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Korean Native Black Goat: A Review on its Characteristics and Meat Quality

Abstract

The Korean native black goat (*Capra hircus coreanae*, KNBG) is an indigenous breed of Korea, consisting of four registered strains: Jangsu, Tongyeong, Dangjin, and the Gyeongsang National University strain. KNBG meat is highly valued for its health benefits, including low levels of saturated fat and cholesterol, along with high levels of protein, calcium, and iron. It is a rich source of essential amino acids and other bioactive compounds, including L-carnitine, creatine, creatinine, carnosine, and anserine, which contribute significantly to maintaining good health. The increasing popularity of KNBG meat has expanded its culinary applications, including its use in various traditional dishes. Herbs and spices are often employed to further mitigate its distinct aroma and increase consumer appeal. This review highlights the distinctive attributes of KNBG, focusing on its nutritional composition, bioactive compounds, and meat quality. It underscores its potential as a health-promoting food source and explores innovative pathways for product development to address market challenges. Further research is needed to clarify KNBG's health impacts, ensure the authenticity and integrity of goat meat considering regulatory shifts, and optimize its role as a sustainable, health-promoting food for domestic and global markets.

Keywords: Korean Native Black Goat, meat quality, volatile organic compound

Introduction

The goat population in Korea surpasses 500,000 heads, encompassing a variety of breeds, including the Australian Feral, Boer, Nubian, and Saanen. Among these, the Korean Native Black Goat (KNBG; *Capra hircus coreanae*) is the only indigenous breed. Traditionally, KNBG has been highly valued for its extract, renowned for its medicinal properties and are particularly beneficial for pregnant women, older adults, and adolescents (Akter et al., 2024). Recently, there has been a noticeable shift towards using KNBG meat in regular meals, including roasted dishes, boiled preparations, and soups. This transition is influenced by growing awareness of its nutritional value and health benefits, leading to a notable rise in its consumption as part of a balanced diet (Kim et al., 2020a).

In addition to its growing popularity, KNBG meat offers substantial nutritional benefits. It is a rich source of high-quality protein and bioavailable heme iron to support dietary requirements. The meat's low cholesterol and fat content further establishes its status as a healthy red meat alternative. Furthermore, KNBG meat contains high levels of unsaturated fatty acids (UFAs) and polyunsaturated fatty acids (PUFAs), which are linked to a reduced risk of cardiovascular diseases and stroke. KNBG meat is also characterized by its distinct aroma and flavor, often described as earthy or gamey, typical of goat meat (Aung et al., 2023; Chen et al., 2012). While these sensory traits are appreciated by some consumers, they may deter others due to the pronounced odor. To enhance its quality and market acceptance of KNBG meat, researchers have explored various strategies, such as crossbreeding, dietary modifications, and castration techniques (Choi et al., 2007; Chung et al., 2007; Hwangbo, 2015; Hwangbo et al., 2008; Hwangbo et al., 2009; Jung et al., 2008).

This review provides a comprehensive summary of recent findings on KNBG meat quality, including its nutritional value, strain diversity, and productivity. It aims to support further research and practical applications in food product development, livestock management strategies, and public health promotion.

KOREAN NATIVE BLACK GOAT

Diversity of KNBG breeds

Three predominant KNBG strains—Jangsu, Tongyeong, and Dangjin— are recognized as Korean purebred goats in the Domestic Animal Diversity Information System (DAD-IS) of the Food and Agriculture Organization of the United Nations (FAO) (Kim et al., 2021c; Lee et al., 2020b). The Jangsu strain is prevalent in Beo-nam-myeon, Jangsu-gun, Jeollabuk-do Province; the Tongyeong is concentrated in Yokjido, Tongyeong, Geongsangnam-do Province; and the Dangjin strain is commonly found in Anmyeondo, Taean, Chungcheongnam-do Province. Morphologically, Jangsu and Tongyeong strains typically characterized by black coat color, while the Dangjin strain often exhibits long black or dark brown coats (Figure 1) (Lee et al., 2019b). The strains also show differences in features such as wattles, horns, ears, tails, and beards, which aid in their identification. Recently, a new strain, the Gyeongsang-National-University (GNU) strain, was developed at Gyeongsang National University. This strain demonstrates exceptional genetic diversity, particularly in comparison to the Dangjin strain. Its development addresses the increasing demand for high-quality KNBG meat and aims to enhance the breed's traits (Kim et al., 2021c). KNBGs comprise approximately 80% of South Korea's total goat population, highlighting their vital role in maintaining the country's livestock biodiversity (Saturno et al., 2020). To preserve the unique genetic resources of KNBGs, various studies have employed microsatellite markers to evaluate genetic diversity across strains (Kang et al., 2021; Kang et al., 2023; Lee et al., 2020a; Park et al., 2019; Suh et al., 2012). Suh et al. (2012) used 30 microsatellite markers to analyze the genetic diversity of three major KNBG strains, identifying 277 distinct alleles, 102 of which were strain-specific. Expanding on this, Kang et al. (2021) provided a comprehensive evaluation of genetic diversity, including the GNU strain, through comparative analyses with crossbred goats in Korea. Using Neighbor-Joining tree analysis, the study revealed significantly greater genetic distances in crossbred goats compared to KNBG strains (Figure 2). Additionally, the GNU strain exhibited closer genetic proximity to the Jangsu and Tongyeong strains than to the Dangjin strain. This difference is likely due to the geographical proximity of these regions, which facilitates gene flow and results in closer genetic clustering.

Productivity of KNBG

Effective KNBG productivity is influenced by several critical factors, including housing, feeding, and reproduction management. Each of these factors plays a distinct role in optimizing growth, health, and reproductive success. Housing systems are particularly important in KNBG management, with two main approaches commonly utilized: extensive open sheds for shelter and intensive pens designed to optimize population density (Song et al., 2006). Given that many goat farms in Korea are situated in remote areas (Son et al., 2021), approximately 45% of KNBGs are raised on small-scale farms employing diverse housing methods (Son, 1999). For example, a farm in Cheongju, Chungcheongbuk-do, features a barn with a natural soil foundation, rice straw bedding, vinyl-enclosed walls, and an iron panel roof with transparent plastic plates (Byeon et al., 2020). In research settings, metabolic cages are frequently employed for dietary experiments (Cho et al., 2017).

Feeding practices play a vital role in influencing KNBG productivity, particularly through targeted dietary strategies. Recent studies highlight the benefits of high-protein diets incorporating a mix of roughage and concentrated feed. Typically, KNBGs are raised on pasture, with rice straw serving as the primary roughage, supplemented with commercial pellets after weaning (Lee et al., 2019a). During the growing period, they are provided with high-protein alfalfa grass, with alfalfa hay introduced during the finishing stage.

Productivity metrics, such as birth weight and weaning weight, serve as critical indicators of early growth and overall performance. For instance, birth weights for KNBG strains range from 1.9 to 2.3 kg for Dangjin, 2.0 to 2.1 kg for Jangsu, and 1.8 to 2.0 kg for Tongyeong (Table 1). Although KNBGs generally have lower birth weights compared to Boer and Saanen goats, their weaning weights (at 3 months of age) are comparable to Boer goats. This observation suggests their viability as meat-producing goats when appropriate feeding strategies are employed to improve growth and productivity.

However, KNBGs tend to exhibit slower growth rates compared to other breeds (Lee et al., 2019b). Research on growth performance has produced mixed findings. Some studies report no significant difference in daily weight gain (Choi et al., 2007) while others indicate improved performance with specific dietary treatment (Ahmed et al., 2015; Hwangbo et al., 2009). These results point to the need for optimizing diet formulations to enhance growth performance and strengthen the economic potential of KNBGs for meat production.

Reproductive management is another key factor in maximizing KNBG productivity. Female KNBGs reach puberty earlier than other breeds, typically experiencing their first estrus between 121 and 176 days, with cycles lasting 17-25 days (Song, 2003). This early maturity allows for first gestation to occur at 6-8 months, with an average gestation period of 150 days. The initial kidding usually occurs at 382.0 ± 25.2 days in intensive systems and 412.1 ± 32.7 days in extensive systems (Song et al., 2006). Challenges such as delayed reproductive cycles in twin-born females are addressed through strategies like estrus synchronization and semen collection with cryopreservation, which aim to enhance the KNBG population size and improve breeding efficiency (Kim et al., 2019; Kim et al., 2022b; Kim et al., 2021a; Kim et al., 2021b; Lee et al., 2018). Future research should prioritize standardizing methodologies to reduce variability in studies of growth performance and reproductive efficiency in KNBGs. Furthermore, implementing genetic conservation practices for each strain is essential to protect and preserve genetic diversity. These practices should focus on strain-specific growth rates and the potential of crossbred animals, thereby optimizing overall performance of KNBGs.

MEAT QUALITY

KNBG meat is recognized for its rich nutritional composition, characterized by high levels of protein, B vitamins, and essential minerals such as calcium, phosphorus, potassium, sodium, and magnesium (Lee, 2018). It is notably abundant in taurine and glutamic acid, which play vital role in physiological functions such as digestion, antioxidant defense, and immune system support (Ali et al., 2021). Various strategies have been implemented to enhance the quality of goat meat. These dietary modifications, adjustments in slaughter age, advancements in slaughter techniques, and careful optimization of aging periods (Ahmed et al., 2015; Aung et al., 2023; Choi et al., 2007; Hwangbo et al., 2008; Kim et al., 2016; Kim et al., 2012; Lee et al., 2023a; Wattanachant, 2018). Several factors contribute to the distinctive qualities of KNBG meat, such as muscle fiber type, physicochemical properties, bioactive compounds, and volatile organic compounds. These factors significantly influence the overall quality, flavor, and nutritional value of the meat.

Muscle Fiber Type

Skeletal muscle contains three primary fiber types: Type I (slow-twitch oxidative), Type IIA (fast-twitch oxidative-glycolytic), and Type IIB (fast-twitch glycolytic). Type I fibers, darker in color due to high myoglobin content, support endurance and are found in muscles used for sustained activities, such as legs. Type IIA fibers balance endurance and strength with moderate oxidative and glycolytic capacity. Type IIB fibers, lighter in appearance and relying on anaerobic glycolysis, are found in muscles used for rapid and powerful contractions, such as the shoulders and back (Brooke and Kaiser, 1970). The distribution of these fibers affects muscle function and meat quality, influencing tenderness, juiciness, and flavor (Joo et al., 2013).

Extensive research has been conducted on muscle fiber composition in Korean livestock (Table 2), including Korean Native beef cattle (Hanwoo beef) (Hwang et al., 2010; Kim et al., 2000), pork (Cho et al., 2019; Eom et al., 2024; Hwang et al., 2018b), and KNBGs (Bakhsh et al., 2019; Hwang et al., 2019; Hwang et al., 2017). Observed muscles include the *longissimus dorsi* (LD), *longissimus* *lumborum* (LL), *longissimus thoracis* (LT), *psoas major* (PM), *semimembranosus* (SM), and *gluteus medius* (GM). These studies have elucidated differences in muscle fiber types across species, with implications for meat quality attributes such as tenderness, flavor, and overall acceptability.

For KNBGs, the muscle fiber composition offers insights into meat quality across different ages (Table 2). Young goats tend to exhibit a balanced distribution of fiber types, particularly in muscles like the LD and GM, suggesting that their meat provides a desirable mix of tenderness and flavor suitable for a various culinary application. However, adult goats show a higher proportion of Type IIB fibers, particularly in the SM and GM muscles, which may result in tougher, leaner meat. These changes highlight the need for specific cooking methods, such as slow cooking, to enhance tenderness and improve overall eating quality of the meat (Hwang et al., 2019).

