohibited to consuming. The growing awareness of Muslim consumers about their religious obligations is halal food, creating greater demand for halal food and other consumer goods. Indonesia is currently a potential market for halal food considering that over 80% of the population is Muslim. Halal meat is one of the products that should receive special attention. The critical point of halal to the product of animal origin is the animal species, the slaughtering process, the distribution until the process of preparing the product for the consumer.

This religious aspect is to help ensure food safety for consumption through adherence to good animal feeding practices at farm level and good manufacturing practices (GMP) during the procurement, handling, storage, processing and distribution of feed and animal feed ingredients in the production process. The main focus is on halal practices and safety in animal and meat production systems. Topics of concern such as animal welfare issues in livestock production, livestock processing, the concept of halal and religious issues. Halal assurance system developed by Indonesian Council of Ulama is already used in many countries around the world. It provides safety and comfort for consumers.

3.2. Sensory quality

Eating quality or palatability is determined by a single consumer response or a combination of factors such as flavor, juiceness and the tenderness of cooked meat. Assessment of sensory factor of meat is generally done by panel test by using hedonic scale. At this time some sensory indicators can be assessed quantitatively by using equipment. Indicators commonly practiced by consumers in this sensory assessment including:

1. Meat color

The color of fresh meat is one of the main criteria that consumers pay attention to at the time of purchase. Color of the meat can be determined by a meat pigment called myoglobin. Myoglobin content is influenced by genetic factors of livestock, age, feed, muscle activity, species and slaughtering techniques. Besides, the color of the meat is also determined by the reactions that occur in myoglobin. The color of fresh meat favored by consumers is a bright

red color. The dark color of the meat is assessed as meat that has been stored for a long time and has been damaged. The color of the meat that has not been exposed to oxygen is a purplish red, then if it has been oxidized for several minutes it will be bright red. The bright red color may turn red or brown if there is oxidation or if the meat is stored long, or reddish-green if decay has occurred.

Ref. [16] showed no difference in semitendinosus muscle color from angus cross, bali cattle, brahman cross, peranakan ongole and simmental × PO. The results of this study are consistent with [17] that there was no difference in the color of the flesh between cattle *Bos taurus* and *Bos indicus*. Ref. [18] reported that the bright red color is the color of meat expected by consumers. The red color of bali beef is more darker ($P < 0.05$) than wagyu beef.

2. Tenderness

Tenderness is also a major criterion in the assessment of meat quality. If the meat is not tender, that the meat is less acceptable to consumers. Ref. [12] mention that tenderness means a quality that represents a number of structural properties of skeletal muscle proteins and is associated with all factors affecting muscle and muscle proteins (e.g. growth and development of livestock, nutrition, pre- and post- cooling, processing and cooking). The first time consumers assess the tenderness of meat is when meat first chewed. Therefore, to assess objectively based on processing that occur during mastication (the process of cutting, tearing and pressing).

Ref. [19] grouped Warner-Bratzler Shear (WBS) into four categories: very soft (WBS <3.2), soft (3.2 < WBS <3.9), intermediate (3.9 < WBS <4.6), and hard (WBS > 4.6). The strength of cut is negatively correlated with tenderness, the higher on cutting strength value mean lowest level of tenderness or tough. Ref. [20] reported that the lowest cutting strength value in male buffalo (7.17 ± 2.69 kg cm^{-2}) and female buffalo (5.89 ± 3.54 kg cm^{-2}) were present at approximately 1 year (tooth turn I0). Highest on WBS value of buffalo meat mean this meat was tough. Tenderness value of bali beef (5.8 ± 1.7 kg cm^{-2}) and brahman cross (6.3 ± 1.3 kg cm^{-2}) was not different, and angus cross beef (2.5 ± 0.3 kg cm^{-2}) had the lowest WBS value, in other words angus cross beef is more tender than other beef cattle [16].

3. Flavor

Flavor is also an important sensory aspect in consumer acceptance of meat products. It is estimated that about 1000 volatile compounds that have been identified are present in various meats (cattle, chickens, pigs, sheep and goats).

There is no qualitative difference between the types of compounds present among the livestock species, but there are differences in quantitative terms. For example, the concentrations of 3.5-dimethyl-1,2,4-trithiolane and 2,4,6-trimethylperhydro-1,3,5-dithiazine (thaidine) compounds in mutton were higher than other livestock species. While the aroma of beef is more influenced by mercapto thiophenes and mercaptofuran compounds [21]. Another indicator of this sensory rating is the amount of marbling, texture and juiceness.

