Recherche sur la production et la qualité de la viande en Australie, Chine et France

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Recherche sur la production et la qualité de la viande en Australie, en Chine et en France : perception des consommateurs, facteurs affectant la qualité sensorielle de la viande, effets nutritionnels et métaboliques sur l'efficience de la production ovine et bovine

Mots-clés : Meat quality ; Sensory quality ; Consumer perception ; meat production ; sustainability

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Cet article est un compte-rendu de la session 30 (Looking back, looking forward - Research on Beef production and quality in China and France (CSBF) and between Australia-France-China (The Triangle Project)) du 74ème congrès européen des sciences animales (European Federation of Animal Science (EAAP)) qui s'est tenu à Lyon du 28 août au 1er septembre 2023.

Résumé :
La filière de l'élevage connaît en Chine une évolution notable vers la qualité et la durabilité, portée par les efforts de collaboration à l'échelle mondiale et les progrès de la recherche. Cet article, qui est une compilation des travaux présentés au congrès EAAP (session 30), donne un aperçu des sujets clés de de la filière viande en Chine, en France et en Australie, allant de l'évaluation de la qualité des produits vers le développement durable du secteur de la viande en passant par la coopération triangulaire entre la France, la Chine et l'Australie jusqu'aux caractéristiques de qualité et à la réglementation de la viande et de la production de viande. De plus, cet article explore les perceptions des consommateurs et les facteurs affectant les qualités sensorielles, ainsi que l'évaluation du persillé chez les bovins français. En outre, il explore la relation complexe entre la nutrition, le métabolisme et l'efficacité de la production de viande bovine et ovine. À travers un ensemble de résultats de recherche, cet article met en lumière le paysage multiforme de l'élevage en Chine et les facteurs évolutifs qui influencent sa croissance.

Abstract: Research on Meat production and quality in Australia, China and France.
The livestock industry in China is experiencing a notable shift towards quality and sustainability, driven by globally collaborative efforts and research advancements. This article, which is a compilation of the work presented at the EAAP congress (session 30), provides an overview of key topics in the meat industry of China, France and Australia. Ranging from the quality assessment and sustainable development of the meat field through triangular cooperation, to the quality characteristics and regulation of meat and meat production. Additionally, it explores consumer perceptions and factors affecting sensory appeal, as well as marbling evaluation in French bovines. Furthermore, it delves into the intricate relationship between nutrition, metabolism, and the efficiency of beef and lamb production. Through a collection of research findings, this article highlights the multifaceted landscape of China's livestock industry and the evolving factors influencing its growth.

INTRODUCTION

The livestock industry in China stands at a pivotal juncture, where the confluence of quality evaluation, sustainable development, consumer perception, and research progress is reshaping the landscape of the meat industry (Liu *et al.,* 2023). China's meat industry is undergoing a transformation from quantity towards quality and sustainability, characterized by the successful cooperation between key research institutions and teams, for example the "Australia-France-China Triangle project", initiated several years ago with research underway in the near future. Researchers like Meng *et al.* (2016) are contributing to this paradigm shift, exploring the significance of the international cooperation and its impact on the industry. In fact, in order to strengthen bilateral cooperation in research and development of beef cattle production, the Centre for Sino-French Beef Development and Research (CSFB) was established in 2005 based on a formal agreement signed by the French and Chinese Agriculture Ministers. The Centre is a technical platform for mutual exchanges of scientific information between France and China in the livestock sector to encourage development and cooperation in the beef cattle industry. In the past 20 years, on the basis of CSBF, teams in France (INTERBEV, FGE, INRAE, IDELE) and China (China Agricultural University) have collaborated on the improvement of genetics, nutrition, management, slaughter practice, carcass deboning, grading and meat quality of beef cattle (Meng *et al.,* 2006). And with the development of the innovative Meat Standards Australia (MSA) beef grading system, collaborative efforts between Chinese, French and Australian scientists have ensued in the field of eating quality of beef and lamb utilising MSA principles.

On the other hand, sheep meat production is also a significant part of the Chinese livestock sector, the research of Luo and colleagues delves into methods for enhancing both the quantity and quality of lamb and sheep meat products. Understanding the intricacies of sheep meat production and quality improvements is vital for the industry's success (Shi *et al.,* 2023). Furthermore, the complex relationship between nutrition, metabolism, and the efficiency of beef and lamb production is explored in various studies by Zhou and Wu and colleagues offering insights into aspects of liver nutrient metabolism, diet effects on rumen fermentation, and the nutritional composition of meat (Wu *et al.,* 2015).