Studies on KNBG muscle fiber have shown variations across muscles and slaughter ages (Figure 3, A-D). Research by Hwang et al. (2017) revealed significant differences in muscle fiber area among LL, PM, SM, and GM muscles ($p<0.05$). The PM muscle exhibited the highest area of Type I fibers, while LL and SM had lower percentages. LL had the largest percentage of Type IIA fibers, while SM had the highest percentage of Type IIB fibers, and PM h($p<0.05$). Slaughter age also significantly impacted muscle fiber characteristics, with adult (18 mon) KNBGs showing larger muscle fibers compared to young (9 mon) goats.

Physicochemical composition

The physicochemical properties of meat encompass both its physical and chemical characteristics, each playing a vital role in determining overall meat quality (Anneke et al., 2019). Key physical attributes include color, texture, and pH, while nutrient composition, fat content, and fatty acid profile represent important chemical characteristics. Among these factors, meat color is a critical quality indicator highly valued by consumers. In KNBG meat, color metrics such as brightness (L*), redness (a*), and yellowness (b*) are significantly influenced by the animal's slaughter age (Table 3) (Choi et al., 2023). Younger goats produce meat with a lighter, pinkish-red hue, attributed to lower myoglobin levels —the protein responsible for red color of muscle tissue (Saccà et al., 2019). As KNBG goats mature, increased myoglobin accumulation results in darker, more intensely red meat. Additional factors, including nutrition, cooling rate, muscle type, muscle pH, post-mortem storage conditions, oxygen exposure, and myoglobin concentration, also influence meat color (Jaramillo-López et al., 2021). Intramuscular fat content contributes to yellowness in KNBG meat, with higher fat levels producing a more pronounced yellow hue (Choi et al., 2023).

Apart from age, meat color and overall quality are influenced by breed, diet, and processing methods. For instance, a low-energy diet can result in darker meat, likely due to reduced glycogen reserves, which subsequently lower pH and alter lactic acid production (Gardner et al., 2014). Consumer preferences often favor darker meat, which can be influenced by dietary and processing factors (Hughes et al., 2020). Variations in pH levels are also observed based on sex and rearing conditions, with males typically exhibiting lower pH values than females. Notably, Choi et al. (2023) reported significant reduction in pH levels in the LL muscle of female KNBG x Boer crossbreds slaughtered at a later stage. In contrast, by Bakhsh et al. (2018) found no significant differences in pH, color, or water-holding capacity between head-only electrical stunning and stunning-free methods.

The proximate analysis evaluates the primary components of meat, including moisture, crude protein, crude fat, ash, carbohydrate, and fiber. Research indicates no significant differences in crude protein and fat content between male and female KNBGs (Kim et al., 2020a). This consistency persists across various dietary enhancements, including browses, green tea by-products, alfalfa, or commercial concentrates (Ahmed et al., 2015; Choi et al., 2006; Hwang et al., 2018a; Kim et al., 2022a). KNBG meat is notably leaner than beef, pork, and chicken (Table 4) with protein content ranging from 17.23% to 21.27%, and relatively low fat levels (0.80% to 9.98%). Its high levels of unsaturated fatty acids (UFA), particularly oleic acid, enhance its umami taste and overall palatability of the meat (Table 5) (Kim et al., 2022a).

KNBG meat is also rich in essential minerals such as potassium, sodium, phosphorus, calcium, and iron, which support skeletal structures, nerve transmission, and overall physiological functions. These minerals concentration vary across muscle types, slaughter ages, and cooking methods (Hwang et al., 2018a; Hwang et al., 2017; Kim et al., 2022a; Kim et al., 2020a; Kim et al., 2020b) (Table 6). The meat’s high bioavailability of heme iron and low sodium content make it particularly beneficial for addressing deficiencies in vulnerable populations, such as infants, adolescents, pregnant women, and the elderly (Wood, 2017).

Research on KNBG initially focused on its extract, revealing significant mineral content and health benefits. Early studies, such as those by Kim and Lee (1998), examined the mineral and fatty acid profiles of KNBG extract. Park and Kim (2000a; 2000b) further confirmed its rich mineral composition, including calcium, potassium, phosphorus, magnesium, and sodium. Building on this foundation, subsequent innovations included Song and Jung's (2002) KNBG granular tea infused with traditional herbs, and Song et al.'s (2004) KNBG pills enriched with danggui, licorice, perilla, and ginger. Yang et al. (2011) developed an herbal KNBG extract with potential obesity-suppressing properties, while Ha (2017) introduced a KNBG extract combining bones, vegetables, and mushrooms. Finally, studies by Lee (2017; 2019) led to the development of KNBG black soup with *Epimedium koreanum*, noted for its antioxidant and antidiabetic effects. KNBG meat, particularly in traditional Korean black goat soup (heukyeomso-tang), offers a low-fat, low-cholesterol, high-calcium, and high-iron alternative to beef and pork, renowned for its unique flavors and health benefits (Lee and Kim, 2008).

Consumer preferences for KNBG products reveal a variety of usage patterns and motivations. These preferences are primarily driven by the meat's nutritional profile, low-fat content, and rich umami flavor. Consequently, it appeals to health-conscious consumers seeking alternatives to more common meats such as beef and pork. A comprehensive survey on KNBG meat consumption by Choi et al. (2022b) explored preparation preferences, reasons for selection, and influencing factors. Results showed that 38.2% of consumers prefer KNBG meat in soup, 28% grilled, and 19.9% in tonic extract, with other preferences also noted. Health benefits were cited by 27.9% of respondents as the primary reason for choosing KNBG meat, while 21.1% valued its suitability for families, and 15.8% appreciated its local availability. Positive feedback highlights the meat's nutritional benefits, whereas its distinctive smell and tougher texture are often noted as drawbacks compared to other meats. Additionally, research on KNBG meat has increasingly focused on its application in various meat-based dishes, such as jerky (Baek and Kim, 2024b) and sausage (Park et al., 2020). It has also explored its integration into traditional Korean recipes like bulgogi (Choi et al., 2022a) and tteokgalbi (Lee et al., 2023b).

The bioactive compound of KNBG meat

KNBG meat is a notable source of bioactive compounds - naturally occurring substances that exert positive physiological effects on the body and contribute to various health benefits. Key bioactive components in KNBG meat include L-carnitine, creatine, creatinine, and anserine, each offering distinct advantages. L-carnitine, commonly found in meat and dairy, plays a crucial role in lipid metabolism and has been associated with weight management in obesity (Lee et al., 2016). Creatine supports energy metabolism and shows therapeutic potential in enhancing muscle strength and mass, particularly in elderly populations with age-related muscle wasting and neuromuscular disorders (Chrusch et al., 2001). Creatinine, a byproduct of muscle metabolism, serves as an indicator of renal function and is influenced by muscle mass and high-protein diets (Piéroni et al., 2017). Additionally, anserine and carnosine, found in skeletal muscle and nerve tissues, provide buffering and anti-inflammatory properties (Kaneko et al., 2017). Supplementation with these compounds may enhance cognitive functions and improve blood flow in certain brain regions among older adults.

The levels of these bioactive compounds in KNBG meat are influenced by factors such as sex, castration, dietary composition, and storage conditions (Table 7). Female and castrated goats generally exhibit higher concentrations of bioactive compounds compared to intact goats (Aung et al., 2023). Additionally, goats fed a low-alfalfa diet tend to have elevated levels of these compounds compared to those on a high-alfalfa diet (Kim et al., 2022a). Further studies are needed to elucidate the metabolic mechanisms under different dietary conditions and interventions.

The antioxidant potential of KNBG meat has been evaluated using assays, such as including 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) radical scavenging activity, ferric reducing ability of plasma (FRAP) activity, and oxygen radical absorbance capacity (ORAC). KNBG rib cuts show the highest ORAC activity compared to leg, neck, and loin cuts, exceeding the antioxidant capacity of Korean native black pig meat (Moon et al., 2021). The FRAP assay highlights that KNBG neck cuts possess significantly higher antioxidant activity than other cuts (Kim et al., 2022a). Kim et al. (2022a), noted that the antioxidant activity in KNBG meat may be enhanced by endogenous antioxidants present in concentrated diets, with differences observed between low- and high-pasture-fed goats.

Recent research has extended the focus of KNBG meat to its osteoprotective properties. Akter et al. (2024) investigated the effects of KNBG extract derived from leg and rib bones, highlighting its estrogen-like activity and potential benefits for bone health. The extract demonstrated anti-menopausal effects by promoting MCF-7 cell proliferation and upregulating estrogen-related genes (ERα, ERβ, and pS2). Furthermore, KNBG extract enhanced osteogenesis and mineralization in MC3T3-E1 cells by modulating the Wnt/β-catenin pathway, increasing levels of Runt-related transcription factor 2, osteoprotegerin, and collagen type 1. It also inhibited osteoclastogenesis by reducing the formation and activity of osteoclasts in RAW264.7 cells and downregulating key signaling molecules, including receptor activator of nuclear factor κB and tumor necrosis factor receptor-associated factor 6.

Although current research underscores the potential of KNBG meat bioactive compounds, in vivo studies remain limited and warrant further expansion. Future research should aim to bridge in vitro findings with practical applications in human health through well-designed in vivo models. Specifically, studies should evaluate the impacts of these compounds on lipid metabolism, muscle function, cognitive health, and bone density. Additionally, long-term investigations into the dietary incorporation of KNBG meat could provide critical insights into its potential as a functional food. Such research would not only substantiate its health-promoting claims but also enhance its value in both scientific and consumer domains.

Volatile organic compounds

Goat meat, particularly from intact buck goats such as KNBGs, is known for its distinctive aroma which can attract or deter consumers (Aung et al., 2023). This aroma and its associated flavor are largely influenced by volatile organic compounds (VOCs), which are organic chemicals contributing to sensory qualities. Cooking methods further modulate the flavor profile, enhancing sweetness, saltiness, bitterness, or sourness—flavors often linked to high iron content (Flores, 2023). Advanced analytical techniques, such as electronic nose systems (Kang et al., 2013) and gas chromatography-mass spectroscopy (GCMS) (Kim et al., 2020a; Lee et al., 2023a) have provided detailed insights into the VOC composition of KNBG meat. Table 8 summarizes the VOCs identified under various treatments.

Studies highlight the impact of processing and physiological factors on KNBG VOC profiles. Kang et al. (2013) observed significant differences in VOC profiles between high-pressure processed (HPP) and untreated KNBG meat samples. Compounds such as 9,12-octadecadienoic acid, octadecanoic acid, and 2,6-nonadienal were notably prominent in HPP samples. The oxidation of n-3 long-chain fatty acids produces 2,6-nonadienal, which strongly influences goat meat's flavor due to its low olfactory threshold (Paleari et al., 2008). Indole, a compound linked to boar taint odor, was also detected and is associated with elevated gonadal hormone levels in intact males, leading to consumer aversion due to its fecal-like smell (Flores, 2023; Zhao et al., 2017).

Sex and diet significantly influence VOC profiles within KNBG breeds. Kim et al. (2020a) demonstrated that intact males exhibited higher levels of VOCs, such as 1-hydroxy-2-propanone and 2,4-octadiene, compared to castrated males and females. These differences can be leveraged in marketing strategies to cater to diverse consumer preferences. Additionally, a high-forage diet reduces levels of 2,4-octadiene, contributing to milder flavor profiles in castrated and intact goats (Lee et al., 2023a). Compounds like 1-hydroxy-2-propanone, derived from glucose degradation, impart sweet, caramel-like odors, whereas 2,4-octadiene, linked to fatty acid oxidation, contributes to broader flavor complexity (Piveteau et al., 2000).

