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Review article

Some major factors affecting carcass composition in goats

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ABSTRACT

This review article looks at some major factors that influence carcass composition in goats. The resultant carcass composition of various animal species differs considerably depending on several environmental factors and management practices. These several factors which are within control of animal producers may be manipulated to achieve desirable effects in carcass composition. Some of the factors which have been implicated to cause considerable variation in carcass composition include genetic, nutrition, age at slaughter, sex of animal and weight of animal. Carcass composition differ among animal species, even within more similar or homogenous groups such as small ruminants and differences are mainly species dependent.

1. Introduction

Goat meat is becoming popular because of the consumer market that increasingly demands healthy food, since it has a low fat content compared to other red meats (Kannan et al., 2003). Carcass composition of various species differs considerably in terms of carcass weight, percentages of fat, muscle and bone (Irshad et al., 2013). Goats tend to deposit most of their fat in the visceral rather than carcass depot and produce leaner carcasses (Devendra and Owen, 1983). Body energy reserves, mainly represented by fat and muscle body content, as well as body composition, are important determinants of carcass quality in livestock (Mora et al., 2007). The carcass fat

content is highly variable and can be influenced by breed, age, sex, nutrition, body weight, physiological condition and physical activities (Owen et al., 1978; Kirton, 1988).

On the other hand, the quality characteristics of goat meat might be influenced by factors such as slaughter age, breed, castration, nutrition and butchering methods (Costa et al., 2008). Among these, nutrition is predominant, because changes in animal diets may improve both the quantity and quality of the final product (Geay et al., 2001). As animals become older and heavier the proportion of fat in their carcasses increases and the proportion of muscles and bones decreases. The ideal carcass can be described as one that has a minimum amount of bone, a maximum amount of muscle and an optimum amount of fat. The physical and chemical of goat meat at the point of consumption are the results of sequential influencing factors that each, to a greater or lesser extent, can be directed by producers. This review attempt to highlight the influence of some major factors on goat carcass composition.

2. Plane of nutrition and dietary additives/supplements influencing carcass composition in goats

Carcass composition is a product of many different production systems from widely varying environments and nutritional regimes. Limited nutrient intake maximizes lean tissue accretion and minimizes fat deposition regardless of gender (Goetsch, et al., 2011). Abbasi et al (2011) concluded that feeding diets differing in energy and protein ratio had dissimilar effects on carcass quality in Markhoz kid goats. In addition, the animals fed diets containing highest energy and protein presented greater carcass chemical components compared to lowest levels. These results might explain the effectiveness of dietary nutrient concentration in influencing carcass composition from goat kids. The same results were confirm by earlier report which suggested that some carcass characteristics improved by dietary energy and protein supplementation (Shahjalal, et al., 1992). Sebsibe et al., (2007) comparing the physical composition, chemical fat, proportion of primal cuts, lean: bone and lean: fat ratios observed that the initial slaughtered group with the carcass of fed groups indicated that the bone proportions decreased and the fat increased in the fed groups. Central Highland goat having the initially lowest fat proportion made considerable improvement in its fat proportion (3.3 times over its initial fat proportion) as a result of stall-feeding. It was concluded that the lower fat values recorded in Central Highland goat for chemical fat, physical fat, fat thickness and total internal fat, this breed was assumed to be less physiologically mature than the other breeds. Mariniva et al. (2001) suggested that goat meat lacks juiciness and an increased amount of subcutaneous and intermuscular fat would prevent the carcass from drying out during hanging. This corroborates with the findings of Owen et al. (1978) who indicated that even when the market requirement is for a lean carcass, a certain level of carcass fat (10 to 15%) could be desirable from the consumer's point of view so that the cooked meat does not become too dry. The Ethiopian goats had less total non-carcass fat and relatively higher carcass fat, which may help to minimize chilling losses and improve the eating quality of the meat (Sebsibe et al., 2007).

