

Effect of supplementation with a mixture of *Curcuma longa* and *Rosmarinus officinalis* extracts on growth performance, meat quality and lipid metabolism gene expressions in young castrated Polish White Improved bucks

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ABSTRACT. Caprine products are an important component of the economy and nutrition in many countries. Goat meat has a specific taste, and its quality can be influenced by the diet of the goats themselves. The aim of the study was to analyse the effect of supplementation with a mixture of dried *Curcuma longa* (turmeric) and *Rosmarinus officinalis* (rosemary) extracts on meat quality traits and the expression of genes associated with fatty acid metabolism in young castrated Polish White Improved bucks. These genes included diacylglycerol-o-acyltransferase (*DGAT1*), stearoyl-CoA desaturase (*SCD*), lipoprotein lipase (*LPL*), adipose triglyceride lipase (*ATGL*), acetyl-coenzyme A carboxylase alpha (*ACACA*) and peroxisome proliferator-activated receptor gamma (*PPAR γ*), sterol regulatory element-binding transcription factor (*SREBF1*). The use of extracts had no apparent effect on the quality of buck meat. The bucks supplemented with an extract mixture were heavier after 124 days of rearing than controls, primarily due to greater daily weight gain. They had higher cold carcass weights and improved slaughter performance. No differences in the expression of lipid metabolism genes were recorded, indicating that supplementation did not negatively affect metabolic processes. During meat maturation, both groups exhibited similar changes in lightness and pH. However, the colorimetric analysis revealed lower a^* and b^* values, indicating paler meat – desirable for consumers. It can be suggested that the supplementation with a mixture of dried *C. longa* and *R. officinalis* extracts did not negatively impact the culinary quality of the meat. However, further research is necessary to fully understand the effects of the supplementation.

Introduction

Caprine products hold significant economic importance in many countries. At the end of the 20th

century, the goat industry, especially milk production, experienced substantial growth and development (Dubeuf, 2021). Currently, goat breeding has a high economic value, especially on small farms

and rural areas, and women play a vital role in their rearing. Due to their adaptive traits, and thus lower maintenance requirements, indigenous goats tend to dominate in regions with lower levels of development (Monau et al., 2020). Although most dairy goats are bred in low-income countries, they are gaining popularity in developed and high-income countries. For example, goat production is associated with lower greenhouse gas emission than other ruminants, which aligns with environmental protection efforts (Dubeuf, 2021).

Depending on the breed, goats can provide dairy, skin, wool, and meat products. Goat meat (chevon) has a specific taste influenced by both genetics and diet. It is a lean meat with favourable nutritional qualities, making it a staple red meat in many regions across the world (Ceyhan and Ul Hassan, 2023). Goat meat is recognized for its high-quality protein, healthy fatty acids, vitamins, micro- and macronutrients such as riboflavin, iron, vitamin B₁₂, zinc or potassium. In developed countries, goat meat has gained attention as it can be the basis of weight loss diets due to its lower fat content compared to other meats. The increasing global consumption of this meat reflects its growing popularity and recognition of its nutritional value (Chambers, 2001).

With stricter regulations on antibiotic use and generally increased consumer interest in the origin and quality of meat, there is a growing need to identify natural additives that can enhance animal growth and improve meat quality. Nutraceuticals, including various bioactive compounds, have shown potential in improving the quality of meat, including beef. As a result, the inclusion of herbs in animal nutrition is becoming more common. Turmeric (*Curcuma longa*) and rosemary (*Rosmarinus officinalis*) are among the most promising herbs for use in ruminants. These herbs contain bioactive compounds that are known to exert beneficial effects on animal health and meat quality (Waszkiewicz-Robak et al., 2017).