Consumer perception plays a vital role in shaping the livestock industry, Liu and colleagues explore how consumers view the challenges associated with livestock production and meat consumption and meat alternatives (Liu *et al.,* 2023). Understanding consumer perspectives is key to aligning industry practices with public expectations. Additionally, a comparative approach is adopted in research by O'Reilly *et al.* (2020a) assessing the sheepmeat eating quality thresholds for Chinese, American, and Australian consumers. This cross-cultural analysis provides insights into the variations in consumer preferences (O'Reilly *et al.,* 2020a).

Furthermore, the establishment and widespread adoption of standardized quality descriptors are paramount for the growth, international trade, and prosperity of the meat industry. The study of Barro and colleagues on the comparison of beef eating quality terminology databases holds the potential to contribute to the worldwide standardization of meat quality parameter. Additionally, the utilization of precise quality characteristics is equally indispensable for the advancement of the meat sector. Marbling, an essential element of meat quality, is scrutinized in French cows by Nicolazo De Barmon and colleagues who explored the factors affecting marbling levels. While marbling has not yet been a widely used measure of quality by the beef industry in France and China. Despite so, it is important to develop and adopt such a crucial quality trait to enhance the quality assurance of beef. The knowledge derived from the research on marbling assessment in French cows will not only encourage marbling development in the beef industry of Europe and China, but also inform beef breeding and management practices (Liu *et al.,* 2021). In this ever-evolving landscape, research and collaboration are driving the livestock industry towards greater sustainability, quality, and consumer satisfaction. This collection of studies encapsulates the dynamic nature of the industry and sets the stage for a deeper exploration of the topics at hand.

I. INDUSTRY OVERVIEW

I.1. Sustainable development of China's beef industry driven by a successful triangle beef cooperation

China's beef cattle industry has developed rapidly in recent years, which is inseparable from a successful international beef cooperation between China, France, Australia and other countries. By the end of 2021, China had 98.17 million inventory cattle population, of which 82.54 million were beef cattle. The total beef output was 6.98 million tons, the beef imports were 2.33 million tons, and the per capita beef consumption was 6.58kg. China's beef cattle inventory and beef output have jumped to the third place in the world, and its annual beef import has ranked the first place in the world, indicating that China has developed into a major beef producer and consumption country in the world. The international cooperation in China's beef industry has experienced three stages: the early stage from 1949 to 1979, the steady development stage from 1980 to 2000, and the comprehensive development stage from 2001 up to now. Among them, the establishment of the Centre for Sino-French Beef Research and Development and the successful Triangle beef cooperation between China, France and Australia are the most remarkable, which have become an important supporting force to promote the right development of China's beef industry. In the future, China's beef industry will develop towards the large-scale, health and sustainability.

I.2. The production and quality improvement of mutton in China

China has been the world's largest producer in mutton from 4.08 million ton in 2013 to 5.14 million ton in 2021, meanwhile the quality has been improved. In China, there are three kinds of feeding methods for mutton production including grazing, restricted grazing time plus supplementary feeding and house-feeding. The different feeding methods led to the meat quality change, such as intramuscular fat deposits increasing in lamb meat, specifically over-rich in ω-6 polyunsaturated fatty acids but low in ω-3 polyunsaturated fatty acids. Generally, the ratio of ω-6 to ω-3 fatty acids in meat increases from 1 to 20 when lambs are switched from a grazing pasture to house-feeding with concentrate. It is impressed that the ω-6/ω-3 ratio with restricted grazing time of 0 hr, 2 hr, 4 hr, 8 hr and 12 hr was decreasing gradually with 20.23, 9.74, 6.18, 4.99 and 4.28 for the weaned male Tan lambs, and with 5.75, 3.8, 3.67, 3.94, 3.45 and 1.26 in the weaned male Ujumuqin lambs, since the different kinds of grass were intake in different pasture between them. However, the ω-6/ω-3 ratio in the muscle of Hu sheep was significantly lower than that of Tan sheep and Duper sheep by feeding the same diet. The fatty acid composition of lamb can be improved by feed additives. The addition of vitamin E to the diet reduce the drip loss of meat and the content of stearic acid and branched-chain fatty acids related to the “mutton odor”, but improve the content of CLA and unsaturated fatty acids in muscle. Feeding different types of oil in diet had a significant effect on the fatty acids composition in lamb meat. The soybean oil and canola oil increased the ω-6/ω-3 ratio from 9.59 to 14.23, but fish oil decreased the ratio to 1.70 significantly. The addition of alfalfa saponins, a compound that regulates lipid metabolism, reduced the ω-6/ω-3 ratio from 6.45 to 5.60. In summary, there has been an adverse effect on the composition change of fatty acids in lamb meat by changing grazing system to housing feeding. However, this adverse effect can be improved by either grazing regime plus concentrate feeding or house feeding by different additives, or special sheep breed with the high preferred fatty acid composition.