Comparative analyses have revealed significant variations in VOC profiles between intact males and female KNBGs. Female rib cuts exhibit higher concentrations of aromatic ethanol and 2-butanol, contributing sweet and oily aromas, respectively (Aung et al., 2023). In contrast, intact males demonstrate elevated levels of 1-octene, a compound associated with irradiation odors in goat meat, and 2,3-octanedione, known for its contribution to a pungent, cheesy aroma (Kim et al., 2020a). Branched-chain fatty acids, particularly those prominent in intact males, further contribute to the development of boar taint odor, influencing the characteristic flavor of KNBG meat (Paleari et al., 2008).

4-methyloctanoic acid (4-MOA), a branched-chain fatty acid, is another key contributor to the distinct aroma of goat meat, often described as "gamey" or "sweaty" (Chen et al., 2012). Its concentration varies based on factors such as age, sex, and diet, with higher levels observed in older intact males due to increased lipid oxidation and hormonal influences (Tangkham, 2018). 4-MOA's low olfactory detection threshold amplifies its sensory impact, often leading to consumer aversion, particularly in markets unaccustomed to goat meat flavors (Salvatore, 2003). Mitigation strategies focus on dietary manipulation, as forage-based diets have shown potential in reducing 4-MOA levels in goat fat (Tangkham, 2018). These dietary adjustments, combined with advanced cooking techniques offer effective strategies to balance goat meat's natural flavor profile and improve consumer acceptance.

MARKET POTENTIAL OF KOREAN NATIVE BLACK GOAT MEAT

The market potential for KNBG meat is significant, particularly in the context of global trends favoring sustainable and health-promoting foods. With its high protein content, low-fat levels, and bioactive compounds such as L-carnitine and creatine, KNBG meat aligns with consumer preferences for functional foods that promote overall well-being. While goat meat is widely consumed in developing countries, its availability in Western markets remains niche, often limited to specialty stores or immigrant communities (Dhanda et al., 2003). However, its exceptional nutritional profile and ecological benefits offer an opportunity to position KNBG meat as a premium option for health-conscious consumers worldwide.

The recent ban on dog meat consumption in South Korea has contributed to a growing interest in KNBG meat (Shin, 2024). This policy prohibits breeding, slaughtering, and distributing dogs for meat and includes strict penalties and financial support for affected businesses. As restaurants and consumers look for culturally acceptable alternatives, KNBG meat has emerged as a favored choice, offering a similar texture and traditional restorative image. This shift in consumer behavior is creating new opportunities for goat meat in the domestic market (Teo, 2024).

Dog meat has historically been associated with traditional Korean dishes like "boshintang," often consumed during Chobok, the hottest summer days, for its perceived health benefits (Lee, 2024; Teo, 2024). However, with the enforcement of the ban, many dog meat sellers and restaurants face challenges, including declining sales. Some have started transitioning to goat meat, particularly KNBG, as a way to sustain their businesses (Ap, 2024). This transition has further boosted demand for KNBG meat and highlighted its cultural and nutritional significance.

In countries where dog meat is also banned, issues with illegal sales have been reported, with dog meat sometimes disguised as goat meat (Zulu, 2024). To address this, the South Korean government is working on developing detection kits to ensure compliance with the law and prevent banned products from entering the market (Seo, 2024). However, the lack of research on KNBG meat, particularly in areas like DNA identification, poses a challenge. Advancing research not only on KNBG's quality but also on its genetic markers could help authenticate KNBG meat and protect its reputation as Korea's original goat breed.

Effective branding strategies could leverage KNBG meat's cultural and culinary heritage in Korea. Traditional dishes like black goat soup (Lee and Kim, 2008) and tteokgalbi (Lee et al., 2023b) can be showcased alongside modern innovations such as sausages (Kang and Kim, 2024b; Lee et al., 2024) and jerky (Aung et al., 2024; Baek and Kim, 2024a; Choi et al., 2024a; Choi et al., 2024b). Emphasizing its eco-friendly production and nutritional value through certification programs can also build trust and appeal to both domestic and international markets. Additionally, addressing challenges like goat meat's unique aroma with innovations such as sous-vide preparations and marinated cuts (Kang and Kim, 2024a; Tangwatcharin et al., 2019; Teixeira et al., 2020) can make it more approachable for new consumers. These strategies position KNBG meat as a sustainable, nutritious, and culturally rich choice for modern diets.

CONCLUSION

KNBG is an indigenous breed known for its low-fat content, bioactive compounds, and nutritional benefits. However, challenges like slow growth rates and limited production hinder its broader adoption. Efforts to address these include enhanced feed strategies, crossbreeding, and genetic conservation. Recent research highlights the potential of flavor-related VOCs, innovative cooking methods, and processed products such as sausages and jerky to improve consumer acceptance. Additionally, the recent ban on dog meat consumption in South Korea has significantly increased the demand for KNBG meat as a culturally acceptable alternative. To ensure the sustainable development of this market, it is crucial for the government to establish and enforce robust policies aimed at preventing fraudulent practices. These include the mislabeling of other meats or non-native black goat products as KNBG. Implementing such measures is essential to safeguard consumer trust, preserve the authenticity of the KNBG brand, and support the local farmers.

Limited in vivo evidence substantiates the health benefits of KNBG bioactive compounds. Further studies on these effects and sustainable livestock practices are needed. Moreover, the development of DNA-based identification methods could support the authenticity of KNBG meat, particularly as the government works to prevent the illegal sale of dog meat disguised as goat meat. Combined efforts to improve meat quality, reproductive efficiency, and population size are essential for positioning KNBG as a premium, sustainable, and culturally significant meat product globally.

References

Ahmed ST, Lee JW, Mun HS, Yang CJ. 2015. Effects of supplementation with green tea by-products on growth performance, meat quality, blood metabolites and immune cell proliferation in goats. J Anim Physiol Anim Nutr 99:1127-1137.

Akter R, Son JS, Ahn JC, Morshed MN, Lee GJ, Kim MJ, An JT, Kong BM, Song J-H, Yang DC. 2024. Korean black goat extract exerts estrogen-like osteoprotective effects by stimulating osteoblast differentiation in MC3T3-E1 cells and suppressing osteoclastogenesis in RAW 264.7 cells. Int J Mol Sci 25:7247.

Ali M, Choi Y-S, Nam K-C. 2021. Physicochemical attributes, free amino acids, and fatty acids of the five major cuts from Korean native black goat. Anim Ind Technol 8:23-33.

Anneke, Wattanachant C, Wattanachant S. 2019. Effects of supplementing crude glycerin in concentrated diet and castration on carcass characteristics and meat quality of Thai Native x Anglo Nubian goats. WJST 16:477-486.

Ap. 2024. Korea publishes compensation plan for dog meat farmers ahead of 2027 ban. The Korea Times. Available: https://www.koreatimes.co.kr/www/nation/2024/09/113_383188.html. Accessed Dec 5 2024.

Aung SH, Abeyrathne EDNS, Hossain MA, Jung DY, Kim HC, Jo C, Nam K-C. 2023. Comparative quality traits, flavor compounds, and metabolite profile of Korean native black goat meat. Food Sci Anim Resour 43:639-658.

Aung SH, Hossain MA, Park J-Y, Choi Y-S, Nam K-C. 2024. Development of semi-dried goat meat jerky using tenderizers considering the preferences of the elderly. Journal of Animal Science and Technology 66:807.

Baek U-B, Kim H-Y. 2024a. Physicochemical Properties of Restructured Black Goat Jerky with Various Types of Ultra-Ground Seaweed Powders. Food Science of Animal Resources 44:483.

Baek U-B, Kim H-Y. 2024b. Physicochemical properties of restructured black goat jerky with various types of ultra-ground seaweed powders. Food Sci Anim Resour 44:483-497.

Bakhsh A, Hwang Y-H, Joo S-T. 2019. Effect of slaughter age on muscle fiber composition, intramuscular connective tissue, and tenderness of goat meat during post-mortem time. Foods 8:571.

Bakhsh A, Ismail I, Hwang Y-H, Lee J-G, Joo S-T. 2018. Comparison of blood loss and meat quality characteristics in Korean black goat subjected to head-only electrical stunning or without stunning. Korean J Food Sci Anim Resour 38:1286-1293.

Brooke MH, Kaiser KK. 1970. Muscle fiber types: How many and what kind? Arch Neurol 23:369-379.

Byeon HS, Jeon BY, Jeong HW, Kim CS, Jang RH, Kang SS, Chae MH, Han ST, Han MN, Ahn B. 2020. Massive human Q fever outbreak from a goat farm in Korea. J Biomed Transl Res 21:200-206.

Chen H, Wang Y, Jiang H, Zhao G. 2012. A novel method for determination and quantification of 4-methyloctanoic and 4-methylnonanoic acids in mutton by hollow fiber supported liquid membrane extraction coupled with gas chromatography. Meat science 92:715-720.

Cho CH, Yang BM, Park NS, Lee HS, Song M, Yi YJ, Heo JM, Wickramasuriya SS, Cho HM, Lee SK. 2017. Relationship linking dietary quercetin and roughage to concentrate ratio in feed utilization, ruminal fermentation traits and immune responses in Korean indigenous goats. J Kor Grassl Forage Sci 37:10-18.

Cho I-C, Park H-B, Ahn JS, Han S-H, Lee J-B, Lim H-T, Yoo C-K, Jung E-J, Kim D-H, Sun W-S. 2019. A functional regulatory variant of MYH3 influences muscle fiber-type composition and intramuscular fat content in pigs. PLoS genetics 15:e1008279.

Choi D-M, Kang K-M, Kang S-M, Kim H-Y. 2023. Physicochemical properties of black Korean goat meat with various slaughter ages. Animals 13:692.

Choi D-M, Kang K-M, Kim H-Y. 2022a. Quality properties of black Korean goat *bulgogi* with various levels of *Lactobacillus acidophilus*. Korean J Food Sci Technol 54:498-504.

Choi D-M, Kim H-Y, Lee S-H. 2024a. Effects of Various Spice Marinades on the Physicochemical and Sensory Properties of Black Goat Jerky. Food Science of Animal Resources.

Choi D-M, Kim H-Y, Lee S-H. 2024b. Study on Ways to Improve the Quality of Black Goat Meat Jerky and Reduce Goaty Flavor through Various Spices. Food Science of Animal Resources 44:635.

Choi S, Hwangbo S, Kim Y, Sang B, Myung J, Hur S, Jo I. 2007. Effects of dietary energy level on growth and meat quality of Korean black goats. JAST 49:509-514.

Choi SH, Choy YH, Kim YK, Hur SN. 2006. Effects of feeding browses on growth and meat quality of Korean black goats. Small Rumin Res 65:193-199.

Choi Y-S, Jeong J-Y, Gu M-J, Jeon D-H, No Y-J, Park J-Y, Nam K-C. 2022b. Survey of actual consumption conditions and consumer perception of black goat. KAIS:467-469.

Chrusch MJ, Chilibeck PD, Chad KE, Davison KS, Burke DG. 2001. Creatine supplementation combined with resistance training in older men. MSSE 33:2111-2117.

Chung J, Kim J, Ko Y, Jang I. 2007. Effects of dietary supplemented inorganic and organic selenium on antioxidant defense systems in the intestine, serum, liver and muscle of Korean native goats. Asian Australas J Anim Sci 20:52-59.

Dhanda JS, Taylor DG, Murray PJ, Pegg RB, Shand PJ. 2003. Goat meat production: Present status and future possibilities. Asian-Australas J Anim Sci 16:1842-1852.

