Small Ruminant Research 121 (2014) 80–88

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Chevon quality enhancement: Trends in pre- and post-slaughter techniques☆

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ARTICLE INFO

Article history:
Available online 1 April 2014

Keywords:
Goat
Chevon quality
Stress
Electrical stimulation
Calcium chloride injection

ABSTRACT

Goat meat (chevon) consumption has increased in the US primarily due to the growing immigrant population. Chevon preference among mainstream consumers, however, has suffered from the misperception that it is inferior in quality to beef, lamb, or pork. Researchers have studied several pre- and post-slaughter techniques to enhance chevon quality. This paper will briefly review techniques that show promise to further improve quality characteristics of chevon. Among preslaughter factors, minimizing animal stress is an important step to quality chevon production, as stress can result in inferior meat quality characteristics. Diet can have a marked effect on nutritional properties of chevon, particularly fatty acid profile. Feeding goats a concentrate diet results in a higher level of oleic acid, but lower linolenic acid in the longissimus muscle, compared to feeding a hay diet. Dietary brown seaweed extract supplementation in goats results in increased color stability of chevon cuts because of higher antioxidant levels. Administration of a low dose of bovine somatotropin in goats does not influence meat quality characteristics or pre-rigor μ-calpain, m-calpain, and calpastatin activities. Several post-slaughter techniques have been studied and proven to be beneficial. It is well-established that aging chevon retail cuts significantly improves tenderness, and the caselife of chevon cuts is comparable to that of beef, lamb, and pork cuts. Postmortem electrical stimulation has been reported to significantly accelerate muscle glycolysis and improve tenderness of chevon. Subjecting deboned chevon cuts to hydrodynamic pressure processing or calcium chloride injections has been shown to significantly improve quality characteristics, particularly tenderness. With emerging markets for chevon in the US, there is a critical need for further research on pre- and post-slaughter techniques in goats to further improve product quality.

1. Introduction

Goat meat (chevon) consumption has steadily increased to 1.5 million heads of goats annually in the US during the past two decades due to the growing immigrant population and the demand will increase in the future (Ibrahim, 2011). Net importation of competitively priced chevon into the US from Australia and New Zealand has been on the rise (USDA-FAS, 2006). However, its popularity among the general US consumers has grown rather slowly; primarily due to the misperception that chevon is inferior in quality to other traditional species meat (Griffin et al., 1992).

☆ This paper is part of the special issue entitled Industrial and Rural Activities in the Goat Sector including Science, Innovation and Development (Based on XIth International Conference on Goats, Gran Canaria, Spain), Guest Edited by Noemí Castro.

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http://dx.doi.org/10.1016/j.smallrumres.2014.03.009
0921-4488/

Red meat is considered an important source of protein, vitamins, and minerals. Consumption of red meat also provides the fats which are an important source of energy and helps in the absorption of fat-soluble vitamins. However, red meat contains high levels of saturated fat (40–50%), which is associated with increased incidences of coronary heart diseases. Compared with beef and lamb, chevon has a lower fat content, which is more attractive to health-conscious consumers (McMillin and Brock, 2005). Abundant literature is available on goat carcass characteristics; however, data on postmortem muscle metabolism and development of meat quality is not abundant. Information on ante- and post-mortem factors that influence the development of meat quality is very important to determine appropriate techniques to enhance quality characteristics and improve public perception.

Animal stress causes metabolic changes that can negatively affect meat quality in goats as in other meat animal species (Kannan et al., 2002b; Kadim et al., 2006, 2008). Diet in goats can have a significant effect on the nutritional properties of meat (Sen et al., 2004; Webb et al., 2005; Kannan et al., 2006). Dietary antioxidant supplementation in ruminants has been reported to extend the caselife of meat. Several postmortem techniques such as aging, carcass electrical stimulation, hydrodynamic pressure (HDP) processing, and calcium chloride ($CaCl_2$) injection have proven to enhance meat quality, particularly tenderness. The effects of these techniques on chevon quality characteristics are reviewed in this paper.