3.3. Nutrient quality

Nutrients contained in the meat also entered into consideration consumers to choose meat. Meat as a protein source has a complete amino acid composition and high digestibility as

well as macro and micronutrients, all of which are essential for good health throughout life. The healthiest balanced diet will include moderate amounts of lean meat, along with enough carbohydrates, fruits and vegetables, also milk and other dairy products. How much red meat should be consumed? According to the report of The Scientific Advisory Committee on Nutrition (SACN) on "Iron and Health 2010" led to new guidance on eating red and processed meat. Advice for adults, their intake is an average of 70 g daily [22].

Nutrient meats such as protein content, amino acid composition, fat content, fatty acid composition, minerals and vitamins can be chemically analyzed or biochemically. In principle a common method can be used but there are some inappropriate methods used in meat analysis. For example, to determine the protein content can be used Kjeldahl method. This method is less appropriate to use because meat protein consists of several kinds of myofibril protein, sarcoplasmic, NPN and connective tissue. For that reason BEFFE method can be derived from Germany [11]. At 100 g of beef contains 201 Kcal, 18.8 g protein, 14 g of fat, 11 mg of calcium and 2.8 mg of iron. Meat protein can help produce muscle tissue. The red color produced from beef contains a lot of iron. This iron that will produce hemoglobin which will deliver oxygen from the blood to all new muscle cells, the production of antibodies and protect the body from infection. Ref. [23] states that the average muscle protein content of longissimus dorsi aceh cattle is 15.94% with fat content of 5.63%.

The chemical composition of meat varies depending on location and function of muscle in the body. The muscles present in active organs contain more protein content compared to the muscles at the passive organs. Ref. [24] reported the content of bali beef nutrient i.e. ash content, protein content and carbohydrate levels of active muscle is higher when compared with passive muscle value ($P < 0.05$). While fat and water content of active muscle was low when compared with passive muscle. Ash content, protein and carbohydrate content of active muscle (0.99, 16.60, 5.99%) and the content of passive muscle respectively (0.90, 14.60, 4.32%). Fat and water content of active muscle (6.30, 70.08%) and for passive muscle (6.54, 72.99%).

3.4. Hygiene and toxicology quality

Hygiene factors in meat can be divided into two parts, namely the presence of residue in the meat and microbiological aspects. Both of these aspects are health-oriented. In consumer ratings, hygiene factors are often more important than nutritional factors.

Meat and processed products do not contain natural toxins, but can occur contamination and use of additive(s). Antibiotics can be found in meat if the animal is slaughter before the drug withdrawal (withdrawal time) runs out. Use of antibiotics is usually done in the process of treatment or use in the feed. Other residues can also occur in meat processing.

3.5. Technology quality

Consumers in addition to attention to hygiene factors are also carried out assessment of technological factors. Texture, water-binding power and pH can be felt from the hardness, juiceness and the taste of sour or tasteless. Meat experts say that technological factors are closely related to meat processing. Indicators closely related to this processing include: pH and water holding capacity.

(1) pH

The pH value of meat may indicate a deviation of the quality of the meat, since the pH value of the meat is related to the color, tenderness, taste, water holding capacity and the shelf life of the meat. The isoelectric pH points of the meat proteins are between 5.0 and 5.1 with a normal pH range of 5.5–5.8.

If pH > 5.8, then there are two possibilities of normal or DFD (dark, firm, dry). The second pH test is done at 24 hours after cutting, if pH > 6.2 means the meat is DFD, whereas if the pH is about 5.5 means the meat is normal [25]. Ref. [26] reported that meat with high pH_u has a low tenderness value.

Ref. [27] compares the physical characteristics of ongole crossbreed beef at different body weights. The results showed that body weight has a very low correlation with pH value of meat, that is, 0.192 in *Longissimus dorsi* (average pH value of 5.59) and 0.000 on *bicep femoris* (average pH value of 5.57). Ref. [18] reported that pH bali beef is no different from wagyu beef.

The pH value of meat is generally more influenced by the factor at the time of the slaughter process.