Curcuma longa (turmeric) is a plant belonging to the ginger family (*Zingiberaceae*). It is mainly used for culinary purposes and in industry as a colouring agent. Additionally, turmeric has been utilised in traditional medicine systems to improve digestion, cleanse and strengthen the liver and gallbladder, enhance metabolism, as well as an anti-inflammatory, antioxidant, antibacterial and antifungal agent in animal and human nutrition (Mughal, 2019; Kumar and Sakhya, 2013). Turmeric has been shown to affect rumen fermentation, and consequently, reduce gas production (Faniyi et al., 2016). At present,

turmeric is considered a highly promising natural product with a broad pharmacological spectrum. However, detailed research on turmeric's mechanism of action is needed to develop drugs for specific diseases or disorders (Verma et al., 2018).

Rosmarinus officinalis, commonly known as rosemary, is a member of the family *Lamiaceae*. It is cultivated as an ornamental and aromatic plant, and it is commonly used as a spice. In traditional medicine, it has been applied as a stimulant, analgesic, and an agent improving circulation, soothing inflammatory diseases, and exerting hepatoprotective effect (Rašković et al., 2014). One of the notable characteristics of rosemary, resembling turmeric, is its strong antioxidant effect (Faniyi et al., 2016), delaying lipid oxidation in biological systems and food. It is anticipated that it can be used in functional foods, pharmaceutical products, and food preservation applications (Nieto and Castillo, 2018).

In order for raw meat to be suitable for processing, it must have an appropriate pH value. This parameter of meat influences colour, water holding capacity, shear force and tenderness. Goat meat tends to have a higher pH compare to meat from other species (pH > 6) (Shija et al., 2013). This can be attributed, at least in part, to stressful perimortem handling of animals or the presence of diseases prior to slaughter. Meat with abnormally high pH values tends to be of inferior quality, with a less pronounced taste and a darker colour. Moreover, meat with higher pH values tends to have a shorter shelf life, as it is more prone to spoilage and bacterial growth (Chambers, 2001).

The second important factor is intramuscular fat (IMF), i.e. spots and streaks of fat in lean sections of meat, also known as marbling, which is associated with juiciness and flavour. It is acquired through lipid synthesis and transport, i.e. essential processes occurring during muscle mass gain. Lipid metabolism is controlled at the genetic level by a number of genes, including diacylglycerol-o-acyltransferase (*DGATI*), stearoyl-CoA desaturase (*SCD*), lipoprotein lipase (*LPL*), adipose triglyceride lipase (*ATGL*), acetyl-coenzyme A carboxylase alpha (*ACACA*), peroxisome proliferator-activated receptor gamma (*PPAR γ*), and sterol regulatory element-binding transcription factor (*SREBF1*) (Shi et al., 2013).

The aim of the study was to determine the effect of supplementation with a mixture of dried *C. longa* and *R. officinalis* extracts on basic slaughter parameters and the expression of genes associated with fatty acid metabolism (*DGATI*, *SCD*, *LPL*, *ATGL*, *ACACA*, *PPAR γ* , *SREBF1*) in young castrated Polish White Improved (PWI) goat bucks.

Material and methods

Animal material

The study included 20 PWI young bucks, castrated at the age of three months. The experiment started when the bucks were eight months old and lasted for 124 days. The mean live weight of the bucks was 28.80 kg (\pm 4.93 kg). Goats from this herd were tested serologically for small ruminant lentivirus (SRLV) infection twice a year for more than 20 years, and the bucks were free of SRLV (Czopowicz et al., 2018). To avoid caprine arthritis-encephalitis (CAE), all kids were weaned directly after kidding. The young animals were also serologically tested at the age of six months and just before and the end of the experiment. The bucks were fed according to the system developed by the French Institut National de la Recherche Agronomique (INRA) and adapted by the National Research Institute of Animal Production to the Polish conditions (Strzetelski et al., 2014). The animals were provided with unlimited access to water and salt licks throughout the study. The basal diet comprised high-quality meadow hay (60.8% dry matter (DM)), oats (grain) (19.3% DM), and wheat bran (19.9% DM) offered *ad libitum*. The diet was supplemented with a standard vitamin and mineral mixture routinely used in the herd.