II. CONSUMER PERCEPTION AND FACTORS AFFECTING SENSORY APPEAL

II.1. Perspectives on consumer attitudes to meat consumption

The production and consumption of meat are regularly discussed in the public sphere. As the first widely recognized journal in its field, the scientific journal Meat Science must provide objective data concerning evolution in perception of meat production and consumption. This is the purpose of a special issue focusing on the range, consensus and diversity of consumer attitudes to meat in the world. Several of the 24 papers on this issue highlight different consumer attitudes between countries. For instance, whereas debates around health, environment and welfare issues are quite strong in the USA, there is a sustained demand for meat in this country, despite success of meat alternatives for mostly young, highly-educated and rich consumers. In China, increasing income is the main factor explaining meat consumption, while the biggest concern is safety. Other countries also express their own specific drivers and concerns. An affordable price and safety but also health, animal welfare and environmental issues are among the factors which explain the decrease in meat consumption. Conversely, the pleasure of eating meat, culinary culture, cultural aspects and national traditions are among the main drivers of meat consumption in relationship to the reported customs and social attitudes. Based on this complexity, a comprise has sometimes to be found, for instance between sensory traits and ethical issues related to pig castration and other practices rejected by consumers in many countries. Whereas plant-based products are already commercialized, there are significant technical, ethical and regulatory issues to fix before getting “cultured meat” available in the market. Indeed, information on production processes and product composition are not publicly available, making it impossible to check product characteristics and sustainability. However, consumer reactions are dominated by affective, rather than by cognitive factors. To sum up, the current market is disrupted. Meat producers and also the promoters of meat substitutes must adapt their strategies according to these general trends, nuanced by local specificities, while being more transparent.

II.2. Consumer perception of the challenges facing livestock production and meat consumption

With the global meat market growing and intensive livestock farming systems increasing, the impacts of livestock are a growing concern among consumers, further influencing their meat consumption. Therefore, it is essential to understand consumer perception of livestock production. This study was conducted with 16,803 respondents in China, France, Brazil, Cameroon and South Africa to investigate the different perceptions of the ethical and environmental impacts of livestock among consumer segments depending on their sociodemographic characteristics. On average, the current respondents in China and Brazil and/or who are females, work outside the meat sector, low meat eaters and/or more educated, were more likely to believe that livestock meat production causes serious ethical and environmental problems; while those who from China, France and Cameroon and/or who are women, younger, outside the meat sector, low meat eaters and/or more educated, agree more that reducing meat consumption could be a good solution to these problems. Additionally, an affordable price and sensorial quality are main drivers of food purchase for the current respondents. In conclusion, sociodemographic factors have significant effects on consumer perception of livestock meat production and meat consumption habits. Perceptions of challenges facing livestock meat production differ between countries from different geographical regions depending on social, economic, cultural contexts and dietary habits.

II.3. Comparison of sheepmeat eating quality thresholds for Chinese, American and Australian consumers.