Eom J-U, Seo J-K, Song S, Kim G-D, Yang H-S. 2024. Comparison of chemical composition, quality, and muscle fiber characteristics between cull sows and commercial pigs: The relationship between pork quality based on muscle fiber characteristics. Food Sci Anim Resour 44:87-102.

Flores M. 2023. The eating quality of meat: III—Flavor. In Lawrie's meat science. 9 ed. Toldrá F (ed.). Woodhead Publishing, Sawston, UK.pp 421-455.

Gardner G, Mcgilchrist P, Pethick D. 2014. Ruminant glycogen metabolism. Anim Prod Sci 54:1575-1583.

Ha S-M. 2017. Goat meat and bone and vegetable composite extract composition and the manufacture method. Korea Patent KR101761687B1.

Hughes JM, Clarke FM, Purslow PP, Warner RD. 2020. Meat color is determined not only by chromatic heme pigments but also by the physical structure and achromatic light scattering properties of the muscle. CRFSFS 19:44-63.

Hwang Y-H, Bakhsh A, Ismail I, Lee J-G, Joo S-T. 2018a. Effects of intensive alfalfa feeding on meat quality and fatty acid profile of Korean native black goats. Korean J Food Sci Anim Resour 38:1092-1100.

Hwang Y-H, Bakhsh A, Lee J-G, Joo S-T. 2019. Differences in muscle fiber characteristics and meat quality by muscle type and age of Korean native black goat. Food Sci Anim Resour 39:988-999.

Hwang Y-H, Ismail I, Joo S-T. 2018b. The relationship between muscle fiber composition and pork taste-traits assessed by electronic tongue system. Korean J Food Sci Anim Resour 38:1305-1314.

Hwang Y-H, Joo S-H, Bakhsh A, Ismail I, Joo S-T. 2017. Muscle fiber characteristics and fatty acid compositions of the four major muscles in Korean native black goat. Korean J Food Sci Anim Resour 37:948-954.

Hwang Y-H, Kim G-D, Jeong J-Y, Hur S-J, Joo S-T. 2010. The relationship between muscle fiber characteristics and meat quality traits of highly marbled Hanwoo (Korean native cattle) steers. Meat Sci 86:456-461.

Hwangbo S. 2015. Effects of the grazing of Korean black goats on their reproductive performance and growth performance of goatlings. J Kor Grassl Forage Sci 35:1-5.

Hwangbo S, Choi S-H, Kim S-W, Kim W-H, Son D-S, Jo I-H. 2008. Effects of dietary concentrate levels based on whole-crop barley silage on growth and meat quality in growing korean black goats. JAST 50:527-534.

Hwangbo S, Choi SH, Kim SW, Son DS, Park HS, Lee SH, Jo IH. 2009. Effects of crude protein levels in total mixed rations on growth performance and meat quality in growing Korean black goats. Asian Australas J Anim Sci 22:1133-1139.

Jaramillo-López E, Peraza-Mercado G, Itzá-Ortiz M. 2021. Sampling time and age at sacrifice over pH and meat color in hair sheep. Abanico vet 10:1-8.

Joo S, Kim G, Hwang Y, Ryu Y. 2013. Control of fresh meat quality through manipulation of muscle fiber characteristics. Meat Sci 95:828-836.

Jung G-W, Jo I-H, Hwangbo S, Lee S-H, Song H-B. 2008. Effects of different feeding systems on nutrient availability, nitrogen retention and blood characteristics in native or crossbred Korean black goats. J Kor Grassl Forage Sci 28:341-350.

Kaneko J, Enya A, Enomoto K, Ding Q, Hisatsune T. 2017. Anserine (beta-alanyl-3-methyl-L-histidine) improves neurovascular-unit dysfunction and spatial memory in aged AβPPswe/PSEN1dE9 Alzheimer's-model mice. Sci Rep 7:1-12.

Kang G, Cho S, Seong P, Park B, Kim S, Kim D, Kim Y, Kang S, Park K. 2013. Effects of high pressure processing on fatty acid composition and volatile compounds in Korean native black goat meat. Meat Sci 94:495-499.

Kang H-C, Kim K-W, Kim E-H, Myung C-H, Lee J-G, Lim H-T. 2021. Genetic diversity and relationship analyses of the Korea native black goat line using microsatellite markers. Korean J Agric Sci 48:693-702.

Kang HC, Kim EH, Myung C-H, Kim JY, Song SH, Yang DY, Sun CW, Lim HT. 2023. A study on conservation value evaluation of native black goat using Microsatellite (MS) marker information. JABG 7:37-44.

Kang K-M, Kim H-Y. 2024a. Effects of Sous-vide Cooking Temperature on Triceps Brachii of Black Goats. Food Science of Animal Resources 44:861.

Kang K-M, Kim H-Y. 2024b. Physicochemical Properties of Korean Black Goat Sausage with Aronia melanocarpa Powder. Resources Science Research 6:48-58.

Kim H-J, Kim H-J, Kim K-W, Lee J, Lee S-H, Lee S-S, Choi B-H, Shin D-J, Jeon K-H, Choi J-Y, Jang A. 2022a. Effect of feeding Alfalfa and concentrate on meat quality and bioactive compounds in Korean native black goat loin during storage at 4° C. Food Sci Anim Resour 42:517-535.

Kim J-S, Kim, Kwan-Pil,, Lee M-C. 1998. Mineral contents and fatty acid composition of jemsosojoo. J Korean Soc Food Sci Nutr 27:220-226.

Kim K-W, Jeon D, Lee J, Kim S, Lee S-H. 2019. Hormone analysis during artificial estrus induction in Korean black goats. JKAIS 20:224-230.

Kim K-W, Kim H-J, Lee E-D, Kim D-K, Lee J, Lee S-S, Jang A, Lee S-H. 2020a. Comparison of meat quality characteristics and aromatic substances of Korean native black goat ribs by different sex. J Food Nutr Res 8:585-590.

Kim K-W, Kim H-J, Lee J, Lee E-D, Kim D-K, Lee S-S, Jang A, Lee S-H. 2020b. Effects of raising periods on physicochemical meat properties of Korean native black goat. JKAIS 21:435-442.

Kim K-W, Lee E-D, Kim D-K, Choi B-H, Kim SW, Lee S-H. 2022b. PSXII-4 Estrus synchronization and artificial insemination in Korean black goats using frozen-thawed semen. J Anim Sci 100:208-209.

Kim K-W, Lee E-D, Lee J, Lee S-S, Lee S-H. 2021. Pregnancy rate in Korean black goats with natural and synchronized estrus after artificial insemination with frozen semen. KSBB Spring Meeting and International Symposium, Jeju, South Korea.

Kim K-W, Lee J, Kim KJ, Lee E-D, Kim SW, Lee S-S, Lee S-H. 2021b. Estrus synchronization and artificial insemination in Korean black goat (*Capra hircus coreanae*) using frozen-thawed semen. JAST 63:36-45.

Kim K-W, Lee J, Lee S-S, Kim S, Lim HT, Kim Y, Lee S-H. 2021c. Estimation of effective population size of Korean native black goat using genomic information. Intl J Agric Biol 25:575-580.

Kim K, Kim Y, Lee Y, Baik M. 2000. Postmortem muscle glycolysis and meat quality characteristics of intact male Korean native (Hanwoo) cattle. Meat Sci 55:47-52.

Kim S-U, Choi Y-S, Yoo D-J, Ku M-J, Lee G-H, Park S-G. 2016. Effects of total mixed rations with corn on growth and meat quality of castrated Korean black goats. J Kor Grassl Forage Sci 36:350-356.

Kim SW, Yoon SH, Kim J-H, Ko Y-G, Kim DH, Kang GH, Kim Y-S, Lee SM, Suh SW. 2012. Effects of feeding levels of concentrate on the growth, carcass characteristics and economic evaluation in feeds based on rice-straw of Korean black goats. J Kor Grassl Forage Sci 32:429-436.

Lee B-J, Lin J-S, Lin Y-C, Lin P-T. 2016. Effects of L-carnitine supplementation on lipid profiles in patients with coronary artery disease. Lipids Health Dis 15:1-8.

Lee H-R. 2024. Summer heat fails to boost dog meat consumption. South Korea: The Korea Times. Available: https://www.koreatimes.co.kr/www/nation/2024/07/113_378619.html. Accessed Dec 4 024.

Lee J-A, Kang K-M, Kim H-Y. 2024. Changes in Physicochemical Characteristics of Goat Meat Emulsion-type Sausage According to the Ratio of Fat and Water Contents. Food Science of Animal Resources.

Lee J. 2018. Goat meat, a healthy food to strengthen the health. Available: http://www.rda.go.kr/middlePopOpenPopViewApi.do?no=1326. Accessed January 19th 2024.

Lee J, Jeon D, Lee S, Kim S, Ko Y, Roh H, Kim K. 2018. PSXIII-22 Changes of reproductive hormones and pregnancy rate with different estrus synchronization methods in Korean black goats. J Anim Sci 96:362.

Lee J, Kim H-J, Lee S-S, Kim K-W, Kim D-K, Lee S-H, Lee E-D, Choi B-H, Barido FH, Jang A. 2023a. Effects of diet and castration on fatty acid composition and volatile compounds in the meat

of Korean native black goats. Anim Biosci 36:962-972.
Lee JA, Cho S-H, Kim H-W, Kim Y, Bae I-S. 2023b. Quality characteristics of goat meat tteokgalbi prepared with the addition of *Centella asiatica* powder. J Korean Soc Food Cult 38:336-344.
Lee S-H, Kang H-C, Lee S-S, Lee J, Kim E-H, Myung H-C, Kim K-W, Lim H-T. 2020a. Development of a microsatellite marker set for the individual identification and parentage verification of Korean native black goats. J Life Sci 30:912-918.
Lee S-H, Lee J, Chowdhury MMR, Jeon D, Lee S-S, Kim S, Kim DH, Kim K-W. 2019a. Grazing behavior and forage selection of goats (*Capra hircus*). J Kor Grassl Forage Sci 39:189-194.
Lee S-H, Lee J, Jeon D, Kim S, Kim K-W. 2019b. Morphological characteristics and growth performance of Korean native black goats. JKAIS 20:149-155.
Lee S-H, Lee J, Lee E-D, Kim S, Lee S-S, Kim K-W. 2020b. SNP-based genetic diversity and relationships analysis of the Korean native black goat and crossbred goat. JKAIS 21:102-108.
Lee Y-A. 2017. Black goat healthy soup with korean epimedium and manufacturing method thereof. Korea Patent KR1020170023423A.
Lee Y-A. 2019. Black goat healthy black-soup and manufacturing method thereof. Korea Patent KR20180129149A.
Lee Y-J, Kim S-C. 2008. A study of residents consciousness of local food menus excavation and development in Gyeongju areas. Korean J Food Cook Sci 24:549-559.
Moon S-H, Kim NY, Seong H-J, Chung SU, Tang Y, Oh M, Kim E-K. 2021. Comparative analysis of proximate composition, amino acid and fatty acid content, and antioxidant activities in fresh cuts of Korean native goat (*Capra hircus coreanae*) meat. Korean J Food Preserv 28:303-312.
Paleari MA, Moretti VM, Beretta G, Caprino F. 2008. Chemical parameters, fatty acids and volatile compounds of salted and ripened goat thigh. Small Rumin Res 74:140-148.
Park BK, Kim YS, Seong J, Kong HS. 2019. Analysis of genetic diversity and relationships of Korean native black goat using microsatellite markers. JARB 34:183-189.
Park C, Kim Y. 2000a. Composition in amino acid and changes in protein, mineral contents during storage of black goat extracts. J Korean Soc Food Sci Anim Resour 20:257-263.
Park C, Kim Y. 2000b. A study on the lipid oxidation of black goat meat extracts during storage periods. J East Asia Soc Dietary Life 10:48-54.
Park J-Y, Lee S-Y, Choi Y-S, Nam KC. 2020. Quality characteristics of low-fat black goat sausage using loquat leaf. J Agric Life Sci 54:59-65.
Piéroni L, Bargnoux A-S, Cristol J-P, Cavalier E, Delanaye P. 2017. Did creatinine standardization give benefits to the evaluation of glomerular filtration rate? EJIFCC 28:251-257.
Piveteau F, Le Guen S, Gandemer G, Baud J-P, Prost C, Demaimay M. 2000. Aroma of fresh oysters

Crassostrea gigas: composition and aroma notes. J Agric Food Chem 48:4851-4857.