The bucks were divided into a control group ($n = 10$) and an experimental group ($n = 10$). The latter was supplemented with a mixture of dried extract from *R. officinalis* and *C. longa* at a ratio of 896:19 (Selko[®] AOmix, Trouw Nutrition Polska sp. z o.o., Grodzisk Mazowiecki, Poland). A significantly higher ratio of rosemary to turmeric was also used previously by Hashemzadeh-Cigari et al. (2014). The dose of 1.6 g/day, as recommended by the producer for dairy goats, was also consulted for young castrated bucks with a representative of the company. The supplement was provided individually to the bucks in starch capsules, which were administered orally before the morning feeding. During slaughter in a certified slaughterhouse, liver fragments were collected and immediately frozen in liquid nitrogen and stored at -80°C for further analysis.

Measurements of meat quality traits

Live weight was measured before the experiment (LW1) and at the end of the experiment just before the slaughter (LW2). Based on these measurements, the daily gains of the bucks were calculated. After slaughter, all carcasses were weighed to determine the cold carcass weight (CCW), and slaughter performance (SP) parameters were estimated.

Meat was determined using a CP-251 pH meter (Elmetron, Zabrze, Poland) by inserting an electrode into the muscle and reading the value off the liquid crystal display. Readings were recorded 1 h (pH1) and 48 h after slaughter (pH48) along with temperature measurements. Both measurements were taken at three points along the longest dorsal muscle (loin), i.e. in the neck, dorsal and lumbar sections. The pH meter was calibrated by placing the electrode in a buffer at $\text{pH} = 7$. After about a minute, when the measurement stabilised, the electrode was rinsed with demineralised water and then placed in a buffer at $\text{pH} = 4$. The procedure was repeated until a reliable measurement was obtained in both liquids.

Meat colour analysis was conducted by measuring the degree of light reflection from the tested sample in the range from 400 to 700 nm at 20 nm intervals. The CIELab (International Commission on Illumination system) parameters, i.e. L^* (lightness), a^* (+/, red to green), and b^* (+/, yellow to blue) values of the meat samples were determined using a Minolta CR 200b colorimeter (Illuminant C, 0 viewing angle). Meat colour was assessed simultaneously with pH measurements, 24 h after slaughter.

Gene expression

Total RNA was isolated using a RNeasy Mini Kit (Qiagen, Hilden, Germany) according to the manufacturer's protocol. Qualitative and quantitative analysis of RNA was performed using a NanoDrop 2000 spectrophotometer (NanoDrop, Wilmington, USA) and a 2100 BioAnalyzer (Agilent Technologies, Massy, France). Reverse transcription was performed using the Transcriptor First Strand cDNA Synthesis Kit (Roche, Basel, Switzerland) according to the manufacturer's protocol. The isolated cDNA was diluted to 50 ng/ μl and used as a template to perform real-time PCR reactions.

The mRNA expression of the seven selected genes (Table 1) was measured in the liver, as it is one of the two (besides adipose tissue) central tissues involved in whole-body energy metabolism. Moreover, previous pharmacokinetic studies on animals have demonstrated that most of the absorbed flavonoids from turmeric is metabolised in the liver. Transcript levels were determined by real-time PCR using a LightCycler[®] 480 thermocycler (Roche, Basel, Switzerland). The sequences of the primers used in the analyses are shown in Table 1. Cyclophilin A (*PPIA*) and battenin (*CLN3*) were used as the reference genes (Jarczak et al., 2014). The reaction mixtures were prepared using the commercial LightCycler[®] 480 SYBR Green I Master kit (Roche, Basel, Switzerland) according to the manufacturer's

Table 1. Gene name, symbol, primer sequences, amplification product sizes, GenBank accession numbers and references to primer sequences

