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Incorporation of Herbal Plants in the Diet of Ruminants: Effect on Meat Quality: Review

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A B S T R A C T

The use of herbal plants as food additives in animal nutrition to enhance meat processing efficiency and meat quality has been reviewed. Today, the consumer demand is safety, nutritive value, taste, uniformity, meat variety and good appearance of meat products. Thus, to meet the consumers' demand, development of product and research should be improved. Studies have been shown that the use of herbs, spices, and their extracts are of the major interventions, which were adopted in the industry of the meat for improving its quality traits. In the present paper, the most recent literature about use of bioactive compounds in herbal plants for evaluating a number of parameters related to meat quality, including fat content and distribution, water content, water holding capacity, collagen content, pH, tenderness color, Lipid oxidation and flavor were reviewed.

Keywords: Ruminants, herbal plants, lipid oxidation, meat pH and meat quality

Introduction

Increasing the awareness of consuming red meat and its products were observed recently. For instance, World Health Organization (WHO) reported the characterization of the red meat intake "probably carcinogenic to humans" (1). While number of gaps of the knowledge concerning this topic was referred by others (2). In addition, consumption of red meat has been associated with a greater incidence of chronic diseases (3). As a result, new breeding techniques like adding herbal plants as antioxidant have been increased interest which provides potential benefits of health to consumer. Thus, dietary supplemented with natural antioxidants for example, rosemary, curcuma, oregano, and Thyme are considered a most effective techniques for modifying and improving composition of fatty acid in ruminant's meat to reach the consumer demands (4). Nutritional unsaturated fatty acids have accentuated as an active way of adjusting the fatty acid composition of ruminants' meat (5). Nevertheless, unsaturated dietary fats in ruminants can cause oxidative stress (6). It can also predispose meat to lipid or protein oxidation (7) that could influence shelf life, nutritional value and sensory properties in ruminants' meat (8). Consequently, improving unsaturated fatty acids in the meat of ruminants needs concomitant antioxidant improvement to attenuate protein oxidation or lipid oxidation; thus, food industry has been required to use natural antioxidants such as *Nigella sativa*, Curcumin and *Andrographis paniculata* in different products to enhance food quality and nutrition value, substitute synthetic antioxidants and delay oxidative of lipid degradation (9).

Case in point, compared with the direct addition to meat products, the muscle foods stability greatly improved, after the incorporation of food additives in ruminants' feed, because antioxidants are deposited where they are most required. The best available technology is the use of natural antioxidants in animal feed to modify the stability of oxidative of intact muscle food. In addition, the beneficial effects of including natural antioxidants in the feed on health of man because they protect important biological cellular components from reactive oxygen species (ROS) attacks including proteins, membrane lipids and DNA (10). Thus, natural antioxidants such as spices, herbs and their extracts has been added to a multiplicity of foods to enhance their sensory characteristics and increase shelf-life (11). The opportunity of ruminants has been also feeding diets provides with medicinal plant and aromatic like sage, thyme leaf and rosemary as natural antimicrobials and antioxidants a very intriguing prospect to substitute synthetic antioxidants (12).

The primary aim of this paper is a review of the most recent literature about use of bioactive compounds in herbal plants on consumer acceptability of ruminant meat, including the fat content and distribution, water content, water holding capacity, collagen content, pH, tenderness color, lipid oxidation and flavor.

The Impact of Red Meat Eating on Human Health

Meat consumption has markedly increased in latest years. Food Agriculture Organization statistics (FAO) showed that meat consumption has risen worldwide from (~30 kg/person/year) in the 80's to (~43.4 kg/person/year) in 2015 (13), with values in the USA as high as (~125 kg/person/year) (14). Despite, the 2016 US Dietary Guidelines for Americans recommend that red meat and its products can be consumed in moderation (15). These guidelines are based in part on epidemiological evidence linking to high red meat consumption to an increased risk of type 2 diabetes and digestive system diseases, potential risk for stroke, cancer, and cardiovascular disease (16, 17). Health status as regards red meat consumers has always been a scientific field of much interest. Nonetheless, consumers have already become more health-conscious, so they concerned about cholesterol and saturated fat intake, as well as a high acid load from meat consumption (18, 3). As it is well-known, cholesterol is an important lipids factor that has a bad image due to its negative health effects. According to the American Heart Association (19) for humans with normal cholesterol levels in blood, daily fat intake should not exceed 30% of total calories and also cholesterol consumption should be less than 300 mg/d, as elevated levels of (LDL-C) low-density lipoprotein cholesterol as well as levels of plasma triglycerides are linked to an increased risk of (CVD) cardiovascular disease (20). In fact, the proximate composition of red meat is highly encouraging such as the fat and fatty acid content which could be one of the factors causing cardiovascular disease (CVD) (21). Several studies have confirmed that it is possible to change the meat image and meat products from commonly known image to one of healthy living, elimination fats, reduction saturated fatty acid and adding herbs, fibers, spices, and extracts, etc., by modifying the ruminants 'diet (22, 23). In the case of meat, the purpose of using functional ingredients in the diets is not only to provide the meat some attractive qualities, as well as to improve its picture during these health-conscious times. However, meat is beneficial to one's health with respect to obesity for instance, and it has satiating properties. This aspect is very significant in the production of functional meat products that are tasty and satisfying (22). Fatty acid and vitamin E content can be changed through modify the ruminant's feed (23) for example adding herbal plants to the diets could improve fatty acid profile in muscle in lambs (24). It should be possible to create new meat products with potential health benefits by incorporating natural bioactive compounds. These meat products would create a whole new market for the meat industry (12).

Certain Factors that Have an Effect on Ruminant Meat

Ruminant meat is influenced by myriad factors, which can be broadly categorized as intrinsic and extrinsic factors. The intrinsic (Genetic tools) factors include breed, age, species, sex etc. while the extrinsic (non-Genetic tools) factors include, diet, weather condition, physical activities, slaughter weight and others (23).