Saccà E, Corazzin M, Bovolenta S, Piasentier E. 2019. Meat quality traits and the expression of tenderness-related genes in the loins of young goats at different ages. Animal 13:2419-2428.

Salvatore L. 2003. Instrumental and sensory analysis of volatile organic compounds in porcine adipose tissue. Ph. D. thesis, VUT. Melbourne, Australia.

Saturno JFL, Dilawar MA, Mun H-S, Kim DH, Rathnayake D, Yang C-J. 2020. Meat composition, fatty acid profile and sensory attributes of meat from goats fed diet supplemented with fermented *Saccharina japonica* and *Dendropanax morbifera*. Foods 9:937.

Seo J-E. 2024. Seoul government develops kit to detect dog meat fraud. South Korea: Korea JoongAng Daily. Available: https://koreajoongangdaily.joins.com/news/2024-08-14/national/socialAffairs/Seoul-government-develops-kit-to-detect-dog-meat-fraud/2112928. Accessed Dec 4 2024.

Shin H. 2024. South Korea passes bill to ban consumption of dog meat. South Korea: Reuters. Available: https://www.reuters.com/world/asia-pacific/south-koreas-parliament-expected-pass-bill-ban-dog-meat-trade-2024-01-09/. Accessed Dec 4 2024.

Son G-I, Hong E-J, Shin H-J. 2021. Case Report: A case of caprine arthritis encephalitis in dairy goat farms in South Korea. Front Vet Sci 8:773039.

Son Y. 1999. Production and uses of Korean native black goat. Small Rumin Res 34:303-308.

Song H-B, Jung S-H. 2002. Granular tea using black goat meat and process for preparation thereof. Korea Patent KR20010068419A.

Song H-B, Jung S-H, Kong G-O. 2004. Granular pills using black goat meat and process for preparation thereof. Korea Patent KR20020065972A.

Song HB. 2003. Reproduction traits in the Korean native goat doe. Korean J Anim Reprod 27:287-297.

Song HB, Jo IH, Sol HS. 2006. Reproductive performance of Korean native goats under natural and intensive conditions. Small Rumin Res 65:284-287.

Suh S, Byun M, Kim Y-S, Kim M-J, Choi S-B, Ko Y-G, Kim D-H, Lim H-T, Kim J-H. 2012. Analysis of genetic diversity and relationships of Korean native goat populations by microsatellite markers. J Life Sci 22:1493-1499.

Tangkham W. 2018. Evaluation of 4-methyloctanoic acid compound in goat meat. Ann Short Reports 2018; 1 1021.

Tangwatcharin P, Sorapukdee S, Kongsrirat K. 2019. Sous-vided restructured goat steaks: process optimized by thermal inactivation of Listeria monocytogenes and their quality characteristics. Food science of animal resources 39:863.

Teixeira A, Silva S, Guedes C, Rodrigues S. 2020. Sheep and goat meat processed products quality: A review. Foods 9:960.

Teo W. 2024. South Korea eschews dog stews for black goat stews to beat summer heat. The Straits Times. Available: https://www.straitstimes.com/asia/east-asia/south-korea-eschews-dog-stews-for-black-goat-stews-to-beat-summer-heat. Accessed Dec 5 2024.

Wattanachant C. 2018. Goat meat: Some factors affecting fat deposition and fatty acid composition. Songklanakarin J Sci Technol 40:1152-1157.

Wood JD. 2017. Meat composition and nutritional value. In Lawrie s Meat Science. Woodhead Publishing, Cambridge, MA, USA.pp 635-659.

Yang S, Song G-S, Nam K-B, Kim S-D, Park J-E, Kim K-H. 2011. Manufacturing method of extract from black goat. Korea Patent KR101079147B1.

Zhao J, Wang M, Xie J, Zhao M, Hou L, Liang J, Wang S, Cheng J. 2017. Volatile flavor constituents in the pork broth of black-pig. Food Chem 226:51-60.

Zulu B. 2024. Some drinking places sell dog meat disguised as goat, warns VAZ. Diggers News. Available: https://diggers.news/local/2024/02/20/some-drinking-places-sell-dog-meat-disguised-as-goat-warns-vaz/. Accessed Dec 4 2024.

Tables

Table 1. Body weight of Korean Native Black Goat, Boer, and Saanen goats at early stage

Body weight	Korean Native Black Goat strains[1]						Boer[2]		Saanen[3]	
	Dangjin		Jangsu		Tongyeong					
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Birth weights (kg)	1.9±0.5	2.3±0.6	2.1±0.5	2.0±0.4	1.8±0.5	2.0±0.4	2.69±0.07	2.86±0.07	2.75±0.62	3.07±0.58
Weaning period (kg)	9.3±2.9	10.2±3.8	9.3±2.5	10.1±2.7	9.0±2.3	9.7±3.0	9.48±0.36	9.45±0.35	7.09±0.77	7.03±0.64
12-mon-old (kg)	18.7±4.1	22.2±2.0	19.3±3.5	18.3±6.0	16.5±3.3	21.2±4.4	15.41±1.00	17.80±1.03	NR	NR

[1] Korean native black goats, maintained as purebred closed herds since 1997–1998, were studied for phenotypic traits from 2010 to 2019 at the Livestock Genetic Resources Center, National Institute of Animal Science, Korea. A total of 706 goats were analyzed, comprising 189 Dangjin lineage (91 female, 98 male), 242 Jangsu lineage (124 female, 118 male), and 275 Tongyeong lineage (125 female, 150 male). The weaning age of KNBG was 3 mon. The data are based on descriptive measurements collected during the study period, with no specific format for statistical presentation (e.g., mean ± Standard Deviation [SD] or mean ± Standard Error [SE]) specified in the original records. Source: Lee et al. (2019).

[2] Boer goat data were collected from 2012 to 2017 during an on-station breeding program at the Debre-Birhan Agricultural Research Center, Ethiopia. A total of 512 goats were analyzed, classified by sex (female and male), and presented as Least Squares Mean (LSM) ± Standard Error (SE). The weaning age of Boer goats was 3 mon. Statistical analysis was performed using the GLM procedure of SAS 9.0, with means compared using the Tukey-Kramer test. Weight adjustments were applied using standard formulas for growth stages. Source: Mustefa et al. (2019).

[3] Saanen goat data were collected from June to November 2016 at AZ-Zahra Farm, Sandakan, Sabah, Malaysia. A total of 105 goats (80 female, 25 male) were analyzed, classified by sex (male and female). The weaning age of Saanen goats was 2 months. Data are presented as mean ± Standard Deviation (SD), and statistical differences between groups were determined using Student's t-test. Source: Khandoker et al. (2018).

NR: not reported.

Table 2. Muscle fiber area percentage of different livestock in Korea

Animals and Treatments	Muscle type	Muscle fiber types (%) Type I	Type IIA	Type IIB
Korean native black goat[1]			Young goat	
Age	*Longissimus dorsi*	19.08^{c}	41.46^{a}	39.46^{d}
	Psoas major	44.36^{a}	25.66^{d}	29.98^{e}
	Semimembranosus	26.18^{b}	33.50^{bc}	40.32^{cd}
	Gluteus medius	27.78^{b}	34.62^{b}	37.60^{d}
			Adult goat	
	Longissimus dorsi	20.14^{c}	31.08^{bcd}	48.78^{ab}
	Psoas major	46.12^{a}	27.76^{cd}	26.12^{e}
	Semimembranosus	28.68^{b}	18.50^{e}	52.82^{a}
	Gluteus medius	26.14^{b}	27.98^{bcd}	45.88^{bc}
	SEM	2.620	3.256	2.686
Hanwoo beef[2]	*Longissimus dorsi*	24.3	12.4	63.7
	Psoas major	31.9	16.2	52.9
	Semimembranosus	8.0	22.6	69.4
Pork[3]	*Longissimus lumborum*	5.76 ± 0.78^{C}	4.76 ± 1.00^{B}	89.48 ± 0.93^{A}
Castration	*Psoas major*	9.63 ± 1.61^{B}	20.46 ± 2.10^{A}	69.91 ± 3.28^{B}
	Infra spinam	51.06 ± 2.86^{A}	20.24 ± 2.74^{A}	28.70 ± 2.20^{C}

[1] Korean native black goat data were collected from 10 castrated male goats: five young goats (9 months old) and five adult goats (18 months old). Muscle fiber area percentages were measured for four muscles: *Longissimus dorsi*, *Psoas major*, *Semimembranosus*, and *Gluteus medius*. Values are expressed as means, with SEM calculated for each muscle type across all goat ages. Superscripts ($^{a–e}$) indicate significant differences ($p<0.001$) within the same column. Source: Hwang et al. (2019).

[2] Hanwoo beef data were collected from 18 Korean native cattle steers graded as Korean Carcass Grade 1++ by the Korean Animal Products Grading Service. Muscle fiber area percentages were measured for three muscles: *Longissimus dorsi*, *Psoas major*, and *Semimembranosus*. Data are presented as mean values, and no standard deviation (SD), standard error (SE), or standard error of the mean (SEM) was provided in the original document. Source: Hwang et al. (2010).

[3] Pork data were collected from eight castrated crossbred pigs (Landrace × Yorkshire × Duroc). Muscle fiber area percentages were measured for three muscles: *Longissimus lumborum*, *Psoas major*, and *Infra spinam*. Values are presented as means ± SE (n=8). Superscripts ($^{A–C}$) indicate significant differences ($p<0.05$) within the same column. Source: Hwang et al. (2018).