Gene name	Gene symbol	Primer sequence	Product size (bp*)	GenBank/UniProt Accession	Reference
Cyclophilin A	<i>PPIA</i>	F GGATTATGTGCCAGGGTGGTGA R CAAGATGCCAGGACCTGTATG	120	AY_247029.1	Jarczak et al. (2014)
Battenin	<i>CLN3</i>	F TTCTGACTCCTTGGGACACA R CAACCTGCCCACCTATCAGT	62	NM_001075174	Jarczak et al. (2014)
Diacylglycerol O-Acyltransferase	<i>DGAT1</i>	F CCACTGGGACCTGAGGTGTC R GCATCACCACACCAATTCA	101	DQ380249.1	Shi et al. (2013)
Stearoyl-CoA desaturase	<i>SCD</i>	F TGCTGACAACCTATCTGGATGC R AAGGAATCCTGCAAACAGCTA	178	AF325499.1	Dong et al. (2013)
Lipoprotein lipase	<i>LPL</i>	F TTCAGAGGCTATTACTGGAAATCC R ATGTCAATCACAGCATTCTACT	235	JQ670882.1	Dong et al. (2013)
Adipose triglyceride lipase	<i>ATGL</i>	F GGAGCTTATCCAGGCCAAT R TCGGGCAGATGCTACTC	180	GQ918145.1	Dong et al. (2013)
Acetyl-coenzyme A carboxylase alpha	<i>ACACA</i>	F CATGAAATGTACGCGGACC R GGTGGTAGATGGGAAGGAGGA	230	NM_001009256	Dong et al. (2013)
Peroxisome proliferators-activated receptor γ	<i>PPARγ</i>	F CATTCTGCTCCGCACTAC R TGGAACCCTGACGCTTT	238	JN854246.1	Dong et al. (2013)
Sterol regulatory element-binding transcription factor	<i>SREBF1</i>	F CTGCTGACCGACATAGAAGACAT R GTAGGGCGGGTCAAACAGG	81	HM443643.1	Shi et al. (2013)

*bp – base pairs; F – forward primer, R – reverse primer

protocol. Primer annealing temperature was optimised in preliminary tests performed on cDNA mixtures by PCR, and the experimental primer annealing step was set to 45 cycles at 60 °C. The size of the PCR products was determined by running 2% agarose gel electrophoresis and visualising the bands using a G:BOX device (Syngene, Frederick, USA).

Statistical analysis

To assess the normality of the distribution, the PROC UNIVARIATE procedure of SAS package (SAS/STAT, 2002-2012, version 9.4) was employed. Before analysis, the relative expression of the studied genes was transposed using a natural logarithm. Subsequently, comparisons were performed using analysis of variance (ANOVA) and the GLM procedure implemented in the SAS package. The model included a fixed group effect, as all other effects were the same in both groups.

Results

At the end of the experiment, the goats in the experimental group, which received the turmeric and rosemary mixture, were almost 4 kg heavier (LW2) compared to the control group (41.4 vs. 37.7 kg). The experimental group also had a higher CCW and slaughter performance (Table 2). Moreover, the supplemented animals demonstrated a higher average daily gain in relation to control animals, although the *P*-value of 0.11 (Table 2) indicated rather a trend; however, changes are typically considered trends within the range of $0.05 < P < 0.1$ (Fagergren et al., 2003; Bruce et al., 2009).