A new cuts-based Meat Standards Australia (MSA) model has been developed within Australia to predict eating quality grades of sheep products. It is based on untrained Australian consumers therefore it is important to examine whether the expectations of consumer groups in other countries align with Australian perceptions. Whilst it is known that American, Australian, and Chinese consumer's sensory perceptions of sheepmeat are very similar (O'Reilly *et al.,* 2020a), their allocation to MSA quality grades has not been examined. The objective of this study was to examine American, Australian, and Chinese consumer allocation of Australian lamb and yearling products into MSA quality grades and determine whether differences exist in the eating quality grade thresholds between these consumer groups. Untrained consumers were recruited across Australia, China and the USA (720 per country). Each consumer tasted and scored 6 grilled sheepmeat samples (3 loin and 3 topside muscles) collected from 164 lambs and 168 yearlings. Samples were scored on tenderness, juiciness, liking of flavour and overall liking on a scale line of 0-100, in addition to assignment of a quality grade: 2 star (fail), 3 star, 4 star, or 5 star. Linear discriminate analyses were used to weigh the importance of the four sensory traits and determine quality thresholds for each consumer group. Chinese consumers had lower quality grade thresholds than American and Australian consumers, ranging from 6 to 11 points lower. Within each consumer group, there was minimal difference between the thresholds for lamb or yearling products. The combined lamb and yearling thresholds for 2-3 star, 3-4 star and 4-5 star were: 37, 56, 74 for China, 43, 65, 81 for Australia, and 46, 67, 82 for the USA. Thresholds reflected the pattern observed in allocation of samples to quality grades, with Chinese consumers assigning a larger proportion of samples to higher quality grades, while American and Australian consumer allocations were more critical. These findings suggest that quality perceptions can vary for consumer groups, and may reflect consumer demographic differences which have demonstrated a small impact on eating quality preferences (O'Reilly *et al.,* 2020b). Thus, assignment of sheepmeat products to quality grades may need adjustment to ensure quality expectations are met within export markets.

II.4. Marbling evaluation and factors effecting expression in French cows

The importance of fat infiltration or "marbling" in meat for organoleptic quality has been proved. Thus, this is a research axis of the French bovine meat interbranch organization (Interbev) to improve beef quality for consumers (Denoyelle *et al.,* 2022). In this respect, the French Livestock Institute (IDELE) developed a grid with 6 levels of marbling (from 1 (no marbling), to 6 (very high marbling)) for the French meat industry to be used in slaughterhouses. The objective of this study is to make a clear picture of marbling levels from French breeds and to see if professional opinions regarding possible factors affecting meat marbling would merit to be further studied. Marbling of 3218 carcasses from various breeds, categories and slaughterhouses have been evaluated by different graders. Most carcasses were from cows, they can be divided in three classes: 1/3 poorly marbled (1 or 2), 1/3 with a medium level (3) and the last third marbled or extremely marbled (4, 5 or 6). Different carcass traits seem to affect marbling levels. Once again, breed impact has been confirmed: early maturing breeds are more marbled (around 50% of dairy cows graded equal or more than 4) than late maturing ones (only 25% of beef cows). The category also affects marbling level: as previously seen in different studies, young beef bulls are poorly marbled (70 to 80% graded 1 or 2) whereas females have higher marbling score (only 25 to 30% graded 1 or 2). Moreover, carcasses with high marbling level are the more fatty, heavier and with the best conformation. This observation is linked to fattening which affects these characteristics and marbling deposition. However, a large variability exists at the same level of weight, conformation and fatness. Therefore, a given conformation, weight or fatness score doesn't guarantee a marbling level. Age effect on marbling is not really clear and has to be more studied. Thus, these results give references to the French meat industry to better answer to consumers' demands, especially from an organoleptic aspect.

II.5. Comparison of beef eating quality terminology databases

The standardisation of the evaluation of beef eating quality is a prerequisite to set up a global meat research database and to drive continuous improvement in meat quality prediction. This is the case of the Meat Standards Australia (MSA) methodology, which is based on common definitions of carcass characteristics for carcass graders to maintain skills and accreditation to ensure data consistency (Watson, Polkinghorne, and Thompson, 2008). In this line, the objective of this project was to extract and compare relevant terms related to beef eating quality present in pre-existing ontologies and terminology databases. The technical terms used in the MSA methodology were considered as the reference. Their equivalence in different languages (French, Portuguese and Spanish) including minor languages (e.g. Basque) was recorded. A semi-automatic search was carried out in existing databases. This was followed by a manual part to search for the available definitions and establish the equivalence of the terms in the different databases. A total of 19 databases freely accessible online were consulted, including specific ontologies for animal production, (ATOL, NAL USDA, and GACS), the Meat thesaurus available in the AGROPORTAL ontology, online dictionaries, and materials from world-renowned institutions (MLA, ICAR, USDA, IBEEF, AMSA). In total, we identified 56 terms used in the meat industry, in animal production, carcass quality and sensory characteristics. No database could find all the terms used in this research. Besides, some terms (marbling, subcutaneous fat thickness, carcass weight, ribeye area, etc.) are easy to find but are described differently in each database. For example, marbling is measured differently in some countries, which is important to point out in the database. In conclusion,

among the consulted sources and ontologies for animal production already established, some of the more specific terms used in the MSA methodology are still missing. Conversely, carcass classification databases lack information on pre-slaughter factors that influence beef quality, mainly for the MSA methodology.