Table 3. Korean Native Black goat meat color and pH under different treatments

Treatment	Sex	Meat cut	Treatment groups	L	a*	b*	pH
Different gender[1]	Male	Rib	Male	33.81±3.46	21.22±1.70	8.70±0.98	6.21±0.03
	Female	Rib	Female	36.86±0.66	22.92±1.06	9.88±0.76	6.46±0.13
			p-value	0.0069	0.0641	0.0435	0.0010
Raising period[2]	Female	NR	24 mon	38.42±0.39	22.42±0.93	10.64±0.50	6.55±0.01^{a}
			48 mon	31.74±0.38	19.71±0.48	8.56±0.54	5.88±0.00^{b}
			p-value	<0.0001	0.0108	0.0435	<0.0001
Diet combined with storage day[3]	Castrated male	Loin	KHA1	41.41^{a}	24.61^{a}	14.17^{a}	6.00^{b}
			KHA5	38.42^{b}	19.55^{b}	11.37^{b}	6.17^{a}
			KHA10	37.56^{Bb}	15.23^{c}	10.05^{bc}	6.23^{a}
			KHA15	37.98^{b}	14.04^{c}	9.71^{c}	6.28^{a}
			SEM	0.663	0.772	0.336	0.040
			KLA1	40.81^{a}	25.01^{a}	13.94^{a}	5.92^{c}
			KLA5	38.79^{b}	18.75^{b}	10.88^{b}	6.10^{b}
			KLA10	38.88^{Ab}	16.53^{c}	10.26^{c}	6.19^{ab}
			KLA15	38.07^{b}	15.17^{c}	10.09^{c}	6.27^{a}
			SEM	0.289	0.478	0.152	0.027
			SEM (storage day)				
			1	0.647	0.395	0.224	0.030
			5	0.459	0.807	0.326	0.027
			10	0.307	0.646	0.226	0.036
			15	0.568	0.651	0.254	0.041
Wet aging time (aging days)[4]	Castrated male	LL	LL0	38.67	22.52	11.19	5.91^{by}
			LL5	38.07	20.46	9.86	5.88^{by}
			LL10	38.14^{A}	21.68	9.57^{x}	5.96^{by}
			LL15	36.70	20.48^{B}	9.80^{y}	6.21^{ax}
			SEM	0.53	1.08	0.78	0.03
		BF	BF0	37.8^{a}	19.75^{b}	10.39^{a}	6.08^{ax}
			BF5	37.84^{a}	21.28^{b}	9.00^{b}	6.07^{ax}
			BF10	36.8^{aby}	20.02^{b}	7.10^{cy}	6.04^{ax}
			BF15	36.13^{b}	25.03^{ax}	11.07^{ax}	5.93^{by}
			SEM	0.33	0.63	0.42	0.01
			SEM (storage day)				
			0	0.49	1.40	1.05	0.04
			5	0.34	0.73	0.50	0.02
			10	0.73	0.70	0.39	0.01
			15	0.50	0.42	0.20	0.01
Slaughter age[5]	Female	LL	3 mon	44.99^{a}	5.65^{f}	5.23^{e}	5.79^{c}
			6 mon	42.47^{b}	7.44^{e}	6.13^{d}	5.87^{bc}
			9 mon	37.15^{c}	9.01^{d}	6.50^{d}	5.89^{b}
			12 mon	35.68^{d}	11.00^{c}	7.33^{c}	6.06^{a}
			24 mon	35.43^{d}	12.23^{b}	9.17^{b}	6.07^{a}
			36 mon	35.47^{d}	14.03^{a}	10.03^{a}	6.09^{a}
			SEM	0.10	0.07	0.07	0.01

[1] Data were collected from 28-month-old male and female Korean Native Black Goats (KNBG) with rib cuts used for analysis. Superscripts ($^{a–b}$) indicate significant differences ($p<0.05$) within the same column. Source: Kim et al. (2020a).

[2] Data were collected from female KNBG under different raising periods. Goats were raised for 24 months and 48 months. Muscle type was not reported (NR). Superscripts ($^{a–b}$) indicate significant differences ($p<0.05$) within the same column. Source: Kim et al. (2020b).

[3] Data were collected from 10 castrated male KNBG. The goats were fed for 90 days under two different feeding systems: KHA (high alfalfa diet treatment, 8:2 alfalfa:concentrate ratio) and KLA (low alfalfa diet treatment, 2:8 ratio). The loin muscle was used for analysis. Samples were cut into 1.5 cm thick slices, placed on polystyrene trays covered with low-density polyethylene (LDPE) film, and stored aerobically at 4 ± 2℃. Numbers (0–15) assigned to each treatment group indicate the storage or aging duration in days. Values are presented as means. SEM (Standard error of the mean) was calculated for each diet across storage days and for each storage day across diets. Superscripts ($^{a–c}$) within the same column indicate significant differences ($p<0.05$). Superscripts ($^{A–B}$) within the same column indicate significant differences ($p<0.05$) between storage days. Source: Kim et al. (2022).

[4] Data were collected from 21 castrated male Korean Native Black Goats (KNBG). Muscle samples included *Longissimus lumborum* (LL) and *Biceps femoris* (BF). The goats were wet-aged vacuum packaging at 4℃. Numbers (0–15) attached to each treatment group represent the storage or aging time duration in days. Values are expressed as means, with SEM (n=8) calculated for each parameter across all storage days. Superscripts ($^{a–b}$) within the same column indicate significant differences ($p<0.05$) between storage days. Superscripts ($^{x–y}$) within the same storage day indicate significant differences ($p<0.05$) between different muscle types. Source: Ali et al. (2021).

[5] Data were collected from 30 female Boer × KNBG with slaughter ages at 3, 6, 9, 12, 24, and 36 mon. Muscle samples used in this analysis included *Longissimus lumborum* (LL). Values are expressed as means, with SEM (n=30) calculated for each parameter across all slaughter ages. Superscripts ($^{a–d}$) within the same row indicate significant differences ($p<0.05$) between slaughter ages. Superscripts ($^{a–e}$) within the same column indicate significant differences ($p<0.05$). Source: Choi et al. (2023).

Table 4. Proximate composition of Korean native black goat meat and meat from other livestock in Korea

Animals	Treatments	Meat cut	Treatment groups	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude ash (%)
KNBG	Raising Period [1]	NR	24 mon	72.80±0.49	17.77±0.33^{b}	9.98±0.42^{a}	0.89±0.02^{b}
			48 mon	73.60±0.14	21.27±0.91^{a}	7.5±0.70^{b}	1.05±0.06^{a}
			p-value	0.0519	0.0034	0.0034	0.0100
	Castration time (KNBG x Nubian crossbred) [2]	NR	Intact	76.83±0.49^{a}	17.23±0.08^{b}	0.80±0.01	1.12±0.25
			15 d	74.220.99^{b}	20.45±2.47^{a}	2.39±1.51	0.93±0.16
			3 mon	75.54±1.31^{ab}	17.52±0.40^{ab}	1.87±1.15	0.99±0.02
			5 mon	74.90±0.35^{ab}	17.58±0.45^{ab}	2.31±0.11	0.93±0.01
			7 mon	74.92±0.39^{ab}	17.72±0.06^{ab}	2.01±0.39	0.89±0.15
Chicken	Different Breeds [3]	Breast	WM	70.82	21.62^{a}	2.44^{b}	1.38^{a}
			CB	71.50	20.56^{b}	3.33^{a}	1.07^{b}
			SEM	0.346	0.109	0.163	0.073
Hanwoo Cattle	Carcass fat color [4]	LL	Normal	64.76	21.63	13.23	3.70
			Yellow	63.45	20.84	14.75	3.82
			SEM	0.580	0.232	0.664	0.060

[1] Data were collected from female KNBG under different raising periods. Goats were raised for 24 months and 48 months. Muscle type was not reported (NR). Superscripts ($^{a–b}$) indicate significant differences (p<0.05) within the same column. Source: Kim et al. (2020b).

[2] Data were collected from 45 castrated male Korean Native Black Goats (KNBG) with castration performed at 0.5, 3, 5, and 7 months of age. Muscle type was not reported (NR). While data are presented as mean values, standard deviation was calculated but not shown in the table. Superscripts ($^{a–b}$) indicate significant differences (p<0.05) within the same column. Source: Choi et al. (2010).

[3] Data were collected from 200 mixed-sex Woorimatdag^{TM} (WM) chickens and 200 commercial broilers (CB). Values are expressed as means, with SEM (n=18) calculated for each parameter across breeds. Superscripts ($^{a–b}$) within the same column indicate significant differences (p<0.05) between breeds. Source: Jung et al. (2014).

[4] A total of 20 carcasses from Hanwoo females were collected from slaughterhouses in Korea between May and July 2022. Carcass fat color was graded according to the Korea Institute for Animal Products Quality Evaluation (KAPE) standards. Carcasses with yellow fat (fat color grade 6 or 7) were categorized as the yellow group (n = 10), while those with normal fat (fat color grade 3) were categorized as the normal group (n = 10). Both groups were matched for similar carcass properties, including quality grade, carcass weight, and age. Muscle samples, including *Longissimus lumborum* (LL), were analyzed for various meat quality parameters. Values are expressed as means, with SEM (n=10) calculated for each parameter across carcass fat color. Source: Kim et al. (2023).

Table 5. Effects of dietary treatment, castration, and rearing system on fatty acid composition of goat meat

Variables (%)	Korean Native Black goat[1]					Mestiço goat[2]	
	High forage		Low forage		SEM	Rearing system	
	CA	NCA	CA	NCA		Extensive	Confinement
C14:0	1.78^{b}	2.29^{a}	1.75^{b}	2.27^{a}	0.13	2.41±0.18^{a}	1.83±0.25^{b}
C14:1	-	-	-	-	-	0.44±0.22	0.48±0.22
C16:0	23.02	24.23	24.00	24.73	0.63	19.64±1.15	20.12±0.42
C16:1n7	1.44^{ab}	1.18^{b}	1.71^{a}	1.28^{b}	0.11	1.87±0.16^{b}	2.60±0.42^{a}
C17:0	-	-	-	-		1.64±0.29^{b}	1.63±0.24^{a}
C17:1	-	-	-	-		1.80±0.49	1.45±0.09
C18:0	15.72^{b}	18.27^{a}	14.44^{b}	17.43^{a}	0.55	20.71±0.84^{a}	17.03±1.08^{b}
C18:1n9	32.68^{b}	28.63^{c}	38.56^{a}	30.96^{bc}	0.93	36.23±1.78^{b}	43.56±1.50^{a}
C18:1n7	2.27^{a}	1.85^{ab}	1.60^{b}	1.45^{b}	0.18	-	-
C18:2n6	10.29^{bc}	12.50^{ab}	8.81^{c}	13.26^{a}	0.79	9.06±1.33^{a}	6.84±0.76^{b}
C18:3n6	0.11^{ab}	0.08^{b}	0.16^{a}	0.08^{b}	0.02	-	-
C18:3n3	1.83^{a}	2.11^{a}	0.59^{b}	0.69^{b}	0.14	3.62±0.54^{a}	2.53±0.28^{b}
C20:1n9	0.36^{ab}	0.47^{a}	0.28^{b}	0.34^{ab}	0.05	-	-
C20:3	-	-	-	-	-	0.25±0.14	0.22±0.12
C20:4n6	7.21^{a}	5.94^{b}	6.08^{b}	5.56^{b}	0.37	-	-
C20:5n3	0.41^{a}	0.25^{b}	0.34^{ab}	0.40^{ab}	0.05	-	-
C22:4n6	2.56^{a}	2.08^{a}	1.50^{b}	1.44^{b}	0.16	-	-
C22:6n3	0.32^{a}	0.12^{b}	0.18^{b}	0.12^{b}	0.03	-	-
SFA	40.52^{b}	44.79^{a}	40.18^{b}	44.43^{a}	1.00	45.52±1.81^{a}	41.42±0.93^{b}
UFA	59.48^{a}	55.21^{b}	59.80^{a}	55.57^{b}	1.00	-	-
MUFA	36.76^{b}	32.14^{c}	42.16^{a}	34.02^{c}	0.91	41.52±2.05^{b}	49.04±1.75^{a}
PUFA	22.73^{a}	23.07^{a}	17.64^{b}	21.56^{a}	1.29	12.94±1.82^{a}	9.59±0.98^{b}
UFA/SFA	-	-	-	-	-	1.22±0.08^{b}	1.42±0.05^{a}
MUFA/SFA	0.91^{b}	0.72^{c}	1.05^{a}	0.77^{c}	0.03	0.93±0.07^{b}	1.19±0.06^{a}
PUFA/SFA	0.57	0.52	0.44	0.49	0.04	0.29±0.04	0.23±0.02
n6/n3 ratio	8.11^{b}	8.42^{b}	14.99^{a}	16.94^{a}	0.67	-	-

[1] The study analyzed volatile compounds in Korean native black goat (KNBG) loin meat from 24 goats (body weight: 48.6 ± 1.4 kg; age: 4.8 ± 1.2 years). The goats were divided into dietary (high-forage diet: 80:20; low-forage diet: 20:80) and castration (castrated [CA] vs. non-castrated [NCA]) treatment groups. Loin samples were collected post-slaughter after 24 hours of refrigeration at 4℃. Data are represented as a means with standard error of the mean (SEM). Means within the same row with different superscript letters ($^{a-c}$) differ significantly at p<0.05. Source: Lee et al. (2023a).