The findings were in agreement with those reported by Hatendi et al. (1992) and Mahgoub et al. (2005) who observed that that the initial slaughter groups had lower carcass fat values than the fed groups. High concentrate diets increase internal and carcass fat in goats, including intramuscular fat though levels are less than in cattle or sheep. Levels of saturated and monounsaturated fatty acids are greater in goats consuming concentrate in confinement compared with rangeland grazing (Goetsch, et al., 2011). In contrary, Reddy and Raghavan (1988) and El-Gallad et al. (1988) observed that diet had no significant effect on the physical composition of the carcass. These results corroborate with the literature (Kumar et al., 1991; Sebsibe and Mathur, 2000). In another study it was concluded that daily zilpaterol hydrochloride supplementation at 0.20 mg/kg BW increases growth performance, feed efficiency, and dressing percentage in castrated goats as a result of greater muscle accretion and causes reduction of fat and visceral organ mass (Hatefi, et al. 2015). However, Moody, (2000) suggested that the factors that affect the magnitude of responses to zilpaterol supplementation in terms of growth performance and carcass characteristics in small ruminants require further study, but may include growth potential, age at time of feeding zilpaterol, nutritional background, initial weight at the start of the finishing program, number of previous days on feed in feedlot, and final weight at time of harvest. Use of fish oil is a nutritional strategy to improve the health claimable long-chain omega-3 fatty acid content and n-6/n-3 ratio in goat meat without changing the sensory properties or colour of meat (Najafi, et al., 2012). Abuelfatah, et al (2013) assessing the effects of feeding different levels of linseed as a source of n-3 **fatty acid** on goat's growth performance and **carcass characteristics** in Boar goats concluded that linseed can be included to goat diets up to 20% (w/w), without adverse effects on growth

and carcass quality of goat. Feeding goat 20% linseed can increase feed efficiency while 10% can improve goat carcass traits.

3. Age and weight of animal influencing carcass composition in goats

Meat of young goats is a material of full value, which can be utilized in the production of healthy meat and it is characterized by a low intramuscular fat content and a high level of protein and mineral elements (Kesava Rao et al. 2003, Pieniak-Lendzion et al. 2003, Sikora and Brys, 2006, Brzostowski et al. 2008). Sen et al., (2004) in a comparative study of stall-fed Ethiopian goats with Indian goats, at similar age and slaughter weight indicated that Ethiopian goats had less total non-carcass fat (3.01 vs. 6.74% on SBW basis) but more chemical fat (12.6 vs. 3.2%) than the Indian goats. Pieniak-Lendzion et al., (2009) reported that half carcass tissue composition of older and younger kids was similar: 60.13-60.50 % of meat, 25.48-25.37 % of bones, and 14.39-14.13 % of fat. However, the significant differences in fat and bone contents were only found in the leg. Furthermore, physiochemical properties indicated that the meat of older animals was darker and had higher values of chemical parameters. Kids slaughtered at lower body weight and fed mainly on goat milk destined to obtain the so-called (white meat) (Luo et al. 2000, Stanisz and Gut, 2005) displayed higher growth rates (Ringdorfer, 2001), better carcass conformation and fatness than smaller kids (Pala et al. . 2005, Pena et al. 2007). Khalil, et al (2012) working with Ardi Saudi and Damascus goats, the results gave an impression to that kids' carcass composition could be appreciated for its high nutritional and dietetic properties since ether extract in the lean was low (16.8 %) and protein content was high (78.8%) on dry matter basis. This implies that carcass and meat composition traits were changed markedly with the animal's age or the weight at slaughter. Ripoll et al. (2011) analyzed the effect of slaughter weight (light carcass weight: 7.6 kg vs. heavy carcass weight: 11.4 kg,) in milk kids. In this case, weight at slaughter had an important effect on meat quality: light kids had a higher compression on texture rates. However, with regard to sensory analyses, meat from light kids was reported tender and juicier than meat from heavy ones, with higher fibrosis and species odor.

Singh et al. (1991) and Dhanda et al. (1999) documented that the percentage of bone decreased significantly with age and weight. In another study on the content of high-priced cuts and meat tissue in animals slaughtered at higher body weights was higher and the meat was characterized by more favorable physicochemical parameters (Kasprzyk and Krupa, 2000, Mioc et al. 2001). Tshabalala et al. (2003) obtained large meat tissue values of (76.19-78.06 %) and bone tissue of (20.16-22.74 %) in legs of castrated kids in relation to breed differences. On the other hand, Luo et al. (2000) recorded a lower content of meat tissue (57.1 %) and higher fat and bone fibre percentage (20.2 and 20.6 %, respectively) in goat kids slaughtered at 50 weeks of age. Pena et al. (2007) observed that kid carcasses of Florida breed when characterized by different content of cuts according to the slaughtering weight their carcasses contained 57-58 % of muscles, 20-25 % of bone, 5-6 % subcutaneous fat and 9-12 % of intramuscular fat.