III. NUTRITION AND METABOLISM EFFECTS ON THE EFFICIENCY OF BEEF AND LAMB PRODUCTION

III.1. Differences in liver nutrient metabolism contribute to residual feed intake of beef cattle

Residual feed intake (RFI) is a good measure of feed efficiency, which is defined as the difference between the actual dry matter intake (DMI) and the predicted DMI based on body size and growth. RFI is a trait independent of growth performance. Compared with the high RFI (HRFI), the low RFI (LRFI) animals can reduce feed consumption without affecting growth performance. As an important metabolic and immune organ, liver plays important roles in physiological processes. The changes of metabolism and gene expression may lead to the variation of feed efficiency. Ninety Angus heifers (410±25 kg, 15 months) were fed with the same diet for 144 days, and all conditions were consistent. All heifers had ad libitum access to water and feed. Daily feed intake of individual animals was obtained from an automatic feed intake recording system, and body weight was obtained at the beginning and end of the experiment and at 14-day intervals. Individual RFI value was calculated through dry matter intake, average daily gain, and middle metabolic weight. The liver samples of heifers were collected with the highest (n=6) and the lowest (n=6) RFI values, and stored at -80°C until subsequent analysis. The results showed that a total of 47 differential metabolites were identified in the liver with different RFI groups ($P<0.05$), which enriched in the following KEGG pathways: protein digestion and absorption, D-Glutamine and D-glutamate metabolism, and aminoacyl-tRNA biosynthesis ($q<0.05$). And a total of 495 differentially expressed genes were enriched in the following KEGG pathways: glutathione metabolism, PPAR signaling pathway, protein processing in the endoplasmic reticulum, B cell receptor signaling pathway ($q<0.05$). For proteomic analysis, a total of 411 differentially expressed proteins ($P<0.05$) only significantly enriched in the glycerophospholipid metabolism pathway ($q<0.05$). After further analysis, we found that PNPLA6, PTDSS1, DGK, CDS2, PNPLA8, LYPLA2 and GPAT4 were up-regulated in the LRFI group. Compared with the HRFI group, the LRFI group had stronger glycerolphospholipid synthesis, cell proliferation, cell membrane transport, cell signal transduction, and immune function, but fat transport was accelerated.

III.2. Effect of high sulfur diet on rumen fermentation and epithelial barrier function in beef cattle

The aim of the study was to investigate the mechanism of high-sulfur diet inducing rumen epithelial injury and inflammation. Eight 24-month-old Angus steers (350kg±43kg) fitted with permanent rumen fistulas were used in a repeated 4×4 Latin square design: Cattles in the control group were fed a basal diet (sulfur content was 0.4%, CON), and those in the experimental groups were fed a diet with sulfur content of 0.6% (LSD), 0.8% (MSD) and 1.0% (HSD) with sodium sulfate, respectively. Total gas production and methane gas concentrations were linearly decreased with dietary sulfur content increasing ($P<0.01$), while hydrogen sulfide gas concentration was significantly increased ($P<0.05$). Compared with CON, the concentration of TVFA and the proportion of butyric acid of HSD were significantly increased ($P<0.01$), but the proportion of propionic acid was significantly decreased ($P<0.01$). The concentration of NH3-N was not significantly different between LSD and MSD, but was significantly lower than that of CON and HSD ($P<0.01$). Total thickness of rumen epithelium in HSD was significantly higher than that in CON and LSD ($P=0.01$), but not significantly different with MSD. Specifically, the thickness of spinous layer and basal layer increased ($P=0.02$), while there was no significant difference between corneum and granular layer. The degree of peeling and keratinization on the rumen papilla surface was more obvious in the HSD. At the same time, the high-sulfur diet led to the formation of large cracks and sprouting of rumen epithelium. The bacteria attached to the rumen epithelium surface were mainly coccus and bacillus in CON, while the high-sulfur diet showed more fusarium and actinomycetes. qPCR results showed that the mRNA expression levels of TJP1 and CLDN-1 genes in rumen epithelial cells in HSD were significantly lower than those in CON ($P<0.05$). According to the above results, it can be inferred that dietary excess sulfur can affect rumen fermentation, change the type of rumen fermentation, and damage the integrity of rumen epithelium morphological structure, thereby increasing the permeability of rumen epithelium and destroying barrier function of beef cattle.

