EFFECT OF INCREASING LEVELS OF STATIN (Atorvastatin) ON CARCASS CHARACTERISTICS AND MEAT QUALITY OF SOKOTO RED GOATS

Abstract

This study aims to investigate the effect of statin on carcass characteristics and meat quality of Sokoto Red goats. Sixteen castrated goats aged 8-9 months old with initial live weight of 29.8±3.0 kg were assigned to four treatments replicated three times. The experiment lasted for a period of 3 month. Treatment 1 was the control (0 mg statin /kg bodyweight) while T2, T3 and T4 were supplemented with statin at 2.5, 3.5, 4.5 mg statin/kg bodyweight, respectively. The result revealed no significant difference (P>0.05) on carcass characteristics. However, meat quality parameters (pH, cook loss, drip loss and cholesterol contents) except colour differed significantly (P<0.05). Supplementation of statin resulted in meat with high water holding capacity while pH values increases with increase in the level of statin. It can be concluded that dietary supplementation of statin at 4.5 mg/kg bodyweight could be a viable feeding approach to produce meat with high water holding capacity and lower cholesterol content. However, the pH values being at higher side could produce dark firm and firm (DFD) meat. Additional study is recommended to investigate myotoxicity effect of statin in order to safeguard consumers against myopathy associated with statin intake in humans.

Keywords: caprine, statin, cholesterol, meat quality, Semimembranosus

1. Introduction

The worldwide population of small ruminants as ~~at~~ of 2018 is 2.18 billion head (FAO 2018). Out of which fifty-five percent are goats, 1 billion head~~,~~ are reared in Asia and 38% in Africa. The world production of goat has surpassed 5 million tons of carcass equivalent and Africa remains the second leading producer of goat meat in the world (Corazzin et al., 2019). The consumption of goat meat, also known as chev~~r~~on, has suddenly showed a surge in the recent years (Getz, 1998; Gipson, 1999; Garba et al., 2019). Though Chev~~r~~on is the main source of meat in developing countries, but it is not very popular in Western countries. However, due to the health benefits associated with consuming lean meat, reduced fat and cholesterol content, perceptions of goat meat are changing. The fat content of meat usually varies, depending on the species, the degree of fattening of the animal before slaughter, the age and weight at slaughter, and whether the animal has been castrated (Madruga et al., 1999).

However, the use of castrated male goats as meat were associated with production of meat with high fat content due to increased fat deposition, and it was established to have positive correlation with cholesterol contents of meat (Soliman, 2018). Dietary cholesterol increasesing blood cholesterol levels leading to the eminent risk of cardiac disease (Soliman, 2018; Carson, 2020).

According to reports, statins hinder the conversion of HMG-CoA into mevalonate, the precursor of cholesterol, thereby limiting cholesterol synthesis in goats(Wang et al., 2016: Garba et al., 2019). Based on previous reports by (Klevenhusen et al. (2011); Wang et al. (2016); Azlan et al. (2017); Candyrine et al. (2018) and Garba et al. (2019), it is suggested that an effective and safe dose of lovastatin can reduce the intestinal CH4 emissions of sheep and goats by approximately 4 mg/kg BW. Thus, the present study was conducted to evaluate the effect of increasing levels of statin supplementation (2.5, 3.5 and 4.5 mg BW) on carcass characteristics and meat quality parameters in goats were investigated in this experiment.

2. Material and Methods

Experimental Site

The research was conducted at the Animal Husbandry Teaching and Research Farm of Usmanu Danfodiyo University. The farm is located in the main university campus about 10 kilometers north of Sokoto City, Wamakko Local Government District, Sokoto State. Sokoto is located in the Sudan-Sahel region in northwestern Nigeria. It is located between 4°8' east longitude and 6°54'' east longitude, between 12°N latitude and 13°58'' north latitude, and is 350 meters above sea level (Mamman et al., 2000). The average temperature is 28.3 degrees Celsius (82.9 degrees Fahrenheit), but the maximum daytime temperature is below 40 degrees Celsius (104.0 degrees Fahrenheit) for most of the year, and the dryness makes the heat tolerable. The warmest months are February to April, with daytime temperatures exceeding 42 degrees Celsius (107.6 degrees Fahrenheit). The rainy season is from late May

to October; during which showers are a daily occurrence. Rainfall starts late and ends early with mean annual rainfall ranging between 500~~mm~~ to 1,300mm. There are two major seasons in the state namely: wet and dry seasons.

Sources and Processing of Experimental Feeds

The raw materials used in the experiment included corn, rice milling waste, cowpea hulls, wheat offal, premix and salt, all purchased from Sokoto Market (Kara). Corn is crushed to reduce particle size, and cowpea husks, rice milling waste, premix and salt are obtained directly from the market (Table 1).