Among the various extrinsic factors, diets are the primary factor that affects the flavor of ruminant meat. Various tissue components are affected by diets and influence the taste, with fatty acids consider an important element (25). The carcass conformation, physicochemical characteristics and meat quality organoleptic parameters like tenderness, proximate analysis, color and fatty acid profile can be modified by the diet (26, 27). Meat of grain fed ruminants contained additional linoleic, n-6 poly-unsaturated fatty acids and oleic acids, whereas meat of forage fed ruminants contained additional linoleic acid, but also additional n-3 poly-unsaturated fatty acids (28, 29). This indicated that the difference in flavor score between grain fed and forage fed ruminants is due to higher levels of oleic acid in grain fed ruminants' meat, as opposed to higher levels of linoleic acid in forage fed ruminants' meat. Pelleted total mixed rations have been reported for enhance the meat quality and animal performance at fattening lambs compared with non-pelleted total mixed ration (30). Lastly, there are rising interest in bioactive substances in several plants as potential instruments that enhance the quality of lambs. This is the case of point, phenolic compounds, like saponins, essential oils rich in terpenes and condensed tannins (31, 32). The scarce information available, (33) indicated that the content of trans-11, C18:1 trans-11and CLA cis-9 are unsaturated fatty acid in sheep could be increased by inhibiting biohydrogenation of ruminal fatty acids caused by tannin as well as Improve stability of color in fresh lamb meat (34). Furthermore, supplemented diets with naturally derived lovastatin at a rate of 4 mg/kg live weight may be a viable feeding method for producing tender meat with lower cholesterol levels (35). (24) who showed that adding Rosmarinus officinalis leaves or Nigella sativa seeds to the lambs' diets had beneficial effects on meat quality in which herbs reduced oxidation of the lipid. The reason can be attributed contents of polyphenols in the herbal plants.

Red Meat Fat and Fatty Acid Composition

The major source of protein in human food is meat of ruminants (36). Recently, incidence of chronic diseases in humans was associated with ruminant meat that contains a high number of saturated fatty acids (36, 1). So, the primary aims in new research are improving the unsaturated fatty acid content and decrease the saturated fatty acids content in meat of ruminants to enhance its healthiness (37, 38). Several studies indicated that ruminant meat content is high saturated fatty acids result from unsaturated fatty acids as bio hydrogenated extensively in the rumen (39, 40). The fats in an animal can be classified as intramuscular and depot fats. Intramuscular fats are present in muscle tissues while depot fats are present in adipose tissues (41). Typically, the depot fats are found in the visceral organs like gonadal, retroperitoneal, epicardial, perirenal, mesenteric and omental (42) and subcutaneous layer while some can be found in intermuscular depots (43). The intramuscular fat comprises of lipids obtained of lipid that membrane bound or adipose cells in muscle "marbling" (41). However, the "intramuscular fat" typically describes marbling in red meat. Triacylglycerol is the major fat component of depot lipids in raw red meat (43). Marbling differs from subcutaneous fat such that it comprises of higher phospholipids related with proteins as lipoproteins or proteolipids than subcutaneous fats (41, 43). In highly marbled meat, triacylglycerols are predominant while cellular phospholipids constitute one-third of fat content in very lean meat (43). In red meat, lipids differ in the type of bonding between carbons and carbon chain length with fatty acids present in triacylglycerol (41). In animal fats, most fatty acids contain an even number of carbons. Branched chain and an odd number of carbon fatty acids are present in ruminants at low levels. The main fatty acids in red meat are (C18:0, C14:0, C16:0) as saturated fatty acids and (C18:1 n-9, C16:1 n-7) as monounsaturated fatty acids and (C18:3n-3, C18:2n-6, C20:4n-6) as PUFA (43, 44). Therefore, researchers are trying to discover a way to improve meat by increasing its content of unsaturated fats compared to saturated fat, which is harmful to human health; for example, rosemary, anise, cumin, Nigella sativa and turmeric (45) herbal plants to the animals feed (35). Discovered that the cholesterol content in meat goats fed naturally produced lovastatin [incubated Palm kernel cake for 10 days with 40 mL of Aspergillus terries spore suspension as described by (46) and modified for PKC by (47) was decreased positively ($P<0.05$) compared to the control. As a result, it is suggested that lovastatin dietary supplementation may be a viable feeding technique for generating less cholesterol in meat which could boost consumers' status of health. Moreover, (4) observed that the major fatty acids in the muscles were C18:1n-9, C18:0 and C16:0. Similar findings were observed in beef (48), mutton (49) and chevon (50). (51) confirmed that dietary supplementation of thyme leaves in lambs feed led to decrease in the percentage of saturation index (S/P), saturated fatty acid (SFA), and thrombogenic (IT) indices and atherogenic, while Importance rises in unsaturated fatty acid (UFA) and poly-unsaturated fatty acid (PUFA) levels have been observed in fresh meat of lamb. This effect generally was more pronounced at the higher thyme leaves level 7.5 percent. On the other hand, meat fatty acids profile was not affected by dietary coriander seed up to 5% in the diets ($P\geq0.05$) (52).

Meat Eating Quality Influence by Herbal Plant

Eating quality of meat is mostly determined by sensory characteristics. The inability to satisfy and anticipate consumer demands regarding sensory attributes lead to economic loss by the producer. Meat sensory traits are affected by several factors which occur at pre and post slaughter stages. Modification of these factors could more promote quality properties (53). Meat eating quality is influenced by a number of factors like pH of meat, color, water holding capacity, tenderness, lipid and oxidation and flavor, the latter being composed in turn of the two distinct factors taste and odor (54, 55).

Meat pH

The postmortem acidification of muscle measured in terms of pH is one of the underlying biochemical changes in muscle-to-meat conversion (56). The pH value has a significant impact on color, storage time, texture in meat and its products; thus, it is one of the most essential attributes within the production of meat (57, 58). The pH value of meat determines its environmental microbial balance where a low pH has a bacteriostatic effect on the meat. Frequently, during the storage the changes of pH occur of raw meat are related with nitrogen compounds or structure of lactic acid by bacteria causing putrefaction and acidification; therefore, the lower glycogen content at slaughter may result in a reduced glycolysis rate, and thus slower accumulation of lactic acid and eventually slower rate of pH decline during the postmortem period (57, 58). Major factors influencing meat pH in ruminants are the amount of muscle glycogen prior to slaughter (59). Diets can affect muscle glycogen in ruminants (60). This was attributed to the utilization of dietary energy or pre-existing reaction to the stress of slaughter, muscle fiber types (red and white) or activity of specific (fast and slow) muscle enzymes including SOD and GSH-Pxin the animals (61). Generally, the pH in the muscle decreases from pH 7.0 upon slaughter to approximately pH 5.3- 5.8 (56) 24 h after slaughter and this range is considered to be normal (62). The effects of dietary medicinal plants on muscle pH in ruminants varied between studies. (63) Conformed that the female lamb meat pH is higher after inclusion of dietary oregano essential oil. Besides, dietary quercetin in Hanwoo cattle increased the loin pH (64). In comparison, (65) found that both storage period and lamb diet, no mean pH variations are absorbed, staying constant during storage. Similarly, dietary quercetin had no effect on muscle pH in Hanwoo beef (66). Also, (51) indicated that thyme leaves feeding did not significantly affect ($P \geq 0.05$) moisture and pH values. Moreover (67) observed that storage affect glycogen content and pH muscle have been affected. The glycogen and pH in muscle at (0) day was higher than on (7) day and (14) day. Postmortem glycolysis may be the explanation for this result. The main change in the muscle-to-meat conversion is the conversion of muscle glycogen into lactic acid, which induces muscle acidification. The concentration of muscle glycogen at the time of slaughter is affected by dietary energy and antemortem stress (37). Similarly, (24) reported that no significant effect ($p \geq 0.05$) indifferent lamb's muscles fed Rosmarinus officinalis leaves or Nigella sativa seeds. The pH muscles and glycogen were similarity in glycolysis at (7) days and (14) days is a sign that the postmortem was done in day one. In conclusion that dietary supplementation and Postmortem storage may be significantly influenced muscle pH in ruminant.