III.3. Comparison of slaughter performance and meat quality of Tan sheep under different feeding regimes

Grazing with time limited is a burgeoning production technology which improves production efficiency and maintains the balance between forage and animal. The change of feeding regime, however, had additional effects on the quality of the meat. The aim of this study is to accurately compare the slaughter performance and meat quality of the Tan Sheep under different feeding regimes. In this study, three groups of three-month-old Tan Sheep were raised in three regimes, grazing(G), grazing with time limited + supplementary feeding (GT) and indoor feeding (F). The sheep of three groups were slaughtered after three months. The results showed the final body weight of the GT was significantly higher than the G and F group. The proportion of subcutaneous fat to carcass of the F group was

significantly higher than GT and G groups. The proportion of tail fat to carcass of the F group was significantly higher than GT group, which was significantly higher than G groups. The Longissimus thoracis et lumborum (LTL) muscle pH45min of the G group was significantly higher than the F group, but pH24h was lower than F group. The initial and 24 hours after slaughter lightness of LTL muscle of the F group were significantly higher than the GT group and G group. The lightness of 48 hours after slaughter of LTL muscle of the F group was significantly higher than the GT group. The yellowness of 24 hours after slaughter of LTL muscle of the F group was significantly higher than the G group. The drip loss of the G group was significantly lower than the F group and the GT group. The cooking loss of the F group was significantly lower than the GT groups, which was lower than the G group. In summary, Tan Sheep under grazing with time limited + supplement feeding regime had higher meat production than grazing regime, and the meat quality was more similar to grazing sheep.

III.4. Effect of Piper sarmentosum extract on the growth and nutrient digestion of Hainan Black goat

Piper sarmentosum as a naturally occurring medicinal plant in the tropics, whose extracts have a wide range of bioactive substances due to their anti-inflammatory, antioxidant and insecticidal activities. This study was conducted to investigate the effects of Piper sarmentosum extract (PSE) addition on the growth performance and meat quality of Hainan black goat. Thirty-six goats (body weight = 9.48 ± 0.25 kg, age = 90 ±10 day; mean ± SD) were fed a 50:50 concentrate: roughage basal diet and randomly divided into four groups: 0 (control), 200 (200 PSE), 400 (400 PSE), or 600 mg/kg DM (600PSE) PSE, respectively. The experimental period was 105 days, with 15 days for adaptation and 90 days for data collection. The results showed that feed efficiency responded linearly ($P<0.05$) with the highest values for the 400PSE group. Average daily gain and dry matter gain were not affected by dietary supplementation with PSE ($P>0.05$). Dietary supplementation with PSE linearly increased the pH24h of longissimus dorsi (LD) muscle ($P<0.05$) but decreased the value of L*24 h ($P<0.05$). As supplementation with the PSE increased, the value of b* in LD muscle responded linearly ($P<0.05$), and 600PSE group had lower values of b*45 min and b*24h than other treatment groups ($P<0.05$). The carcass weight, net meat weight and internal organ development indexes were not influenced by dietary supplementation with PSE ($P>0.05$). Goats receiving 400 mg/kg DM PSE addition had higher digestibility of DM, NDF and ADF ($P<0.05$). In addition, the serum content of glucose, IL-2, IL-4 and IL-6 responded linearly ($P<0.05$) with addition of PSE. The blood activity of glutathione peroxidase and level of total antioxidant capacity were linearly ($P<0.05$) increased in the PSE addition groups whereas decreased in malondialdehyde ($P<0.05$). Therefore, the results indicated that dietary addition of 400 mg/kg DM PSE improved feed efficiency, nutrient digestion and antioxidant capacity in Hainan black goats.