2. Preslaughter factors

2.1. Animal stress

The depletion of glycogen in muscles due to preslaughter stress and the resultant elevated meat pH negatively affect meat quality (Aberle et al., 2001). Kannan et al. (2003) studied the effects of a 2-h preslaughter transportation stress on meat quality characteristics in goats of different age groups. Muscle glycogen concentrations were greater in control than in stressed goats, and higher in old (24–30 mo of age) compared to young (6–12 mo of age) goats; however, pH measured at 15 min and 24 h postmortem was not influenced by stressor treatment. Furthermore, the average initial *Longissimus dorsi* (LD) muscle pH was similar in both young (6–12 mo of age) and old (24–30 mo of age) goats, but the mean ultimate pH was higher in young (6–12 mo of age) than old (24–30 mo of age) goats (Kannan et al., 2003). The higher ultimate pH in the LD of young (6–12 mo of age) goats corresponded with their lower glycogen content compared to that in old (24–30 mo of age) goats. Although overall glycogen concentrations were higher in the LD muscle of control goats compared to stressed goats, LD glycogen differences were only noted in young (6–12 mo of age) goats at 15 min postmortem. The lower glycogen content in stressed goats did not affect ultimate pH. Transportation for 2 h may not have imposed sufficient stress in animals to elicit a change in the ultimate pH of the LD muscle. It has been reported that there could be preslaughter situations where the ultimate pH of meat may not be affected despite a significant preslaughter breakdown of glycogen (Kannan et al., 2003). This trend was also reported by Apple et al. (1994) in lambs with exercise-related stress. However, Kadim et al. (2006, 2010) studied the effects of a 2- or a 3-h preslaughter transportation stress on meat quality characteristics in Omani goats and found that the stressed goats had significantly higher ultimate pH values than unstressed goats. The muscle glycogen levels in goats were not reported in these studies. Similar results were also reported by Apple et al. (1995) in restraint-stressed sheep. Depletion of glycogen and consequent lowering the muscle pH can be induced by catecholamines, muscle contractions, or both factors. Variations in muscle ultimate pH values in the stressed goats may be partially attributed to differences in types and levels of stressors, as well as environmental and genetic factors in the presented studies.

Young (6–12 mo of age) goats are probably more susceptible to stress. In young (6–12 mo age) goats, a 2-h of transportation prior to slaughter was sufficient to cause enough stress to affect glycogenolysis in LD, but not in older (24–30 mo of age) goats. Reports on the effect of age on muscle pH in small ruminants have been conflicting. McGeehin et al. (2001) did not note differences in the pH of lamb LM due to age, although Madruga et al. (1999) found that slaughter age had a significant effect on goat muscle ultimate pH. The pH varies considerably among different goat muscles, which may in part explain the conflicting reports. Kannan et al. (2001) found that the *Triceps brachii* had higher pH values than either the *Semimembranosus* or LD muscle. Similar results were also reported by Kadim et al. (2006) in Omani goats.

Variation of muscle pH in different muscles may also depend on difference in the proportions of red and white muscle fibers that could differentiate energy metabolism patterns during ante- and post-mortem (Swatland, 1982). Based on metabolic activities and contractile properties, skeletal muscle cells are classified into muscle fiber types (Argüello et al., 2001). Researchers have relied upon myosin heavy chain (MHC) molecule isoforms as markers of muscle fiber types, a factor that can greatly influence the quality of meat and meat products (Pette and Staron, 1990; Xiong, 1994). Argüello et al. (2001) identified three distinct MHC isoforms, one slow and two fast, in goat *Semitendinosus* muscle. The authors reported that two of the isoforms were clearly I and IIA MHCs, and the third one tentatively designated as MHC-IIX. In addition, they also reported two additional hybrid fiber types in goat *Semitendinosus* muscle. Further investigation is required to better understand fiber type distribution in different muscles of goat carcasses and their role in the development of meat quality.

2.2. Diet

2.2.1. Concentrate vs. roughage

Diets of animals may influence the carcass and meat composition, muscle pH decline, and possibly the rate of carcass cooling postmortem. The requirements of dietary protein for growing meat goats depend on their maturity and energy intake. Atti et al. (2004) assessed the potential relationship between stage of maturity and dietary protein concentrations using local meat goats of Tunisia. Goats were fed oat hay ad libitum and supplemented with low