(2) Water holding capacity

Water is the most important part in meat composition. Meat contains about 75% water. Muscle protein (myofibrillar) plays an important role in water binding, which determines the quality of meat and its processed products [28].

Water holding capacity is the ability of the meat (especially myofibrillary proteins) to bind water or water added during external influences (e.g. meat cutting, heating, grinding and pressing). Ref. [29] found that water holding capacity of buffalo meat is not affected by age, but it is affected by sex during the storage period of 0, 24, and 48 hours. Result of analysis show water holding capacity of buffalo meat is not influenced by age and sex [20]. There is no difference in water holding capacity of bali beef and wagyu beef [18]. Ref. [16] also reported that there was no difference in binding power of brahman cross beef, bali cattle, ongole cross-breed cattle and simmental × ongole crossbreed cattle on *Semitendinosus* muscles.

4. Relationship of muscle microstructure and meat quality

Carcass is composed of meat, fat, adipose tissue, bone, cartilage, connective tissue and tendon. Muscle turns into flesh after cutting process because its physiological function stops. Muscle is the main component of meat constituents. All muscles have the same basic structure, consisting of muscle cells or fibers that are intertwined together in bundles and form larger groups. Collagen is the most important component related to meat texture. Collagen of old animals grow larger and they have more cross-linked connective tissues, causing the meat to become tough and less tender [12].

Muscle is composed of many bundles of muscle fibers commonly called fasciculi. Fasciculi consist of muscle fibers, whereas muscle fibers consist of many filaments called myofilaments. Connective tissue is composed of an epimysium located around the muscle, perimysium containing blood vessels, and relatively larger nerves located between fasciculi and endomysium containing amorphous component, non-fibrous tissue with fine woven binders surrounding muscle cells or muscle fibers [29].

Muscle fiber is composed of myofibrils containing many myofilaments. Myofibril is an organelle of cylindrical muscle fiber with a diameter of approximately 1–2 μm. A muscle fiber that has a diameter of 50 μm contains 1000–2000 myofibrils. Myofibril consists of segments called sarcomere. The length of sarcomere at rest is approximately 2.5 μm. Sarcomeres have two forms of myofilaments, namely thick filaments (myosin) with a diameter of 10–12 μm and thin filaments (actin) with a diameter of approximately 5–7 μm. The lighter portion of myofibril is called I band, while the thicker part is called A band. I band and A band are arranged in longitudinal parallel within muscle fibers, which causes the cross section of skeletal muscle fibers to appear transverse [12, 30]. Increasing number of muscle cells during prenatal growth can be indicated from the addition of the amount of muscle per fasciculus. Increased muscle size during postnatal growth can be indicated from the addition of muscle cross-sectional area.

Observations on histology of muscle not only result in obtaining images or descriptions of muscle tissues (existence of muscle fibers, connective tissues and intramuscular fat tissues), but also in discovering the size of the tissues (such as diameter of muscle fiber, diameter of fasciculus, and thickness of connective tissue). Nuraini et al. [20] state that the average diameter of muscle fibers of buffalo meat, which is 38.32 ± 1.9 μm, increases under 1 year of age ($I._0$) and reaches the highest point at the age of 3 years (I_3) with 54.95 ± 8.6 μm ($P < 0.05$). This is in line with the decline of buffalo meat tenderness level, which is 6.53 ± 2.89 kg cm^{-2} (under 1 year of age) to 9.63 ± 1.45 kg cm^{-2} (3 years of age). Ref. [29] mentions that many factors affect the diameter of muscle fibers, such as the level of nutrition, the rate of postnatal body weight development, the level of muscle performance and the age of livestock.

Ref. [31] describe the histology and histomorphometry of bali beef and wagyu beef. It appears that the muscle cell diameter (75.00 ± 1.72 μm) and fat cell (195.20 ± 2.17 μm) of wagyu cattle were larger than the muscle cell diameter (45.00 ± 1.89 μm) and fat cell (90.10 ± 2.69 μm) of bali cattle. Foreign tourists in Bali prefer wagyu beef than bali beef. This is partly because wagyu beef is more tender. Histologic observation results in wagyu cattle muscle illustrates that the connective tissue of wagyu beef is very little so that the meat is more tender.