Color

Color of meat one of the most reliable criterions and an important quality parameter, in which consumer can use to judge the acceptability of meat at purchase (68). The major factors of determining meat color are the amount and chemical state of myoglobin, type of myoglobin molecule and the physicochemical conditions of other components in meat such as pH value and postmortem ageing. The aforementioned factors are in turn influenced by the age and sex of animal, intramuscular fat, moisture content, pre-slaughtering conditions and treatments, processing (56) and storage time (50). Dietary supplementation of herbs can influence meat color in ruminants. Dietary supplementation of oregano essential oil improved redness and reduced the formation of metmyoglobin in lambs (68). Similarly, dietary supplementation of Moringaoleifera leaves (69), and turmeric leaves (70) improved redness in different muscles in chevon. Contrarily, dietary quercetin had no effect on color coordinates in beef (64). Nonetheless, (71) reported that meat color parameters are not affected by rosemary essential oils administration ($P \geq 0.05$). Some authors (67) described that adding different parts of Andrographis Paniculate in goat's diets on the lightness and yellowness had no significant effect on Longissimus thoracis et lumborum muscle. Besides, redness values were greater in the (Longissimus thoracis et lumborum) muscle of goats fed diet supplemented with Andrographis Paniculate leaves or Andrographis Paniculate whole plant than those in control group. This finding could be attributed to the phytochemicals that exhibited antioxidant characteristics in the dietary supplement which decreased myoglobin oxidation in ruminant's meat. (72) reported that diet supplemented with quercetin had significantly improved in redness in muscles of Merino lamb. In contrast, (73) who observed that non- significantly effects on color in animals that fed supplemented diet with rosemary extract and green tea catechins in beef. Over chill storage, redness values reduced whereas lightness heightened. These observations were indicative on heightened the oxidation of myoglobin and formation of metmyoglobin (37). Aged for (7) days, similar observations were reported in lambs fed herbal plants (24). Based, (74) showed that increased redness value ($P \leq 0.01$) and reduced yellow appearance and lightness values ($p \leq 0.05$) of both semimembranosus (SM) and longissimus thoracis et lumborum (LTL) muscles of lambs infected with gastrointestinal nematodes fed white-rot fungi-pretreated corn straw. Dietary coriander seeds made a significant different for lightness and yellow appearance parameters. Hence, by adding coriander seeds, lightness and yellow appearance parameters decreased. There was not any significant difference for redness parameter ($p \geq 0.05$) in Sanjabi lambs was seen (52). The most significant parameters of colors were redness to evaluation oxidation of meat (50, 75). With postmortem storage days, the value of lightness had a positive correlation, whereas the value of redness had a negative correlation which was reported by (76). This indicated that over the period of storage, samples have become less red and lighter (75). Thus, ageing Enhanced lightness of meat.

Water Holding Capacity (WHC)

Weight loss and cook yield, sensory characteristics as well as visual acceptability of the meat and meat products were determined by Water-holding capacity (77) during application of external forces, such as heating, cutting, pressing or grinding. Because of reduced weight loss during cutting and storage, and improved ability of the meat to retain water during processing, superior water-holding capacity (WHC) is one of the most important quality parameters of meat. WHC can also have an effect on the quality of meat consumed (78). Water holding capacity in meat can be expressed as drip loss and cooking loss.

Drip Loss

Drip loss, as an indicator of the meat WHC, is one of the important parameters for both the meat industry and the consumer to evaluate meat quality. For the meat industry, drip loss of meat is known to influence its technological quality (such as processing yield) and economic benefits (79). For the consumer, higher drip loss reduces the tenderness, juiciness and sensory quality of the meat, causing lower consumer acceptance (80, 81). Drip loss can make up about 1-3% loss in weight when meat is cut into chops and can be up to 10% in pale soft and exudative (PSE) meat (56,82). Moreover, drip loss induces great loss of nutrients through passage of particles with the water and loss of nutrients. The major physiological and structural postmortem changes associated with drip loss are post slaughter decrease of myofilament lattice postmortem in shrinkage and temperature. It is due to decrease cross-bridges of actomyosin and pH, myofibrillar contraction and shrinkage; and denaturation of myosin; structural changes in muscle fiber leading to an increase in extra cellular space, and changes in cell and basement membrane water permeability (83). (84) indicated that drip loss of longissimus thoracis muscle increased with storage days ($P \leq 0.05$) while after storage for 7 days, significantly lower drip loss of meat was found in fed the lycopene-supplemented diet ($P \leq 0.05$). Thus, studies confirmed that with storage continued, the drip loss has been increased. These results may be the proteins weakening of myofibrillar by enzymes of proteolytic through postmortem, thus affecting the capacity of myofibrillar proteins to retain water (57, 53). Decrease of Water-holding capacity of meat has also linked with Increase in oxidation of protein.

Cooking Loss

Cooking loss is described as the shrinkage of meat as a result water loss and soluble substances from meat due to cooking (85). Cooking loss is very essential for its contribution to the physical appealing of meat to the consumer for acceptance in terms of flavor, size, and tenderness. The age, sex and breed of an animal, time of cooking, rate of cooking, type of the muscles, storage process and days of storage can influence cooking loss (86). The term “cooking loss” is affected by the quality of the raw meat, end-point center temperature, cooking procedure and time. The effect of cooking procedure is lost as the center temperature reaches 80 °C but there is significant though small effect of raw meat quality because of the juiciness of meat (87). The effects of dietary medicinal herbs on water holding capacity of ruminant meat varied between studies. Dietary quercetin did not affect significantly of cooking and drip loss in cattle (57). However, adding different parts of Andrographis Paniculate to the goats’ diets reduced drip or cooking loss in chevon; this could be due to the reduction in the overlapping of myofibrillar proteins (actin and myosin) during storage (88, 67). In addition, (89) reported that no significantly affected variations in cooking loss in meat of pig fed diet supplemented with Houttuynia Cordata, Houttuynia Cordata and Taraxacum Officinale extract powder. Supplementation diets with turmeric powder did not effect on cooking and drip loss as well as the moisture and drip loss affected significantly on the storage time (90). The meat aged (1, 7 or 14 days) had no effect ($P \geq 0.05$) on the cooking losses for beef from heifers supplemented with or without essential oils (clove and/or rosemary essential oil) and/ or active principal blend (eugenol, thymol, and vanillin) (91).