4. Gender and castration influence on carcass composition in goats

Castration is one of those important management activities used to produce carcasses with higher percentages of fat tissues than intact kids (Kabede, et al. 2008). The magnitude of effect of castration on carcass fatness varies considerably with plane of nutrition, although some gender comparisons have not considered stage of maturity (Goetsch, et al., 2011). The effect of castration of Turkish hair kids (weaning at 160-216 days) had no significant effect on the content of priminal cuts in the whole carcasses (57.29-57.42 %), excluding the long leg and ribs. The bone (9.56 vs. 7.09 %) and muscle (52.05 vs. 56.50 %) contents of carcasses differed significantly between intact males and castrated (Koyuncu et al. 2007). Previous studies have been shown that intact animals grow faster and utilize feed better than castrated males (Solomon et al., 1991). In contrast with this view, Mackenzie (1970) and Kyomo (1978) concluded that castrated male goats grow faster and are heavier than intact goats which suffice to suggest that castration through influence of growth and weight might also influence carcass composition . Louca et al. (1977) have shown that flavor and tenderness of castrated kid meat can improved by increasing the amount of intermuscular fat content. In terms of body fat thickness intact kids had less body fat thickness than comparable castrated kids. Kebede et al. (2008) observed thinner body fat thickness in intact Arsi-Bale males than castrated kids. Forrest et al. (1975) attributed such differences to hormonal changes associated with castration; these kids were slaughtered approximately 1 month past at the age of their sexual puberty. The discrepancies in

results might be due to breed differences in growth and stage of maturity at slaughter, fattening period, dietary energy, physiological condition and physical activities. El-Waziry, et al. (2011) observed that intact kids had slightly lower fat weights in omental, mesenteric and perirenal depots than castrates, hence concluded that castration had no significant effects on all studied internal fat depot weights. This was in agreement with report by Ciftci and Kor (2010) who did not get significant difference in omental and mesenteric fat weight between castrated and intact Norduz males. Muscle, bone, subcutaneous fat and intermuscular fat percentages in the chop region for intact and castrated groups were, respectively, 43.15±0.822 and 41.48±0.579%; 24.60±1.026 and 26.84±0.750%; 7.66±0.711 and 10.21±0.615%; 7.48±0.506 and 7.25±0.693%. It was concluded that early castration had no significant on the carcass characteristics of Norduz male kids. Ruminants' gender effect (male, female, castrated) is mainly related to the quantity of fat deposited, deposition site, growth rate and carcass yield. Carcass attributes are more affected by gender; likewise, females are more affected than males due to their higher precociousness (Guerrero, et al. 2013). El-Waziry et al. (2011) reported no differences between castrated and intact kids on all studied internal fat depot weights, chemical composition of the 9-11th rib joint and meat quality of the longissimus muscle except for the separable fat percentage from 9-11th rib joint which was higher for castrated as compared to intact kids. Castrated goat kids had significantly heavier liver weight, more body fat thickness and lighter head weight than comparable intact. Johnson et al (1995) analyzed the effects of sex and castration on cholesterol and fatty contents of cooked goat meat. Reported higher concentration of cholesterol for castrated males (98mg/100g) compared with intact males and females 94 and 100mg/100g, respectively and in terms of cooking meat from intact goat had less total saturation than those from female or castrated goats. However, total cholesterol content was significantly affected by slaughter age or castration these factors being independent of each other (Madruga et al 2000). Oleic and linolenic fatty acids were found to be significantly affected by castration (Madruga et al 2008). Castrated goat meat contained greater unsaturated and polyunsaturated fatty acids than intact goat meat. In contrast with this view, Kumar et al (1983) observed that castration had no significant effect on fat content of goat meat. The lower SFA together with the higher MUFA proportions observed in castrated male in Norwagian goats made meat from these animals nutritionally healthier than that of other animals used. In a different study, Enser et al (1998) suggested that the ratio n-6: n-3 PUFA for male goats is similar to that for bulls. Bas et al (1982) observed level of branched chain fatty acids (saturated C14, C15 and C16) in subcutaneous fat were higher in intact than castrated kids. However, Solaiman, et al. (2011) suggested that there is an increased interest in goat meat production from intact males which is related to the declining demand for animal fat, the increased importance on more efficient red meat production, and the need for superior amount of animal protein.