Table 1: The ingredient and chemical composition of experimental diets

	Dietary treatments			
Ingredients (% DM)	**T1**	**T2**	**T3**	**T4**
Wheat offals	30.0	30.0	30.0	30.0
Corn	3.5	3.5	3.5	3.5
Cowpea husk	45.0	45.0	45.0	45.0
Soybean meal	17.0	17.0	17.0	17.0
Rice milling waste	3.0	3.0	3.0	3.0
Vitami/Mineral premix	0.5	0.5	0.5	0.5
Salt	1	1	1	1
Total	100	100	100	100
Calculated Composition				
Crude protein (%)	17.3	17.3	17.3	17.3
Crude Fibre (%)	19.0	19.0	19.0	19.0
Energy (kcal/kgME)	2025	2025	2025	2025
Ether Extract	4.0	4.0	4.0	4.0

***** Note: Rice straw (treated and untreated) was fed *ad libitum* as basal diet after concentrate feeding at the rate of 1.5% body weight of the animals.

2.2 Experimental design and Animals management

Twelve (12) castrated male Sokoto red goats ~~of~~ aged between 8to 9 month~~s old and~~ with an average live weight of 29.8±3.0 kg~~was~~ were assigned randomly in equal number to four dietary treatments, viz. T1 (Control), T2, T3 and T4 containing 2.5, 3.5, 4.5 mg statin/kg BW. Each animal was allocated to individual pens and fed the experimental diets for the period of 12 weeks. The experimental diets and clean drinking water ~~ware~~ were offered *ad libitum* to each animal.

2.3 Slaughter, Carcass characteristics and Sample collection

At the end of the experiment, goats were weighed and transported to the experimental slaughter house of the Usmanu Danfodiyo University, Sokoto, Nigeria, where they were slaughtered according to the Halal procedure. After preparation stages (skinning, evisceration, and removal of other external offals), carcasses were immediately weighed to obtain hot carcass weight and dressing percentage. Thereafter, carcasses were kept in chilling room at 4°C for 24 h. After 24h cold carcass weight was obtained ~~by re-weighed~~.

Samples from the proximal third of the Semimembranosus muscle (SM) were used for meat quality analyses. All SM samples were cut into three equal subsamples and used for further evaluation of cooking loss, drip loss, pH, color, shear force, measurements. At 24 h postmortem, SM muscle was cut from each carcass, vacuum packaged, and stored frozen (-20 °C) for cholesterol determinations.

2.4 Meat Quality Analysis

Water holding capacity, pH value, colour and cholesterol level which are some of the characteristics for assessing meat quality, were carried out on the SM muscle samples.

2.4.1 Meat pH

The meat pH were evaluated following the method of Okoh and Omojola (2018). Briefly, the pH meter (Fisher Scientific, Pittsburgh, PA) electrode was introduced directly into the fresh

slit made in the carcasses. The pH values were recorded instantly according to the experimental treatments.

2.4.2 Meat colour

The meat colour samples were evaluated as described by Strange et al. (1974). Briefly, a trained panelist (n=12) knowledgeable in color judgement were used to describe the color of samples from Semimembranosus in terms of the three dimensions of colour (value, hue, and chroma) as well as for overall color.

2.4.3 Drip loss

The drip loss was measured according to the procedure described by Garba et al. (2019). In ~~short~~brief, 30 grams of fresh SM samples are collected, individually weighed, vacuum packed, and stored in a refrigerator at 4°C for 24 hours. After taking it out of the package, the muscle was dried with a paper towel and weighed ~~it~~. The percentage change in weight during the subsequent aging period is considered as drip loss.

2.4.4 Cook loss

Measure cooking loss as described in Garba et al. (2019). In short, 20 grams (20g) of fresh meat samples were collected from SM muscle. The sample was packaged in an impermeable polyethylene bag (vacuum) and boiled in a water bath at 850°C for 10 minutes, resulting in a core temperature of approximately 750°C. After the cooking process, let the meat sample cool for 15 minutes at room temperature, then blot it dry with paper towels, re-weigh and record the sample. The cooking loss was expressed as a percentage of the difference between the cooked and uncooked samples.

2.4.5 Muscle cholesterol

Cholesterol determination was carried out as described by Rudel and Morris (1973) using o-phthalaldehyde.

2.5 Statistical analyses

The data were analyzed using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS) package version 9.2 software (Statistical Analysis System, 2007, SAS Institute Inc., Cary, NC, USA). Significant differences between means were detected using Tukey tests. Statistical significance was set at $P<0.05$.

3. Results and Discussion

3.1 Carcass characteristics

Carcass characteristics of Red Sokoto goats fed ~~increasing~~ with different levels of statin revealed that there was no significant difference in all the parameters measured (P>0.05). No differences (P>0.05) in all important carcass evaluation parameters, suggested that statin did not ~~negatively~~ affect carcass evaluation parameters in the present study. Our findings are in line with the previous report by Candyrine et al. (2018). The authors reported that no differences ($P>0.05$) in empty live weight, dressing percentage, and chilling loss when goats were fed naturally produced lovastatin.