[2] Reared intact male goats at 18.3±0.5 kg of initial live weight until 30 kg of live weight; Extensive rearing received typical native brushwood of Northeast region of Brazil called “Caatinga”; while confinement rearing received ensilage containing maize and a mixture of soy, wheat, molasses, and minerals, in the ratio of 40:60 at 4% of live weight. Data are presented as mean ± Standard Deviation (SD) and means within the same row with different letters ($^{a-b}$) are significantly different at p<0.05. Source: Madruga et al. (2006).

SFA, saturated fatty acids; UFA, unsaturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; n6, fatty acid with the last double bond at 6th carbon of the methyl end; n3, fatty acid with the last double bond at 3rd carbon of the methyl end.

Table 6. Mineral content (mg/100g) of Korean native black goat extract, meat and offal organs.

Minerals	KNBG extract[1]	KNBG meat cuts[2]			Saanen goat male kids edible organ[3]				
		Loin	Rump	SEM	Liver	Kidney	Heart	Spleen	Brain
Fe	1.8±0.30	1.35[b]	1.48[a]	0.003	7.78±1.46[b]	3.11±0.34[d]	3.02±0.20[d]	12.8±2.0[a]	1.14±0.20[f]
Ca	5.17±0.14	5.22[b]	6.09[a]	0.029	14.2±4.1[b]	16.6±3.0[ab]	10.7±1.9[c]	10.7±1.9[c]	15.4±2.0[ab]
P	73.73±3.70	3.39	3.34	0.015	359±18[b]	283±10[d]	226±8[g]	345±19[b]	317±21[c]
K	168.41±16.61	325.22[a]	281.40[b]	0.700	291±17[cd]	235±19[f]	277±8[de]	371±24[b]	302±22[c]
Na	52.83±2.81	76.03[b]	94.97[a]	0.215	63.5±4.4[f]	167±9[a]	72.5±4.0[e]	64.6±7.0[f]	137±7[b]
Mg	6.29±0.09	NR	NR	NR	19.0±1.0[d]	17.6±1.1[e]	20.1±0.8[b]	19.2±1.1[cd]	11.2±0.4[h]
Cu	0.06±0.04	NR	NR	NR	2.62±0.35[a]	0.55±0.04[b]	0.40±0.04[c]	0.084±0.007[fg]	0.27±0.04[d]
Zn	0.2±0.04	NR	NR	NR	4.78±1.00[a]	2.44±0.67[b]	1.49±0.16[de]	2.08±0.17[bc]	1.10±0.13[e]
Mn	NR	NR	NR	NR	0.21±0.03[a]	0.067±0.004[b]	0.015±0.001[f]	0.031±0.005[cd]	0.028±0.004[cde]

[1] The study analyzed the mineral content of Korean Native Black Goat (KNBG) extract. The extract was prepared by boiling the whole carcass of a KNBG (weighing 12.6 kg) with 20.4 L of water at 120℃ for 5 hours. Source: Results are expressed as means with standard deviations. Kim and Lee (1998)

[2] This study evaluated the proximate composition, collagen and mineral content, fatty acid profiles, bioactive compounds, and antioxidant activities of loin and rump from 14-mon-old KNBG. Data are presented as means, with SEM calculated for each parameter across muscle types. Means within the same row with different superscript letters ([a-c]) differ significantly at $p<0.05$. Source: Kim et al. (2019)

[3] This study analyzed the proximate and mineral composition of 10 edible by-products (liver, kidney, heart, spleen, brain, tongue, lungs, testicle, thymus, and kidney fat) from intensively reared Saanen goat male kids. Results are expressed as means with standard deviations. Superscripts ([a-h]) indicate significant differences ($p<0.05$) among the included by-products. Note that some superscripts may correspond to comparisons with by-products not presented in this table (e.g., tongue, lungs, testicle, thymus, and kidney fat). Source: Tomović et al. (2017).

NR: not reported.-

Table 7. Bioactive compound of Korean Native Black goat meat by different treatments

Treatments	Storage day	Bioactive compounds (mg/100 g)								
		CoQ10	Carnitine	L-Carnitine (μmol/g)	Acetylcarnitine	Creatinine	Creatine	Carnosine	Anserine	Taurine
Diet treatment during storage period[1]	KHA1	1.70^{Aa}	-	2.80^{Bb}	-	1.67^{Bc}	191.60^{Aab}	46.90^{Ba}	52.98^{Aa}	-
	KLA1	1.43^{Ba}	-	3.29^{Ab}	-	2.71^{Ac}	184.35^{Aa}	54.12^{Aa}	54.99^{Aa}	-
	SEM	0.056		0.105		0.081	2.565	1.695	3.070	
	KHA5	1.60^{Aa}	-	3.42^{Ba}	-	2.08^{Bb}	192.63^{Aa}	46.09^{Ba}	51.66^{Aa}	-
	KLA5	1.30^{Ba}	-	3.84^{Aa}	-	2.97^{Ac}	179.76^{Ba}	54.44^{Aa}	54.09^{Aa}	-
	SEM	0.086	-	0.117	-	0.060	2.522	1.741	3.146	-
	KHA10	1.58^{Aa}	-	3.56^{Ba}	-	2.61^{Ba}	183.33^{Aab}	46.51^{Ba}	50.96^{Aa}	-
	KLA10	1.34^{Aa}	-	3.90^{Aa}	-	3.46^{Ab}	178.43^{Aa}	52.68^{Aa}	54.99^{Aa}	-
	SEM	0.091	-	0.069	-	0.080	2.568	1.571	2.568	-
	KHA15	1.44^{Aa}	-	3.73^{Aa}	-	2.80^{Ba}	179.78^{Ab}	39.67^{Aa}	46.52^{Aa}	-
	KLA15	1.31^{Aa}	-	3.93^{Aa}	-	3.96^{Aa}	171.39^{Bb}	43.28^{Ab}	44.30^{Ab}	-
	SEM	0.068	-	0.124	-	0.106	2.235	2.779	2.698	-
		SEM (across storage day)								
	KHA	0.086	-	0.103	-	0.088	3.047	2.057	3.526	-
	KLA	0.066	-	0.109	-	0.079	1.727	1.954	2.041	-
Gender[2]	Castrated	-	6.58^{y}	-	17.04^{xy}	-	348.99	1.45^{y}	171.09^{y}	90.71^{y}
	Non-castrated	-	9.13^{xy}	-	17.55^{x}	-	364.03	3.30^{x}	201.18^{x}	107.04^{x}
	Female	-	10.23^{x}	-	15.39^{y}	-	351.50	1.43^{y}	215.57^{x}	99.99^{xy}
	SEM		0.589		0.463	-	8.979	0.152	5.956	3.688

[1] Data were collected from 10 castrated male KNBG. The goats were fed for 90 days under two different feeding systems: high alfalfa diet treatment (KHA; 8:2 alfalfa:concentrate ratio) and low alfalfa diet treatment (KLA, 2:8 ratio). Loin was used for analysis. Numbers (0–15) represent the storage or aging time duration in days. Superscripts ($^{a–c}$) within the same column indicate

significant differences ($p<0.05$) between storage days within the same alfalfa level. Superscripts ($^{A–B}$) within the same row indicate significant differences ($p<0.05$) among alfalfa levels on the same storage day. Source: Kim et al. (2022).

[2] Data were collected from 35 Korean native black goats (Capra hircus coreanae) categorized into three groups: castrated males (n=12), non-castrated males (n=11), and females (n=12). Mean values with different letters ($^{x-y}$) within the same column differ significantly ($p<0.05$). Source: Aung et al. (2023).

Table 8. Volatile organic compounds detected from Korean native black goats

Treatments	Volatile organic compounds detected	Retention time (min)	Area ratio (%)		Retention time (min)	Area ratio (%)
High-pressure processing [1]	Octadecane	3.02	0.32	Benzene	13.53	0
	Trans-z-hexenyl formate	3.21	0	Cycloheptasiloxane	14.16	0.49
	Ethylbenzene	4.41	1.61	1,3-Dioxane	15.25	2.43
	Benzene	4.64	6.17	Cycloheptasiloxane	16.41	0.37
	Xylene	56.29	5.94	Indole	18.4	0.68
	1-Undecyne	8.06	0.90	Oleyl alcohol	19.95	0.69
	2,6-Nonadienal	10.23	1.28	Cyclononasiloxane	20.84	0.62
	9,12-Octadecadienoic acid	10.39	trace (<0.01)	2,5-Cylohexadien-1-one	24.58	4.98
	Octadecanoic acid	10.83	trace (<0.01)	Lauric acid	33.92	44.16
	1-Undecyne	10.99	0	Hexadecanoic acid	37.33	4.86

Gender[2]		Electric nose column type					
		MXT-5			MXT-1701		
		Female	Male	*p*-value	Female	Male	*p*-value
	Ethanol	63.40 ± 19.90	34.22 ± 8.90	0.0083	48.69 ± 15.72	24.64 ± 6.46	0.006
	1-Propanol	0.11 ± 0.06	0.29 ± 0.14	0.0165	-	-	-
	1-Hydroxy-2-propanone	0.23 ± 0.06	0.42 ± 0.05	0.0002	-	-	-
	1,1-Dichloropropene	0.03 ± 0.03	0.09 ± 0.03	0.0168	-	-	-
	2-butanol	-	-	-	0.08 ± 0.07	0.00 ± 0.00	0.0161
	Acetic acid	-	-	-	0.03 ± 0.04	0.14 ± 0.08	0.0125
	1-Octene	0.04 ± 0.03	0.14 ± 0.08	0.0128	-	-	-
	2,4-Octadienee	0.02 ± 0.03	0.07 ± 0.02	0.0119	-	-	-
	Z-3-Hexen-1-ol, acetate	-	-	-	0.00 ± 0.00	0.05 ± 0.04	0.0121

Forage diet level and castration[3]		High forage diet		Low forage diet		SEM
	MXT-5	CA	NCA	CA	NCA	
	Dichloromethane	1,905.4^{b}	2,714.2^{a}	564.3^{c}	665.7^{c}	88.2

Methyl propanoate	26.3^{b}	56.8^{b}	91.2^{b}	1,493.0^{a}	78.6
1-Hydroxy-2- propanone	15.3^{b}	43.3^{b}	14.1^{b}	437.7^{a}	25.6
1-Propanol, 2-methyl-	ND	ND	ND	ND	-
[E]-2-penten-1-ol	196.9^{b}	375.8^{b}	238.5^{b}	1,274.1^{a}	63.3
2,4-Octadiene	ND	ND	ND	ND	-
Chlorobenzene	59.1^{b}	53.4^{b}	83.8^{b}	481.3^{a}	23.9
m-Xylene	128.2^{b}	155.9^{b}	187.8^{b}	2,527.7^{a}	132.1
1,2-diethylbenzene	175.7^{b}	225.8^{b}	140.3^{b}	837.0^{a}	38.4

	High forage diet		Low forage diet		SEM
MXT-1701	CA	NCA	CA	NCA	
Dichloromethane	3,234.6^{b}	4,206.9^{a}	1,331.7^{c}	1,576.1^{c}	165.6
Methyl propanoate	ND	ND	ND	ND	-
1-Hydroxy-2- propanone	ND	ND	ND	ND	-
1-Propanol, 2-methyl-	0.0^{b}	0.0^{b}	0.0^{b}	906.5^{a}	53.6
[E]-2-penten-1-ol	ND	ND	ND	ND	-
2,4-Octadiene	93.3^{b}	108.3^{b}	196.0^{b}	1,070.8^{a}	61.3
Chlorobenzene	18.7^{b}	55.2^{b}	70.3^{b}	445.1^{a}	22.7
m-Xylene	113.6^{b}	171.4^{b}	174.0^{b}	2,342.4^{a}	123.9
1,2-diethyl^{b}enzene	62.7^{b}	129.1^{b}	91.0^{b}	745.1^{a}	36.2

[1] The study analyzed volatile compounds in Korean native black goat (KNBG) meat using the longissimus dorsi muscle from 12 male goats (body weight: 25–45 kg). These animals were raised on a diet of rice straw and commercial pellets (15.15% crude protein, 68% total digestible nutrients) and slaughtered following standard procedures. Volatile compound analysis was conducted using gas chromatography–mass spectroscopy (4000 GC–MS, Varian, USA) and electronic nose. Headspace volatiles were extracted with solid phase microextraction (SPME) fiber. Data represents area ratios (%) of the volatile compounds, but specific differentiation between high-pressure processed and control samples was not included in the presented area ratios. Source: Kang et al. (2013).