In the current study, there were no significant differences in pH values between the control and experimental groups measured one hour and 48 h after slaughter. This indicates that the rate of pH decrease was similar in both groups, regardless of supple-

Table 2. Least square means (LSMEANS) and their standard error (SE) for live weight at the beginning and the end of the experiment, daily gain, carcass weight, and slaughter performance for bucks supplemented with a mixture of dried *Rosmarinus officinalis* and *Curcuma longa* extracts and control animals without supplementation

Group	Trait									
	LW1, kg		LW2, kg		CCW, kg		SP, %		DG, g	
	LSMEAN	SE	LSMEAN	SE	LSMEAN	SE	LSMEAN	SE	LSMEAN	SE
Control	27.65		37.70 ^a	1.159	16.66 ^a	0.818	43.46 ^a	0.557	81.12 ^c	4.691
Experimental	29.96 [#]	0.951	41.40 ^{bs}		18.91 ^b		45.21 ^b		92.18 ^a	

LW1 – live weight at the beginning of the experiment; LW2 – live weight at the end of the experiment; CCW – cold carcass weight; SP – slaughter performance; DG – daily gain; ^{ab} – different letters within columns indicate significant differences at $P \leq 0.05$, ^{#s} – different symbols within rows indicate significant differences at $0.05 < P < 0.1$, [^] – different symbols within column indicate significant difference at $P = 0.11$ (tendency)

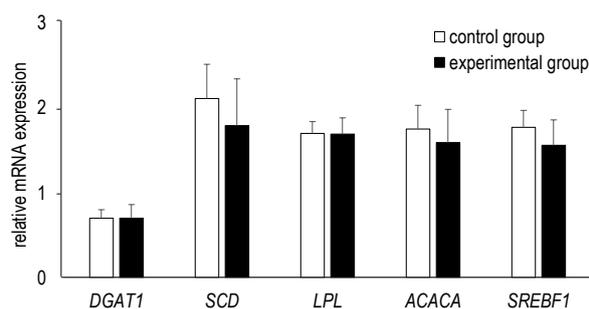
Table 3. Least square means (LSMEANS) and their standard error (SE) for selected meat quality parameters of bucks supplemented with a mixture of dried *Rosmarinus officinalis* and *Curcuma longa* extracts, and control animals without supplementation

Group	Trait									
	pH 1 h		pH 48 h		L^*		a^*		b^*	
	LSMEAN	SE	LSMEAN	SE	LSMEAN	SE	LSMEAN	SE	LSMEAN	SE
Control	6.58 [#]		5.08 [#]		38.84	0.988	23.56 ^a	0.569	2.32 ^a	0.219
Experimental	6.26 [#]	0.112	5.20 [#]	0.301	40.16		21.26 ^b		1.75 ^b	

L^* (lightness), a^* (+/, red to green), and b^* (+/, yellow to blue); ^{ab} – different letters within columns indicate significant differences at $0.05 < P < 0.1$, [#] – different symbols within rows indicate significant differences at $0.05 < P < 0.1$

mentation. The values of a^* and b^* colour components were lower in the experimental group; however, L^* did not differ between the groups (Table 3). Meat temperatures were comparable between the two groups, averaging 21.9°C and 22.44 °C ($P = 0.52$), respectively, after 1 hour, and 9.28 °C and 9.84 °C ($P = 0.51$), respectively, after 48 h.

The expression of the *ATGL* and *PPAR γ* genes was not detected. In addition, there were no differences in the expression of the *DGAT1*, *SCD*, *LPL*, *ACACA* or *SREBF1* genes in the liver between bucks from the control and experimental groups (Figure 1).

**Figure 1.** Expression of the studied genes in the liver of bucks from the experimental and control groups

DGAT1 – diacylglycerol O-acyltransferase; *SCD* – stearoyl-CoA desaturase; *LPL* – lipoprotein lipase; *ACACA* – acetyl-coenzyme A carboxylase alpha; *SREBF1* – sterol regulatory element-binding transcription factor. No significant differences between the groups were recorded at $P > 0.05$.

Discussion

Achieving optimal live weight gain and body weight (BW) before slaughter is an important factor in goat production. Studies have found that supplementation with different herbs and protein sources can improve BW gain. For example, greater daily weight gain was observed following curcumin supplementation in lambs (Marcon et al., 2021), and similar results were recorded after turmeric powder supplementation in goats (Amosu et al., 2020). These reports are consistent with our findings in terms of higher LW2, CCW and SP in the experimental group that received supplementation compared to controls; in addition,

the supplemented bucks demonstrated higher average daily gain. Previous studies have indicated that herbal supplementation may have economic benefits.