5. Genotype and carcass composition in goats

Genotype is a clear source of variation in carcass morphology related to fat quantity or meat quality. In fact, it is a complex factor because results depend upon which criteria of comparison are taken into account: same weight, similar age or similar degree of maturity (live adult weight %) (Guerrero et al. 2013). Genetic variability in performance traits is considerable and has been the target of various breed improvement and crossbreeding programs. Breed and genotype differences in carcass traits also exist; however, few improvement programs have included these traits in selection objectives (Goetsch, et al., 2011). The growth and carcass composition traits differ between breeds within all farm animal species (Irshad et al., 2013). Significant differences in carcass fat content between goat breeds were also previously reported by Johnson et al. (1995). Despite the difference in the non-carcass fat mainly be due to contribution of genotypic variability, the difference in chemical fat may be due to the interaction of sample location and breed (Sebsibe et al., 2007). It is suffice to speculate that different goat breeds (indigenous and/or exotic) may partition fat and muscle differently between body depots. Lawrie, (1998) observed that as an animal matures, it undergoes an increase in the ratio of muscle to bone, followed by a decrease in muscle growth rate and an increase in the ratio of fat to muscle. This implies that different breeds differ in their rate of maturation (early vs late) and average mature weight. The effect of genotype on the different lean : bone, lean : fat and meat : bone ratios were reported by Dhanda et al. (1999) and Getahun (2001). Therefore, standardizing measurements of body composition (proportions of muscle, fat and bone) to the same stage of maturity of body weight (ratio of actual weight to expected mature weight) results in much less variation in carcass composition than standardizing to the same age or weight. For the mature pure indigenous breeds there was no significant ($P<0.05$) breed difference for all the carcass yield components except for the total lean (TL%) as a proportion of EBW (Wanyoike, et al., 1989). Ameha, et al., (2007) observed that breed affected the carcass

characteristics of the three Ethiopian goat breeds. Breed affected the weights of internal fat depots and the physical carcass composition (8-10th rib-cut) ranged from 72 - 73, 6.9 - 10.9 and 17.1 - 20.2% for lean, fat and bone, respectively, and the fat content of the meat ranged from 10.3 - 14.0%. Ethiopian indigenous goats had more chemical fat (10.3 - 14.0 vs. 4.3 - 5.1%) compared to yearling stall-fed Zaraibi goats of Egypt (El-Gallad et al., 1988). El Hag and El Shargi (1996) and Kadim et al. (2003) observed that breed significantly affected the weights of most edible and non-edible carcass components in goats. Genotype is a factor that should be considered in studies on the quality of goat carcass composition in spite of high individual variations and although it is less important than other factors which may be more relevant than breed effect per se. However, it is a multi-causal factor, because differences in metabolism, behavior, social rank, sensibility to stress, way of birth, dam milky capacity, learning capacity or, simply genetic differences, could be presented alone or as additive factors that increase the variation (Guerrero, et al. 2013).

6. Implications

The review attempt to highlight the influence of some individual known factors on carcass composition and their implication on the end product. Some of the factors discussed were nutrition, genotype, castration, age and weight of goats on how they influence carcass composition. There is a potentiality of manipulation of some of these factors to promote desirable carcass composition. Carcass weight is a major factor affecting the composition of the carcass and is closely related to age at slaughter. Thus, at heavier live weight, an animal's carcass will have lower proportions of muscle and bone and a higher proportion of fat. Some goat breeds mature earlier than others and the main breed differences in carcass composition are related to the rate of fat deposition during the later stages of growth. The effect of nutrition on carcass composition is not a simple one as it involves the interactions among level of intake, the composition of the feed, and nutrient needs of the animal.

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