Samples of muscle histology can also be used to discover the thickness of connective tissue that can be an indicator of the level of meat tenderness. Thickness of connective tissue of female buffalo at I_0 age (15.59 ± 2.00 μm) is smaller than at I_2 age (16.29 ± 5.96 μm) and at I_3 age (18.2 ± 5.81 μm) [20]. This condition illustrates that there is an increase in connective tissue as the livestock ages. It is related to the level of collagen in animal tissues. Collagen is the principal protein component of connective tissue and has a major influence on toughness of meat [30]. Collagen of old livestock is more stable against the influence of temperature change, which results in formation of thicker and larger connective tissue. An increase in livestock age

is related to increased level of pyridinoline. The level of *pyridinoline* in younger livestock is lower, making collagen labile against heat.

Efforts to improve the quality of local livestock, in this case cattle and buffalo, have been conducted in various methods, both physical (e.g. aging, cold/frozen storage) and chemically (e.g. using protease enzymes). Refrigerator storage causes the split muscle fibers. Increase in period of freezer storage can result in separation of muscle fibers as well as structural damage to muscle shape caused by ice crystal formation. The fourth day of storing meat inside freezer (−10 ± 1°C) shows mild damage. It is the beginning of muscle fibers cracking. On the 60th day, the structural damage of muscle fibers becomes more severe with ice crystals pressing and tearing cells. On the 75th day, the damage of muscle fibers becomes greater than the 60th day with greater intercellular distance [32].

According to [33] the diameter of muscle fibers of buffalo meat is not influenced by sex difference, but influenced by age difference during different storage periods. The data of research results conducted by Rao et al. [33]. The decrease in muscle fiber diameter occurs gradually from 0 to 48 hours of storage period inside freezer (−15 ± 1°C), so as to increase the tenderness of meat during the period of aging. Freezing also affects the structure of muscle fiber diameter due to histological changes in muscle tissue during frozen storage. Muscle fibers of female buffalo that were stored inside freezer at a temperature of −12°C for 35 days had less structural damage when compared to muscles stored for 79 days. Increased storage time of meat inside freezer can increase the damage of muscle fibers, so that connective tissue and the distance between muscle fibers become more easily decomposed due to the process stretching. Such damage is most likely to result in myofibril alterations.

Another treatment to improve tenderness in meat is to use enzymes, such as papain or bromelain enzymes. Related to [34], the tissue structure of beef samples not treated with bromelain enzyme is seen to have intact-shaped structures of myofibril and sarcolemma. Meanwhile, the myofibrils structure of meat samples soaked with bromelin enzyme for 1 and 4 hours looks incomplete, or in other words, has endured degradation. Descriptively, the alterations that occur in the myofibril structure indicate that giving treatment of bromelin enzyme can improve the tenderness of meat.

5. Conclusion

Summarizing the various studies of meat quality in Indonesia, it is illustrated that the quality of local meat for some criteria such as pH, water holding capacity, cooking loss, meat color, fat color, nutrient content, basically does not differ between local beef cattle and imported beef. The difference is seen in the fatty, degree of marbling and tenderness that will affect the juiceness of meat. But if it is connected with how to process the majority of Indonesian cuisine, which is wet cooking, like *rendang* and *semur,* meat quality already meet the requirements of consumer's preference. For cooking menu that uses dry cooking like barbeque it can be treated like aging with long period or using tenderizing like bromelin or papain enzyme.

Some of the circumstances causing the low quality of meat in Indonesia are most of the breeders employing cattle and buffalo, low quality of feeding, older slaughter age and handling before and at the time of slaughtering process that does not pay attention to aspects of animal welfare. The meat industry in Indonesia is only able to form two market segments namely the local market for middle to lower class consumers and special markets for hotel, restaurant, catering and franchise consumers. Efforts to improve livestock management, selection and crosses with *Bos taurus* breeds are expected to improve local livestock performance in Indonesia.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author details

Henny Nuraini[1,2]*, Edit Lesa Aditia[1,2] and Bram Brahmantiyo[3]

*Address all correspondence to: hennynuraini@ymail.com

1 Department of Animal Production and Technology, Faculty of Animal Science, Bogor Agricultural University, Jl. Agathis Bogor Agricultural University, Darmaga, Bogor, West Java, Indonesia

2 Halal Science Center, Bogor Agricultural University, Indonesia

3 Assessment Institute for Agricultural Technology, Ministry of Agricultural, Tidore Kepulauan City, North Malucas, Indonesia

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