Table 2: Carcass characteristics of Red Sokoto goats fed with different ~~diets of increasing~~ levels of statin

	Treatments				
Parameter	**T1**	**T2**	**T3**	**T4**	**SEM**
Initial body weight (kg)	29.28	29.43	29.63	29.72	0.697
Full live weight (kg)	32.32	32.74	32.24	33.34	0.732
Empty live weight (kg)	30.24	30.76	30.25	30.82	0.642
Hot carcass weight (kg)	13.6	13.92	13.96	13.34	0.233
Cold carcass weight (kg)	13.70	13.96	13.86	13.83	0.324
Dressing percentage	41.62	40.37	40.17	40.94	1.275
Chilled loss (%)	12.86	13.02	12.84	12.90	0.27

SEM= standard error of mean

3.2 Meat quality characteristics

Meat quality traits of Red Sokoto goats fed with increasing levels of statin revealed that there all the parameters measured differed significantly ($P<0.05$) except color scores (Table 3).

Values of the colour scores were similar among treatments. The meat colour is the first criteria used by consumers in judging meat quality and acceptability (Conforth, 1994). Thus, supplementation of statin in goat meat does not alter the colour of the meat.

High drip and purge loss can denote a substantial loss of weight in carcasses and thus affect the yield and quality of meat, thereby becomes economically important (Wright *et al.*, 2005). Supplementation of lovastatin affect drip loss ($P>0.05$). Control treatment had the highest drip loss compared to the other treatments. There was a trend in drip loss as the level of statin increases, the amount of drip loss decreases. Cooking loss followed similar trend with cook loss (Table 3). The mechanism essential for water retention in fresh meat is imbedded in the structure of the muscle cell and in the state of key proteins associated with the myofibril. Cytoskeletal protein was reported to form 10% of muscle proteins (Labeit and Kolmerer, 1995) and therefore, water is released continuously during meat storage (Kristensen and Purslow, 2001; Straadt et al., 2007) as a result of cytoskeletal structure degradation.

One of the main postmortem changes that occur during the conversion of muscle to meat is pH. It affects the quality of fresh meat and its derivatives (Osrio and Osrio, 2000). The pH of the muscle determines various meat parameters, such as water retention, cooking weight loss, shear force, and sensory meat characteristics related to tenderness, juiciness, taste, smell, and color (Bressan et al., 2001). Results of this study showed that supplementation of statin affect pH values. The muscle pH ranged from 6.23 to 6.38 was within the acceptable range (Hedrick *et al.*, 1994) but at high side. Thus, regarded as Dark Firm Dry (DFD) meat which is usually attributed to a darker colour and shorter shelf-life compared to the pH range of normal meat (5.4-5.7) of an unstressed animal. DFD also known as “high pH” could result

due to depletion in muscle glycogen reserves of animals prior to slaughter (Miller, 2007). The high pH values of the meat suggest that goats are generally more highly prone to stress due to peri-mortem concentrations of glycolytic metabolites in muscles (Kannan *et al*., 2003; Simela*et al*., 2004) and in the blood (Kannan *et al*., 2002).

Cholesterol is an indispensable lipid component that has been criticized for its negative effects on health and public concern (hypertension, coronary heart disease, and peripheral artery disease), and is more commonly associated with the consumption of red meat products (Li et al., 2017).. However, cholesterol is the main component of the plasma membrane and a key molecule involved in intracellular transport, protein activity regulation, cell signal transduction, and nerve conduction (Ciardelli et al., 2006). Statin is an inhibitor of HMG-CoA reductase, which is necessary for the synthesis of cholesterol, and thus it reduces cholesterol synthesis. The present study has demonstrated that the cholesterol content in the meat of the statin treated goats reduced significantly ($P<0.05$) compared to the one without statin (control). Similarly, treatments with high dose of statin recorded lowest cholesterol content.

Table 3: Meat quality traits of Red Sokoto goats fed diets with increasing levels of statin

	Treatments				
Parameter	**T1**	**T2**	**T3**	**T4**	**SEM**
Colour scores (%)	7.46	7.21	7.67	7.15	0.064
Drip loss (%)	2.94^{c}	4.89^{a}	3.96^{b}	2.99^{c}	0.608
Cooking loss (%)	15.20^{c}	25.45^{a}	20.67^{b}	15.80^{c}	0.371
pH (unit)	6.45^{a}	6.23^{c}	6.35^{b}	6.38^{b}	0.014
Cholesterol (mg/1000g muscle)	66.7^{a}	65.4^{b}	63.2^{c}	62.0^{c}	0.143

^{a,b,c}Means within the same row with different superscripts are significantly different at $P<0.05$.

SEM= standard error of mean

4. Conclusions

Our results clearly showed that the supplementations of Statin ~~supplementation~~ do not have ~~no~~ any effect on carcass characteristics. Nevertheless, statin supplementation has to a large extent affected the meat quality traits, whereby treatments with high doses (3.5 and 4.5 mg/kg BW) demonstrated high pH as well as better water holding capacity measured through drip and cook losses. The highest dose (4.5 mg/kg BW) is recommended for meat with low cholesterol and high water holding capacity, however, high pH (6.38) from the treatment with 4.5 mg/kg BW) make the meat to be dark firm and (DFD).

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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