Tenderness

Tenderness of the meat is generally recognized as one of the most significant palatability traits for consumer preference and eating quality. Tenderness has traditionally been the subject of research on consumers demand for red meat, as it is a significant determinant of consumers’ satisfaction and the probability of purchase (92). It is a multi-factorial sensory attributes, specified by the complex interaction between antemortem and postmortem factors. These factors range from practices used through the animal production chain, such as the animal husbandry, lair age, feeding resources, genetics transport, exsanguination and stunning via meat storage methods and procedures of cooking for the final product (93). The relative proportions, structure, and composition of intramuscular connective tissue (IMCT) in part, account for the relative toughness of meat (94). The IMCT varies depending on the muscle, animal age, breed, and species. Previous reviews have described the composition and structure of IMCT. Three layers of IMCT maintain the structural integrity of muscle fibers. These include the endomysium, which surrounds individual skeletal muscle fibers, the perimysium, which bundles group of muscle fibers and the epimysium, which wraps the whole muscle. Collagen is the main component of IMCT and more than 90% of intramuscular collagen is located in the perimysium (94-96). Yusuf et al. (2018) (67) observed that dietary supplementation of Andrographis paniculate leaves enhanced the tenderness of different muscles in goats. Dietary quercetin did not affect loin tenderness in Hanwoo cattle (64). It was also seen that adding white-rot fungi-pretreated corn straw to the diets has been improved tenderness of lamb meat (74). (67) reported that shear force values decreased significantly ($P<0.05$) in meat of goats fed diet supplemented with various parts of Andrographis Paniculate (APL) or Andrographis Paniculate whole plant (APW) because

Phenolic compounds could assist calpain activities through conditioning thereby endorsing tenderness of meat. Over chill storage, the shear force values of longissimus thoracis et lumborum (LTL) muscle was decrease in goats. This result may be due to the degradation proteins of myofibrillar through conditioning of postmortem. In addition, the supplementation of carnosol acid in diet, reduced shear force values in Merino lambs (97). Finally, (35) showed that increasing lovastatin supplementation in the feed with the decreased shear force values ($P<0.05$).

Lipid Oxidation

Major purpose by utilizing antioxidants in the meat and meat products for decrease influence the oxidation of lipid to improvement the shelf life and quality of product (98) during mechanisms of biochemical to breaking chain reaction, preventing chain inhibition, decomposing peroxides, binding chain initiating catalysts and reducing localized oxygen concentrations (99). There is a renewed interest in the use of natural antioxidants in foods (100). Plants produce phytochemicals for normal growth and resistance against pathogens and diseases (14) and the phytochemical have antioxidant and antimicrobial properties that can be utilized in food preservation. Natural antioxidants like medicinal plants in foods are favored due to the high cost, scarcity, and toxicity of synthetic antioxidants (101). Oxidation of lipids during the processing and storage of meat is major cause of quality deterioration (102). As well as heme pigments, metal catalyst, and myriad oxidizing agents in the muscle tissue are affected by the presence of unsaturated lipids and makes it susceptible to spoilage of oxidative (103). Quality deterioration in oxidized meat products is characterized by loss of nutrients, flavor deterioration and discoloration (104), and possible formation of toxic compounds that could have detrimental effects on consumers (105, 106). Dietary intervention remains the most effective strategy to modify the oxidative stability of intact muscle foods, where the use of exogenous antioxidant may be difficult or practically impossible (90). In addition, the effective method of application depends on the nature of antioxidants (103). For example, the scientific literature is replete with studies examining the effects of dietary supplementation of medicinal herbs as nature of antioxidants on the oxidative stability of ruminant meat. Thus, dietary supplementation with rosemary extract in sheep inhibited lipid oxidation significantly ($P<0.05$) in mutton (107, 51). Dietary quercetin did not affect thiobarbituric acid reactive substances (TBARS) value in the longissimus dorsi muscle in Holstein-Friesian (64) and Hanwoo (66) and cattle. (69) showed that the lipid oxidation of longissimus thoracis et lumborum muscles decreased significantly ($P<0.05$) in goats fed Moringaoleifera leaves. Nonetheless, there are significantly ($P<0.05$) differed among the treatments during a storage time. Most significantly values of TBARS discovered in all muscles were 0.13–0.26 mg malondialdehyde (MDA)/kg meat were below the 0.5 mg MDA/kg meat. Garba et al. (2019) (35) reported that extremely low oxidation of lipid occurred in the meat, even at 7 days of storage, could be due to oxidation in meat happened 25 days later of storage. It was suggested that Moringa Oleifera leaf could be a potential source of compounds with strong antioxidant potential (108).

Flavor

Feeding is the main trait impact the flavor of the meat. Moreover, flavor is a vital element in consumers' palatability and acceptability of meat. Several factors impact meat eating quality. The major factor is ‘flavor’. The most important precursor components in meat are low-molecular-weight water-soluble compounds and fat, which are responsible for meat flavor (54). The relationship between unsaturated fatty acids (18:3, 18:2, 18:1, 18:0, 16:1, 14:1) desired beef taste and fatty acids studied by (109). Species flavor, on the other hand, is primarily determined by ketones, saturated aldehydes, fatty acids, and unsaturated aldehydes, all of which play a significant role in meat flavor (24). (110) showed that fattening lambs fed diet with rosemary extracts was successful in delaying the flavor degradation of cooked and chilled lamb patties exposed to heavy oxidizing conditions, which are common in meat-serving systems. In the processed lamb meat, the muscle-deposited rosemary diterpenes or/and their metabolites acted as endogenous antioxidants. Thus, in cooked and chilled lamb, flavor stabilization during rosemary-based feed has been developed (52).