[2] The study analyzed volatile compounds in KNBG rib meat from male and female goats aged 28 months, maintained at the Livestock Genetic Resources Center, Korea. Volatile compound analysis was conducted using the HERACLES II electronic nose system equipped with flame ionization detectors and capillary columns (MXT-5 [Gas chromatography metal capillary column, 15 m, 0.53 mm ID, 5.00 µm] and MXT-1701 [Gas chromatography metal capillary column, 30 m, 0.53 mm ID, 0.50 µm]). Data are represented as peak areas ($\times 10^3$) with standard deviation (±SD). Source: Kim et al. (2020a).

[3] The study analyzed volatile compounds in Korean native black goat (KNBG) loin meat from 24 goats (body weight: 48.6 ± 1.4 kg; age: 4.8 ± 1.2 years). The goats were divided into dietary (high-forage diet: 80:20; low-forage diet: 20:80) and castration (castrated [CA] vs. non-castrated [NCA]) treatment groups. Loin samples were collected post-slaughter after 24 hours of refrigeration at 4℃. Volatile compound analysis was conducted using the HERACLES II electronic nose system equipped with flame ionization detectors and capillary columns (MXT-5 and MXT-1701). Data are represented as peak areas ($\times 10^3$) with standard error of the mean (SEM). Means within the same row with different superscript letters ($^{a-c}$) differ significantly at $p<0.05$. Source: Lee et al. (2023b).

Figures

Figure 1. Three main strains of Korean Native Black goat. (a) Jangsu strains, (b) Tongyeong strains, and (c) Dangjin strains. Source: Kim (2020) .

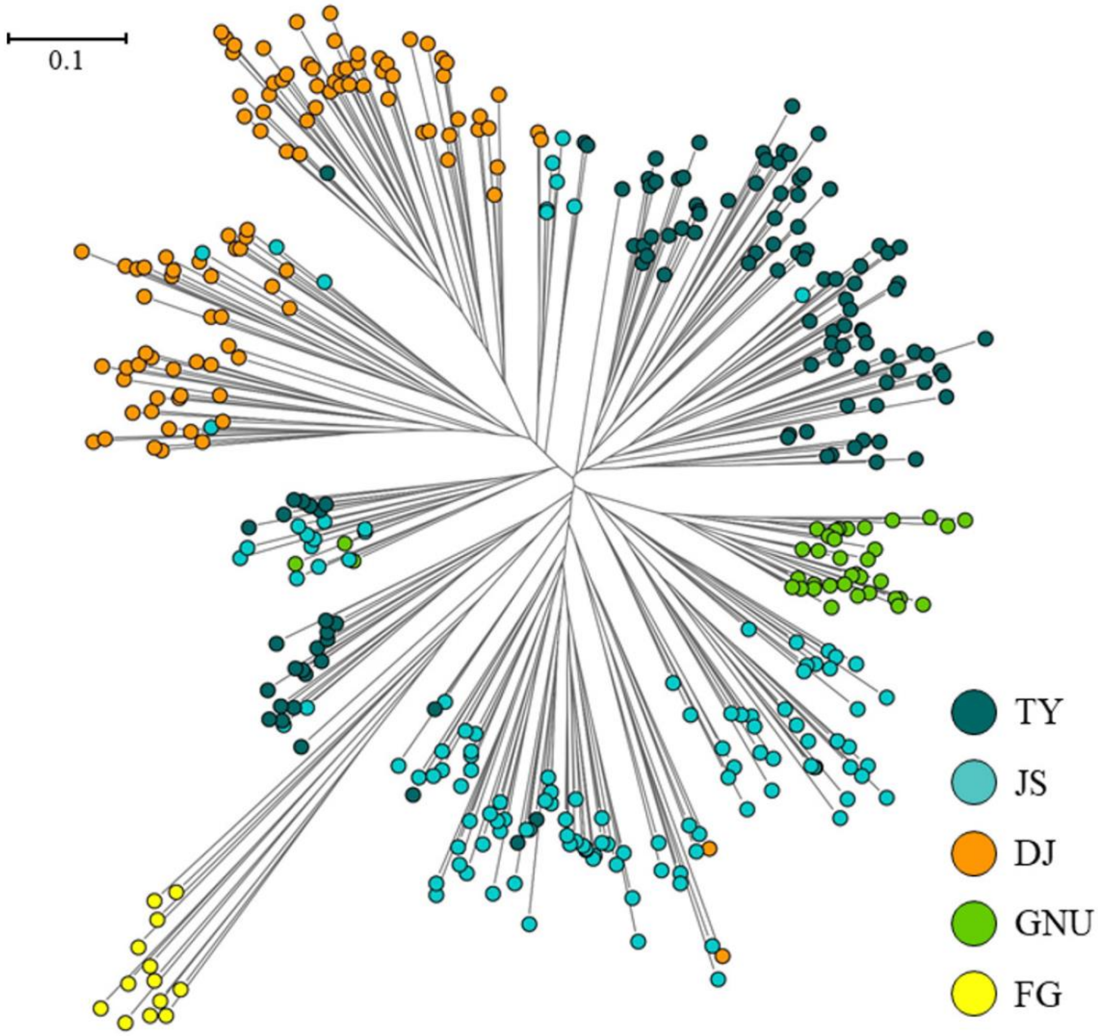

Figure 2. Neighbor-Joining tree method among individuals, using Nei's DA genetic distance index analysis results from 11 microsatellite loci. TY, Tongyeong strain ; JS, Jangsu strain; DJ, Dangjin strain; GNU, Gyeongsang-National-University strain; FG, crossbred line. Source: Kang et al. (2021)

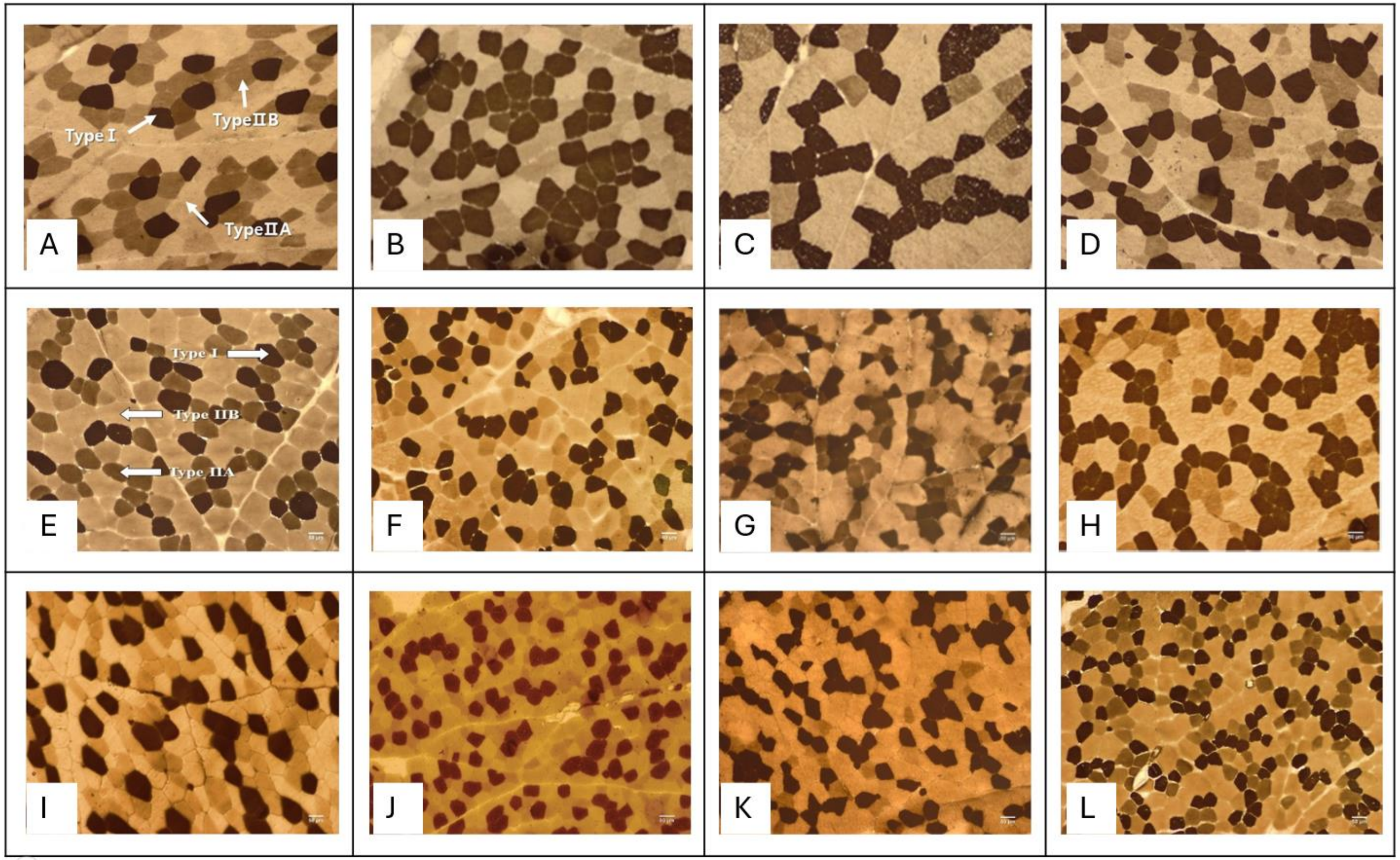

Figure 3. Serial sections of muscles from Korean native black goat, *Longissimus lumborum* (LL; A), *Longissimus dorsi* (LD; E,I), *psoas major* (PM; B,F,J), *semimembranosus* (SM; C,G,K), and *gluteus medius* (GM; D,H,L) stained for myosin ATPase reactivity after pre-incubation at pH 4.6 (A-D) and pH 4.5 (E-L). Magnification of 100× was used (Bar=50 μm). Source : A-D: Hwang et al. (2017); E-L: Hwang et al. (2019).