After the slaughter process, the pH of meat tends to decrease due to endogenous changes. This decrease in pH has a negative impact on the water binding capacity of the meat, affecting its appearance. One of the contributing factors to this pH decrease is the conversion of glycogen into lactic acid, as well as the release of phosphoric acid from adenosine triphosphate (ATP) (Chambers, 2001). In the present study, similar pH values were recorded in both the experimental and control groups. This similarity in pH suggests that the level of animal welfare and the degree of juice leakage in the meat were similar between the two groups.

Goat meat is recognized for its nutritional value and distinct characteristics, making it a popular food choice in many cultures worldwide. Many studies have reported high pH values for goat muscles, which has been associated with the temperament of the animals (Kenny and Tarrant, 1988). Aplocina et al. (2019) recorded higher pH values in goat kid meat (pH 5.77–5.87) compared to lamb meat (pH 5.69–5.71), suggesting a higher likelihood of stress in goats. This was confirmed by peri-mortem concentrations of glycolytic metabolites in muscles (Webb, 2014) and blood (Kannan et al., 2002). Additionally, other studies indicated the presence of normal, or near normal, pH values, e.g. in the meat of Boer x Angora feral goats (Dhanda et al., 1999) or older castrates (Kannan et al., 2003). This suggests that high pH is not necessarily an intrinsic characteristic of the species. Furthermore, goat carcasses with lower pH values tend to have improved tenderness, attributed to longer sarcomeres after chilling, lower shear force values and better colorimetric values compared to those with high pH (Simela et al., 2004).

The quality of meat is strongly influenced by the state of water binding and its visual appearance in terms of colour lightness. Colour is one of the most important distinguishing features in consumer meat evaluation (Jakubowska et al., 2004).

The L^* value is a measurement of lightness, ranging from 0 (dark) to 100 (light), with higher L^* values indicating paler meat. The myoglobin levels in the meat influence two chromatic components: a^* , representing the green ($-60, 180^\circ$) to red range ($+60, 0^\circ$) and b^* , representing the blue ($-60, 270^\circ$) to yellow range ($+60, 90^\circ$) (van Wyk et al., 2022). In the present study, no significant differences were found in the L^* values between the experimental and control groups. It is known that there is a significant linear relationship between the active meat acidity and L^* , with higher L^* values associated with lower pH levels; this contributes to water drip loss from meat during storage (Jankowiak et al., 2021). The similar decrease in pH observed over a 48-h period, along with the almost equal L^* values in the meat from both groups at both measurement points suggested that the supplementation did not decrease the culinary quality of the meat. However, this conclusion requires further specialised studies on meat quality.

In meat classification, a high, positive a^* value indicates an intense red colouring, while a high, positive b^* value represents an intense yellow colour. These two parameters are major factors in the consumer acceptance of ruminant meat and fat. Lower a^* and b^* values were recorded in the experimental group, suggesting an association between supplementation and a decrease in oxymyoglobin (OMb) concentration. OMb is responsible for bright cherry colour of the meat (Karami and Bagheri, 2019), and consumers associate this trait with freshness. However, kid meat has a higher a^* value than lamb meat due to the lower content of intramuscular fat. Moreover, lower OMb levels reduce the accumulation of meat juice (van Wyk et al., 2022). The content of meat juice is also an important factor of meat quality, as high meat juice retention is associated with firmness and higher cooking quality; this is especially important when cooking large cuts of meat, where meat juice is needed to obtain a juicy meal (Aaslyng, 2009).