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REFERENCES

1. McGuire S. World cancer report 2014. Geneva, Switzerland: World Health Organization, international agency for research on cancer, WHO Press, 2015. Adv Nutr. 2016 ;7(2):418-9.
2. Domingo JL, Nadal M. Carcinogenicity of consumption of red meat and processed meat: a review of scientific news since the IARC decision. Food Chem Toxicol. 2017; 105:256-61.
3. Wolk, A. Potential health hazards of eating red meat. J Intern Med,2017. 281(2), 106-122.
4. Adeyemi KD, Shittu RM, Sabow AB, Abubakar AA, Karim R, Karsani SA, et al. Comparison of myofibrillar protein degradation, antioxidant profile, fatty acids, metmyoglobin reducing activity, physicochemical properties and sensory attributes of gluteus medius and infraspinatus muscles in goats. J Anim Sci Technol. 2016;58(1):1-7.
5. Najafi MH, Zeinoaldini S, Ganjkhanlou M, Mohammadi H, Hopkins DL, Ponnampalam EN. Performance, carcass traits, muscle fatty acid composition and meat sensory properties of male Mahabadi goat kids fed palm oil, soybean oil or fish oil. Meat Sci. 2012 ;92(4):848-54.
6. Slim RM, Toborek M, Watkins BA, Boissonneault GA, Hennig B. Susceptibility to hepatic oxidative stress in rabbits fed different animal and plant fats. J Am Coll Nutr. 1996 ;15(3):289-94.
7. Renerre M, Poncet K, Mercier Y, Gatellier P, Métro B. Influence of dietary fat and vitamin E on antioxidant status of muscles of turkey. J Agric Food Chem. 1999 ;47(1):237-44.
8. Bekhit AE, Hopkins DL, Fahri FT, Ponnampalam EN. Oxidative processes in muscle systems and fresh meat: Sources, markers, and remedies. Compr Rev Food Sci Food Saf. 2013;12(5):565-97.
9. Camo J, Beltrán JA, Roncalés P. Extension of the display life of lamb with an antioxidant active packaging. Meat Sci. 2008;80(4):1086-91.
10. Su L, Yin JJ, Charles D, Zhou K, Moore J, Yu LL. Total phenolic contents, chelating capacities, and radical-scavenging properties of black peppercorn, nutmeg, rosehip, cinnamon and oregano leaf. Food Chem 2007 ;100(3):990-7.
11. Shahidi F, Janitha PK, Wanasundara PD. Phenolic antioxidants. Crit Rev Food Sci Nutr. 1992 ;32(1):67-103.
12. Nieto G, Ros G. book of Active Ingredients from Aromatic and Medicinal Plants: Cairo University: Hany El-Shemy; 2017 chapter 14, Dietary Administration of Animal Diets with Aromatic and Medicinal Plants: Influence on Meat Quality; p. 237-254.
13. Food and agriculture organization of the United Nations. Food outlook. Biannual report on global food markets. November 2019. Available from: http://www.fao.org/3/ca6911en/ca6911en.pdf
14. Daniel CR, Cross AJ, Koebnick C, Sinha R. Trends in meat consumption in the USA. Public Health Nutr. 2011 ;14(4):575-83.
15. DeSalvo KB, Olson R, Casavale KO. Dietary guidelines for Americans. Jama. 2016 ;315(5):457-8.
16. Xu X, Yu E, Gao X, Song N, Liu L, Wei X, et al. Red and processed meat intake and risk of colorectal adenomas: a meta-analysis of observational studies. Int J Cancer. 2013 ;132(2):437-48.
17. Choi Y, Song S, Song Y, Lee JE. Consumption of red and processed meat and esophageal cancer risk: meta-analysis. World J Gastroenterol: WJG. 2013 ;19(7):1020.
18. Thomas CL, Shanks BC, Basinger KL, Apple JK, Wiegand BR, Caldwell JD, et al. Evaluation of cholesterol and fatty acid content of lamb and goat longissimus muscle. Meat Sci. 2016(112):169-70
19. American Heart Association. Heart and stroke encyclopedia. Dietary guidelines for healthy American adults. Retrieved August 11, 2017, from World Wide Web http://www.americanheart.org.
20. Jacobson TA, Ito MK, Maki KC, Orringer CE, Bays HE, Jones PH, et al. National lipid association recommendations for patient-centered management of dyslipidemia: part 1—full report. J clin lipidol. 2015 ;9(2):129-69.
21. McAfee AJ, McSorley EM, Cuskelly GJ, Moss BW, Wallace JM, Bonham MP, et al. Red meat consumption: An overview of the risks and benefits. Meat sci. 2010 ;84(1):1-3.
22. Jiménez-Colmenero F, Carballo J, Cofrades S. Healthier meat and meat products: their role as functional foods. Meat sci. 2001 ;59(1):5-13.
23. Jacob RH, Pethick DW. Animal factors affecting the meat quality of Australian lamb meat. Meat sci. 2014 ;96(2):1120-3.
24. Odhaib KJ, Adeyemi KD, Sazili AQ. Carcass traits, fatty acid composition, gene expression, oxidative stability and quality attributes of different muscles in Dorper lambs fed Nigella sativa seeds, Rosmarinus officinalis leaves and their combination. Asian-Australas J Anim Sci. 2018 ;31(8):1345.
25. Melton SL. Effects of feeds on flavor of red meat: a review. J anim sci. 1990 ;68(12):4421-35.
26. Li L, Zhu Y, Wang X, He Y, Cao B. Effects of different dietary energy and protein levels and sex on growth performance, carcass characteristics and meat quality of F1 Angus× Chinese Xiangxi yellow cattle. J Anim Sci Biotechnol. 2014;5(1):1-2.
27. Ramírez-Retamal J, Morales R. Influence of breed and feeding on the main quality characteristics of sheep carcass and meat: A review. Chil J Agric Res. 2014 ;74(2):225-33.
28. Calkins CR, Hodgen JM. A fresh look at meat flavor. Meat sci. 2007 ;77(1):63-80.
29. Elmore JS, Warren HE, Mottram DS, Scollan ND, Enser M, Richardson RI, et al. A comparison of the aroma volatiles and fatty acid compositions of grilled beef muscle from Aberdeen Angus and Holstein-Friesian steers fed diets based on silage or concentrates. Meat Sci. 2004 ;68(1):27-33.
30. Zhong RZ, Fang Y, Zhou DW, Sun XZ, Zhou CS, He YQ. Pelleted total mixed ration improves growth performance of fattening lambs. Anim Feed Sci Technol. 2018; 242:127-34.
31. Vasta V, Luciano G. The effects of dietary consumption of plants secondary compounds on small ruminants' products quality. Small Rumin Res. 2011 ;101(1-3):150-9.
32. Jerónimo E, Alfaia CM, Alves SP, Dentinho MT, Prates JA, Vasta V, et al . Effect of dietary grape seed extract and Cistusladanifer L. in combination with vegetable oil supplementation on lamb meat quality. Meat sci. 2012 ;92(4):841-7.
33. Vasta V, Pagano RI, Luciano G, Scerra M, Caparra P, Foti F, et al . Effect of morning vs. afternoon grazing on intramuscular fatty acid composition in lamb. Meat Sci. 2012 ;90(1):93-8.
34. Luciano G, Monahan FJ, Vasta V, Biondi L, Lanza M, Priolo A. Dietary tannins improve lamb meat colour stability. Meat sci. 2009 ;81(1):120-5.
35. Garba S, Sazili AQ, Mahadzir MF, Candyrine SC, Jahromi MF, Ebrahimi M, et al. Effects of naturally produced lovastatin on carcass characteristics, muscle physico-chemical properties and lipid oxidation and cholesterol content in goats. Meat sci. 2019; 154:61-8.
36. Ekmekcioglu C, Wallner P, Kundi M, Weisz U, Haas W, Hutter HP. Red meat, diseases, and healthy alternatives: A critical review. Crit Rev Food Sci Nutr. 2018 ;58(2):247-61.
37. Adeyemi KD, Shittu RM, Sabow AB, Ebrahimi M, Sazili AQ. Influence of diet and postmortem ageing on oxidative stability of lipids, myoglobin and myofibrillar proteins and quality attributes of gluteus medius muscle in goats. PloS one. 2016;11(5):e0154603.
38. Yagoubi Y, Hajji H, Smeti S, Mahouachi M, Kamoun M, Atti N. Growth performance, carcass and noncarcass traits and meat quality of Barbarine lambs fed rosemary distillation residues. Animal. 2018 ;12(11):2407-14.
39. Ebrahimi M, Rajion MA, Adeyemi KD, Jafari S, Jahromi MF, Oskoueian E, et al. Dietary n-6: n-3 fatty acid ratios alter rumen fermentation parameters and microbial populations in goats. J Agric Food Chem. 2017 ;65(4):737-44.
40. Hobson PN, Stewart CS, editors. The rumen microbial ecosystem. 2nd ed. London: Blackie Academic and Professional; 1997. 719 p.
41. Chau YY, Bandiera R, Serrels A, Martínez-Estrada OM, Qing W, Lee M, et al. Visceral and subcutaneous fat have different origins and evidence supports a mesothelial source. Nat cell biol. 2014 ;16(4):367-75.