III.5. Effects of grazing intensities and supplementary levels on the nutritional composition of lamb meat

Our research objective is to determine the effects of different grazing intensities and supplementary levels on the nutritional composition of lamb meat. Six treatments were compared, with 2 grazing intensities and 3 supplementary levels investigated at both grazing intensities. The 2 grazing intensities were moderate grazing (MG, the utilization rate of grassland is 80%, the plot area is 0.2 ha) and heavy grazing (HG, the utilization rate of grassland is 40%, the plot area is 0.4 ha); The 3 supplementary levels were as follows: 0% supplement (NS), 1% supplement (LS) and 2% supplement (HS) of lamb weight. 72 healthy three-month-old male Hulunbeier lambs were used in a randomized complete block design and divided in 6 groups for the entire experiment, which had 12 lambs (3 plots for each treatment, and 4 lambs in each plot) in each treatment group. After 90 days of grazing, the slaughter experiment was conducted. The results showed that the GR value of lambs decreased with the increase of grazing intensity as well as the decrease of supplementary level ($P>0.05$). The net meat percentage increased with the increase of supplementary level ($P>0.05$). The water content of lumborum muscle in of NS group was higher than that of LS and HS groups ($P>0.05$) and crude protein content was increased in LS group compared to NS group ($P>0.05$). Decreasing the intensity of grazing and increasing the level of supplementary led to a linear increase the proportion of intramuscular fat ($P>0.05$). The n-3 PUFA, including C18:3n3 and C20:5n3 increased in muscle of NS group, and the ratio of n-6/n-3 decreased from 4.76 to 3.03 with decreased supplement level, while the ratio of MUFA to SFA increased in HS group ($P>0.05$). The HG group and NS group increased the contents of EAA (e.g., threonine, valine, isoleucine, leucine, phenylalanine and lysine) and sweet amino acids (e.g., asparagine, glutamicacid, alanine and arginine) ($P>0.05$), compared to MG group and supplementary groups. In conclusion, moderate grazing and supplementary concentrate improved the yield and quality of lamb meat (Yang *et al.,* 2008), while the meat content of fatty acids and amino acids under NS or HG was more beneficial to human health.

CONCLUSION

The meat industry in China is on a transformative journey towards quality, sustainability and consumer satisfaction, aligning with the goal of the global meat sector. This transformation is driven by a synergy of global collaboration and research advancements, as well as a growing demand for both quality and quantity of meat and the recognition of the multifaceted nature of the Chinese meat industry. With the culmination of the COVID-19 pandemic, the meat sector shows great promise for further collaboration and innovation into the future. One notable

aspect of achieving such a goal is the successful tripartite cooperation between China, France, and Australia, and other countries. It is evident that the future holds even greater potential for research cooperation, knowledge exchange, and further advancements in meat production and quality assurance.

The significant global variation in attitudes towards livestock meat production, meat quality perception, and consumer demands underscores the imperative need for ongoing worldwide research on consumer preferences related to meat production and quality. This research should account for demographic factors and continuously evolving industry practices. A key aspect of this evolution includes the standardization of meat quality descriptors and assessment procedures. The absence of precise quality descriptions contributes to the decline in meat consumption. Moreover, the use of varying quality descriptors poses a challenge. For instance, in Europe, the prevailing carcass classification criteria primarily focuses on yield rather than meat quality. Furthermore, even when the same quality trait are applied, the descriptions and operations (measurements) can vary. Therefore, there is a pressing need to establish a consistent terminology to enable effective quality evaluation. Notably, marbling, a well-recognized quality trait, has gained increased attention within the beef industry, particularly in France. While the widespread adoption of a marbling trait is yet to be fully realized in both Europe and China, the research into marbling assessment, the notable advancements in Australia, and the ongoing research in French cows, offer valuable insights for industry practices in Europe and China, and all over the world. This progress has the potential to pave the way for the broader integration of this essential quality attribute.

In the current context of heightened societal concerns of ethics, the environment and human health, the relationship between livestock farming, genetics, nutrition, metabolism, and meat production efficiency provides valuable insights into the determinants of farming efficiency and the overall meat quality. Thus, interdisciplinary research is indispensable for advancing sustainability and meat quality. Such research plays an invaluable role in enhancing production practices and safeguarding the long-term sustainability of the industry. The future path of global livestock production and meat research, with a particular emphasis on China, ought to be in alignment with this direction.

As the livestock industry continues to evolve, collaboration and research will remain central to its growth. The diverse studies presented in the 74th EAAP - European Federation of Animal Science highlight the ongoing commitment to enhancing the meat industry's sustainability, quality, and consumer needs and preferences. These endeavours lay the foundation for a future of greater innovation, deeper exploration, and international cooperation, ensuring that the livestock industry meets the challenges of a changing world.

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