Colour is another important factor considered by consumers when choosing meat. Most studies have focused on the colours of beef and lamb meat. While lamb consumers preferring redder meat choose heavy lambs and those preferring pale flesh choose light lambs, goat meat consumers prefer rather paler and duller meat, with a greater hue angle and lower redness and chroma. The best young goat meat is characterised by high L^* and low C^*ab values (Ripoll, et al., 2019), which align with the characteristics observed in the experi-

mental group of the present study. In the central European climate zone, a bright red colour is desirable for fresh beef, lamb, and goat meat. However, for goat meat, lower a^* and b^* values, indicating paler meat, can be considered appealing to consumers. These characteristics of goat meat offer similar organoleptic experience (taste, smell, colour) and nutritional value as lamb or veal. Here, the experimental group has demonstrated lower a^* and b^* values, i.e. paler meat, which is more preferred by consumers.

Of the tested genes associated with fatty acid metabolism, only *AGTL* and *PPAR γ* were not expressed. This observation is consistent with previous studies indicating that these genes are primarily expressed in epithelial cells and the semitendinosus (ST) muscle in goats (Shi et al., 2013). The *ATGL* protein participates in triglyceride lipolysis and regulates lipid release and storage in adipocytes. *PPAR γ* in turn is essential for fat metabolism, as it is involved in lipid metabolism and facilitates myogenesis and lipogenesis (Li et al., 2013). In the liver, it regulates fatty acid uptake and oxidation, although its expression is lower in ruminants than non-ruminants (Li et al., 2013). It is known that lipid metabolism in the liver may not play a significant role in the increased accumulation of adipose tissue in bucks after castration, as supplementation was not shown to stimulate the expression of these genes in the liver of castrated bucks (Baik et al., 2014).

The absence of *PPAR γ* transcripts in the present study was unlikely to affect *SCD*, *ACACA* or *LPL* expression. *PPAR- γ* is a key transcription factor that regulates *SCD* expression in ruminants, which is also modulated by several nutrients, mainly fatty acids (Pardo et al., 2022). However, the supplementation with a mixture of *C. longa* and *R. officinalis* extracts did not affect the expression of this gene. These findings are consistent with another study in goats where supplementation with elevated levels of rumen-undegradable protein (RUP) and tannin-rich peanut skin (PS) did not result in differences in *SCD* expression (Ryel Min et al., 2020). Moreover, in the present study, supplementation showed no significant effect on *SREBF1* expression.

Both *PPAR- γ* and *SREBF1* are known to regulate the expression of *ACACA*, a key enzyme involved in fatty acid synthesis. It is also associated with conformation traits and meat fat composition in bovines (Pardo et al., 2022). *LPL* is another significant player in fatty acid metabolism. It modulates the breakdown of triglycerides, and the metabolism of fatty acids. As a result, *LPL* plays

an important role in determining muscle lipid composition. The protein encoded by the *DGATI* gene plays a key role in triglyceride synthesis by regulating lipid digestion and absorption, and participates in fat deposition associated with meat quality (Khan et al., 2021).

The lack of *ATGL* and *PPAR γ* expression, as well as the lack of differences in the expression of the *DGATI*, *SCD*, *LPL*, *ACACA* and *SREBF1* genes between the two groups indicated that the supplementation of turmeric-curcumin extract mixture did not negatively affect the lipid metabolism in the tested goats. Furthermore, the lack of expression or absence of differences in the expression profile of genes associated with lipid metabolism probably cannot be explained by castration (Baik et al., 2014).

Conclusions

The mixture of turmeric and curcumin extracts did not negatively affect the lipid metabolism of the castrated young bucks, while it increased daily weight gain, live weight before slaughter, cold carcass weight and slaughter performance of the castrated bucks. The supplementation did not decrease the culinary quality of the meat, while the lower *a** and *b** values could be considered a desirable trait from a consumer perspective. The turmeric-curcumin extract mixture positively affected fattening indicators and meat colour. However, further specialised research is needed to comprehensively understand the impact of supplementation on meat quality.

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Conflict of interest

The Authors declare that there is no conflict of interest.

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