42. Chau YY, Bandiera R, Serrels A, Martínez-Estrada OM, Qing W, Lee M, et al. Visceral and subcutaneous fat have different origins and evidence supports a mesothelial source. Nat cell biol. 2014; 16(4):367-75.
43. Wood JD, Enser M, Fisher AV, Nute GR, Sheard PR, Richardson RI, et al . Fat deposition, fatty acid composition and meat quality: A review. Meat sci. 2008 Apr 1;78(4):343-58.
44. Abd Al-Jaleel RA. Use of turmeric (Curcuma longa) on the performance and some physiological traits on the broiler diets. Iraqi J Vet Med. 2012 ;36(1):51-7.
45. Jahromi MF, Boo LJ, Wan HY, Mohamad R, Shokryazdan P. Production of lovastatin from rice straw using Aspergillusterreus in solid state fermentation. Afr J Pharm Pharmacol. 2013 ;7(29):2106-11.
46. Candyrine SC, Mahadzir MF, Garba S, Jahromi MF, Ebrahimi M, Goh YM, et al. Effects of naturally produced lovastatin on feed digestibility, rumen fermentation, microbiota and methane emissions in goats over a 12-week treatment period. PloS one. 2018 ;13(7): e0199840.
47. Enser M, Hallett KG, Hewett B, Fursey GA, Wood JD, Harrington G. Fatty acid content and composition of UK beef and lamb muscle in relation to production system and implications for human nutrition. Meat sci. 1998 ;49(3):329-41.
48. Muíño I, Apeleo E, de la Fuente J, Pérez-Santaescolástica C, Rivas-Cañedo A, Pérez C, et al. Effect of dietary supplementation with red wine extract or vitamin E, in combination with linseed and fish oil, on lamb meat quality. Meat sci. 2014 ;98(2):116-23.
49. K. Adeyemi KD, Ebrahimi M, Samsudin AA, Sabow AB, Sazili AQ. Carcass traits, meat yield and fatty acid composition of adipose tissues and Supraspinatus muscle in goats fed blend of canola oil and palm oil. J anim sci tech. 2015;57(1):1-4.
50. Nieto G, Bañón S, Garrido MD. Incorporation of thyme leaves in the diet of pregnant and lactating ewes: Effect on the fatty acid profile of lamb. Small Rumin Res. 2012 ;105(1-3):140-7.
51. Nieto G, Bañón S, Garrido MD. Incorporation of thyme leaves in the diet of pregnant and lactating ewes: Effect on the fatty acid profile of lamb. Small Rumin Res. 2012; 105(1-3):140-7.
52. Adeyemi KD, Sazili AQ. Efficacy of carcass electrical stimulation in meat quality enhancement: A review. Asian-Australas J Anim Sci. 2014 ;27(3):447.
53. Arshad MS, Sohaib M, Ahmad RS, Nadeem MT, Imran A, Arshad MU, et al . Ruminant meat flavor influenced by different factors with special reference to fatty acids. Lipid's health dis. 2018 ;17(1):1-3.
54. Arshad MS, Sohaib M, Ahmad RS, Nadeem MT, Imran A, Arshad MU, et al . Ruminant meat flavor influenced by different factors with special reference to fatty acids. Lipid's health dis. 2018; 17(1):1-3
55. Berges E. Importance of vitamin E in the oxidative stability of meat: organoleptic qualities and consequences. Cahiers Options Méditerranéennes (CIHEAM). 1999; 37:347-363.
56. Toldrá F. Lawrie's meat science. 8th ed. Woodhead Publishing UK: Nikki Levy; 2017. 730p.
57. Webb EC, Casey NH, Simela L. Goat meat quality. Small rumin res. 2005; 60(1-2):153-66.
58. Warriss PD. The growth and body composition of animals; 2nd ed. Wallingford: CABI; 2009. Chapter 1, Meat science: an introductory text 2009. p 9-25
59. Muchenje V, Dzama K, Chimonyo M, Raats JG, Strydom PE. Meat quality of Nguni, Bonsmara and Aberdeen Angus steers raised on natural pasture in the Eastern Cape, South Africa. Meat Sci. 2008 ;79(1):20-8.
60. Gardner GE, McIntyre BL, Tudor GD, Pethick DW. The impact of nutrition on bovine muscle glycogen metabolism following exercise. Aust J Agric Res. 2001; 52(4):461-70.
61. Hopkins DL, Hall DG, Channon HA, Holst PJ. Meat quality of mixed sex lambs grazing pasture and supplemented with, roughage, oats or oats and sunflower meal. Meat Sci. 2001;59(3):277-83.
62. Ramírez R, Cava R. The crossbreeding of different Duroc lines with the Iberian pig affects colour and oxidative stability of meat during storage. Meat sci. 2007 ;77(3):339-47.
63. Simitzis PE, Deligeorgis SG, Bizelis JA, Dardamani A, Theodosiou I, Fegeros K. Effect of dietary oregano oil supplementation on lamb meat characteristics. Meat Sci. 2008 ;79(2):217-23.
64. Kang MG, Kim HJ, Jang AR, Gam DK, Yun GS, Jo CR. Effect of dietary supplementation of quercetin on antioxidant activity and meat quality of beef cattle. Korean J of Agr Sci. 2012;39(1):61-8.
65. Bañón S, Méndez L, Almela E. Effects of dietary rosemary extract on lamb spoilage under retail display conditions. Meat Sci. 2012 ;90(3):579-83.
66. Kang MG, Kim HJ, Lee HJ, Jang AR, Yun GS, Jo CR. Effect of Dietary Kocetin TM on Meat Quality of Hanwoo Loin. J Anim Sci Tech. 2011;53(6):541-8.
67. Yusuf AL, Adeyemi KD, Roselina K, Alimon AR, Goh YM, Samsudin AA, et al. Dietary supplementation of different parts of Andrographispaniculata affects the fatty acids, lipid oxidation, microbiota, and quality attributes of longissimus muscle in goats. Food Res Int. 2018; 111:699-707.
68. Muchenje V, Dzama K, Chimonyo M, Strydom PE, Hugo A, Raats JG. Some biochemical aspects pertaining to beef eating quality and consumer health: A review. Food chem. 2009 ;112(2):279-89.
69. Qwele K, Hugo A, Oyedemi SO, Moyo B, Masika PJ, Muchenje V. Chemical composition, fatty acid content and antioxidant potential of meat from goats supplemented with Moringa (Moringaoleifera) leaves, sunflower cake and grass hay. Meat Sci. 2013;93(3):455-62.
70. Karami M, Alimon AR, Goh YM. Effect of vitamin E, Andrographispaniculata and turmeric as dietary antioxidant supplementation on lipid and color stability of goat meat. Small Rumin Res. 2011 ;97(1-3):67-71.
71. Smeti S, Hajji H, Mekki I, Mahouachi M, Atti N. Effects of dose and administration form of rosemary essential oils on meat quality and fatty acid profile of lamb. Small Rumin Res. 2018. 1; 158:62-8.
72. Andrés S, Tejido ML, Bodas R, Morán L, Prieto N, Blanco C, et al. Quercetin dietary supplementation of fattening lambs at 0.2% rate reduces discolouration and microbial growth in meat during refrigerated storage. Meat sci. 2013 ;93(2):207-12.
73. O'grady MN, Maher M, Troy DJ, Moloney AP, Kerry JP. An assessment of dietary supplementation with tea catechins and rosemary extract on the quality of fresh beef. Meat sci. 2006 ;73(1):132-43.
74. Xiang H, Zhao X, Fang Y, Wang F, Liang R, Sun X, et al Wang S. Feeding Fungal-Pretreated Corn Straw Improves Health and Meat Quality of Lambs Infected with Gastrointestinal Nematodes. Animals. 2020 ;10(9):1659.
75. Sabow AB, Sazili AQ, Aghwan ZA, Zulkifli I, Goh YM, AbKadir MZ, et al . Changes of microbial spoilage, lipid-protein oxidation and physicochemical properties during postmortem refrigerated storage of goat meat. Anim Sci J. 2016 ;87(6):816-26.
76. Zakrys PI, Hogan SA, O'sullivan MG, Allen P, Kerry JP. Effects of oxygen concentration on the sensory evaluation and quality indicators of beef muscle packed under modified atmosphere. Meat sci. 2008 ;79(4):648-55.
77. Warner RD. Lawrie´s Meat Science 8th ed. 2017. Chapter 14; The eating quality of meat—IV Water-holding capacity and juiciness; p 419-459.
78. Zhao J, Li K, Su R, Liu W, Ren Y, Zhang C, Du M, Zhang J. Effect of dietary Tartary buckwheat extract supplementation on growth performance, meat quality and antioxidant activity in ewe lambs. Meat sci. 2017 Dec 1; 134:79-85.
79. Den Hertog-Meischke MJ, Van Laack RJ, Smulders FJ. The water-holding capacity of fresh meat. Vet Q. 1997 ;19(4):175-81.
80. Lonergan SM, Huff-Lonergan E, Rowe LJ, Kuhlers DL, Jungst SB. Selection for lean growth efficiency in Durocpigs influences pork quality. J Anim Sci. 2001 ;79(8):2075-85.
81. Wang Z, He F, Rao W, Ni N, Shen Q, Zhang D. Proteomic analysis of goat Longissimus dorsi muscles with different drip loss values related to meat quality traits. Food sci biotechnol. 2016.25(2):425-31.
82. Warriss P D. Meat Science. 2nd ed. CABI: Cambridge; 2010, chapter 1, An Introductory Text. 1-234p.

83. Schäfer A, Rosenvold K, Purslow PP, Andersen HJ, Henckel P. Physiological and structural events postmortem of importance for drip loss in pork. Meat sci. 2002;61(4):355-66.
84. Wang B, Xu CC, Liu C, Qu YH, Zhang H, Luo HL. The Effect of dietary lycopene supplementation on drip Loss during storage of lamb meat by iTRAQ analysis. Antioxidants. 2021 ;10(2):198.
85. Jama N, Muchenje V, Chimonyo M, Strydom PE, Dzama K, Raats JG. Cooking loss components of beef from Nguni, Bonsmara and Angus steers. Afr J Agric Res. 2008 ;3(6):416-20.
86. Guerrero A, Velandia Valero M, Campo MM, Sañudo C. Some factors that affect ruminant meat quality: from the farm to the fork. Review. Act Sci. 2013 ;35(4):335-47.
87. Aaslyng MD, Bejerholm C, Ertbjerg P, Bertram HC, Andersen HJ. Cooking loss and juiciness of pork in relation to raw meat quality and cooking procedure. Food Qual Prefer. 2003 ;14(4):277-88.
88. Karami M, Alimon AR, Sazili AQ, Goh YM, Ivan M. Effects of dietary antioxidants on the quality, fatty acid profile, and lipid oxidation of longissimus muscle in Kacang goat with aging time. Meat sci. 2011;88(1):102-8.
89. Yan L, Meng QW, Kim IH. The effects of dietary Houttuyniacordata and Taraxacum officinale extract powder on growth performance, nutrient digestibility, blood characteristics and meat quality in finishing pigs. Livest Sci. 2011;141(2-3):188-93.
90. Mancini S, Paci G, Pisseri F, Preziuso G. Effect of turmeric (Curcuma longa L.) powder as dietary antioxidant supplementation on pig meat quality. J Food Process Preserv. 2017 ;41(1): e12878.
91. de Oliveira Monteschio J, de Souza KA, Vital AC, Guerrero A, Valero MV, Kempinski EM, et al. Clove and rosemary essential oils and encapsuled active principles (eugenol, thymol and vanillin blend) on meat quality of feedlot-finished heifers. Meat Sci. 2017; 130:50-7.
92. Frank D, Joo ST, Warner R. Consumer acceptability of intramuscular fat. Korean J Food Sci Anim Resour. 2016;36(6):699.
93. Warner D, Jensen SK, Cone JW, Elgersma A. Fatty acid composition of forage herb species. InGrassland in a changing world: 23rd General Meeting of the European Grassland Federation, Kiel, Germany. 2010: 15 p 491-493.
94. Nishimura T. The role of intramuscular connective tissue in meat texture. Anim sci j. 2010 ;81(1):21-7.
95. McCormick RJ, editor. Applied Muscle Biology Meat Science. 1st ed; Boca Raton CRC press; 2009. 360p
96. Purslow PP. New developments on the role of intramuscular connective tissue in meat toughness. Annu Rev Food Sci Technol. 2014; 5:133-53.
97. Morán L, Andrés S, Bodas R, Prieto N, Giráldez FJ. Meat texture and antioxidant status are improved when carnosic acid is included in the diet of fattening lambs. Meat sci. 2012 ;91(4):430-4.
98. Shah MA, Bosco SJ, Mir SA. Plant extracts as natural antioxidants in meat and meat products. Meat science. 2014 ;98(1):21-33.
99. Dorman HJ, Peltoketo A, Hiltunen R, Tikkanen MJ. Characterisation of the antioxidant properties of de-odourised aqueous extracts from selected Lamiaceae herbs. Food chem. 2003;83(2):255-62.
100. Nakyinsige K, Sazili AQ, Zulkifli I, Goh YM, Bakar FA, Sabow AB. Influence of gas stunning and halal slaughter (no stunning) on rabbit's welfare indicators and meat quality. Meat sci. 2014 ;98(4):701-8.
101. McBride NT, Hogan SA, Kerry JP. Comparative addition of rosemary extract and additives on sensory and antioxidant properties of retail packaged beef. Int J Food Sci Tech. 2007; 42(10):1201-7.
102. Falowo AB, Fayemi PO, Muchenje V. Natural antioxidants against lipid–protein oxidative deterioration in meat and meat products: A review. Food Res Int. 2014; 64:171-81.
103. Sample S. Food Industry 2013, Chapter 6; Oxidation and antioxidants in fish and meat from farm to fork; p 114-44.
104. Nute GR, Richardson RI, Wood JD, Hughes SI, Wilkinson RG, Cooper SL, et al . Effect of dietary oil source on the flavour and the colour and lipid stability of lamb meat. Meat Sci. 2007 ;77(4):547-55.
105. Kanner J. Oxidative processes in meat and meat products: quality implications. Meat sci. 1994;36(1-2):169-89.
106. Kanner J. Dietary advanced lipid oxidation endproducts are risk factors to human health. Mol Nutr Food Res. 2007 ;51(9):1094-101.
107. Moñino I, MARTinez CR, Sotomayor JA, Lafuente A, Jordán MJ. Polyphenolic transmission to segureño lamb meat from ewes' diet supplemented with the distillate from rosemary (Rosmarinus officinalis) leaves. J Agric Food Chem. 2008;56(9):3363-7.
108. Moyo B, Oyedemi S, Masika PJ, Muchenje V. Polyphenolic content and antioxidant properties of Moringaoleifera leaf extracts and enzymatic activity of liver from goats supplemented with Moringaoleifera leaves/sunflower seed cake. Meat sci. 2012 ;91(4):441-7.
109. Scollan ND, Dannenberger D, Nuernberg K, Richardson I, MacKintosh S, Hocquette JF, et al Moloney AP. Enhancing the nutritional and health value of beef lipids and their relationship with meat quality. Meat Sci. 2014 ;97(3):384-94.
110. Serrano R, Jordán MJ, Bañón S. Use of dietary rosemary extract in ewe and lamb to extend the shelf life of raw and cooked meat. Small Rumin Res. 2014 ;116(2-3):144-52.

استخدام النباتات العشبية في علائق المجترات: التأثير على جودة اللحوم: مراجعة علمية

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الخلاصة

تمت مراجعة استخدام النباتات العشبية كمضافات علفية في تغذية الحيوانات لتعزيز كفاءة معالجة اللحوم وجودتها. ان مطلب المستهلكين اليوم هو السلامة والقيمة الغذائية والذوق والتوحيد وتنوع اللحوم والمظهر الجيد لمنتجات اللحوم. وبالتالي، لتلبية طلب المستهلكين، يجب تحسين البحث لتطوير المنتج. أثبتت الدراسات أن استخدام الأعشاب والتوابل ومستخلصاتها من أهم الاضافات المعتمدة في صناعة اللحوم لتحسين صفاتها النوعية. في هذه المقال، مراجعة لأحدث البحوث حول استخدام المركبات النشطة بيولوجيًا في النباتات العشبية لتقييم عدد من السمات المتعلقة بجودة اللحوم، بما في ذلك: محتوى الدهون وتوزيعها ، ومحتوى الماء، والقدرة على الاحتفاظ بالماء ، ومحتوى الكولاجين ، الأس الهيدروجيني واللون والطراوة وأكسدة الدهون والنكهة.

الكلمات المفتاحية: المجترات، النباتات العشبية، كسدة الدهون، الأس الهيدروجيني في اللحم، جودة اللحوم