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Original Article

Impact of drenched apple cider vinegar on haemato-serum status of West African Dwarf goats raised under intensive management system

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Abstract
A 70-day study was conducted to investigate the impact of drenched apple cider vinegar (ACV) on haemato-serum status of West African Dwarf (WAD) goats raised in an intensive management system. Twelve WAD goats with an average live weight of 5.00 ± 0.9 kg, grouped into three treatments with four animals per treatment balanced for sexes and weight were randomly assigned to three treatments designated as T1-T3 where T1, T2 and T3 were drenched on daily basis with 0, 1 and 2 ml of ACV, respectively in a completely randomized design (CRD). Data obtained were subjected to one-way Analysis of Variance. Packed cell volume (PCV) and haemoglobin (Hb) were observed to be significantly ($P<0.05$) influenced by ACV. Highest comparable PCV values (29.25 and 27.67 %) were obtained in T2 and T3, respectively while the least value of 21.80 % was obtained in T1. Haemoglobin followed similar trend with PCV. Results obtained on blood serum biochemical parameters showed that total protein (TP) and aspartate aminotransferase (AST) were statistically ($P<0.05$) influenced. Highest similar TP values (69.20 and 71.88 g/l) were obtained for T2 and T3, respectively while the least value (62.57 g/l) was obtained for T1. AST had highest similar values (100.18 and 105.30 IU/L) obtained for T1 and T3, respectively, while least value (76.20 IU/L) was acquired in T2. Highest numerical value (106.58 mg/dl) was recorded for T1 while reduced values (95.88 and 98.65 mg/ml) were obtained in other treatment groups. The study concluded that drenching of WAD goats with up to 2.0 ml of ACV will improve health status of the animal and will not pose health challenge on the consumer due to reduced cholesterol level.

INTRODUCTION

Goats play a vital socio-economic role in the rural areas where most of the peasant farmers live (Anaeto *et al*., 2009) and form a fundamental part of the cultural life and system of Nigeria's peasantry (Ajala, 2004). The role played by ruminant animals like goat in improving the low animal protein intake of Nigerians and citizens of other developing countries cannot be overlooked. Despite the importance of goats, its production is still hampered as a result of nutritional deficiency and health challenges (Asaolu *et al.*, 2012; Arsenopoulos *et al*., 2021). This health challenge has made farmers to rely so much on the use of

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antibiotics and other conventional medications which is posing health threat to the animals due to the development of resistance by the pathogens to the active ingredients in the drugs as a result of its misapplication or over dependence (Haile *et al*., 2004; Waller, 2006; Prichard, 2009; Saddiqi *et al.*, 2011), which also invariably affect consumers' well-being due to its residual effects.

In an attempt to improve the health status of the animals using probiotics, apple cider vinegar (ACV), is been agitated for. Apple cider vinegar is an acidic fermentation product, which has been long advocated for because of its health benefits (Conner and Allgeier, 1976; Naziroglu *et al*., 2014). It contains mainly acetic acid, as well as vitamins, mineral salts, some amino acids, polyphenols, and other organic compounds (Johnston and Gaas, 2006; Stornik *et al*., 2016). While not extensively replicated in many larger mammals, trials on rodents have shown reduced blood pressure after ACV supplementation, perhaps due to changes in calcium absorption, or possibly due to pH changes (Kondo *et al*., 2001). Among farmers, ACV is held to have multiple medicinal purposes, ranging from improved hair coat, to greater milk production, reduced mastitis, to decreased urinary calculi in bucks (Welcome Home Farm, 2011; Winter, 2012). Some credit is given to the vitamins, minerals, and other nutrients in ACV, though the concentrations are extremely low (Mercola, 2009). Meanwhile, farmers reported that goats enjoy water with some ACV added, perhaps the improved hydration is part of the health benefits exhibited (The Goat Spot, 2009). Apple cider vinegar is useful in maintaining acid-base balance of the body.

Apple cider vinegar is an alcoholic or acetic fermented apple fruits (Avci, 2007), and produced either by the traditional method, called the Orleans method, or by the rapid (or submerged) method used in industry by means of different varieties of apple (Yagnik *et al*., 2018). Apple cider vinegar has been hailed as a supplement aiding hyperlipidemia, hypercholesterolemia, nutritional support, antioxidant defense and lowering blood pressure. Utilizing organic acids as nutritional supplements has been regarded as safe and can eliminate harmful intestinal bacteria (Avci, 2007). It has been reported to reduce the serum lipid profile in mice fed a high cholesterol diet. Intra-gastric ACV addition induced a protective effect against erythrocyte, kidney and liver oxidative injury as well as lowering cholesterol levels in human (Avci, 2007). It also decreased blood triglyceride with very low-density lipoprotein levels in rats (Naziroğlu *et al*., 2014) and also improved the tenderness of the meat obtained from animals (Stockhealth, 2022).

The effect of ACV on blood constituents of livestock is very important. Jackson and Cockcroft (2002) stated that clinical examination of blood is necessary to identify the clinical abnormalities present as well as the risk factors that determine the occurrence of the disease in the individual. The haematological and serum blood parameters can reflect physical changes occurring in an animal's body (Opara *et al*., 2010) which could be due to diseases or normal physiological changes in different sexes (Egbe-Nwiyi *et al*., 2015).

Hayajneh *et al*. (2018) reported the anti-oxidative role of ACV in infected chickens which attributed to the presence of beta-carotene that possesses antioxidant

property. It could also improve the immune response against pathogens and also contributes to the acid-base balance (Shahidi *et al*., 2008). Guyrarural (2022) reported that ACV is a supplement that can be applied to reinstate the health of animals. However, there is paucity of information on the effect of ACV on the haematological and serum biochemical status of West African Dwarf (WAD) goats raised under intensive system. Therefore, this study was to investigate the impact of drenched ACV on haemato-serum status of WAD goats raised under intensive management system.

MATERIALS AND METHODS

Experimental site

The study was carried out at the Goat Unit of the Teaching and Research Farms of the Faculty of Agriculture, Adekunle Ajasin University, Akungba Akoko (AAUA), Ondo State, Nigeria. The site is located in the rain forest vegetation zone of South-Western Nigeria between latitude 7°28'55" N and longitude 5°46'05" E. The annual rainfall ranges from 1500-2000mm with a temperature range of 23-26 °C (Olabode, 2014).

Experimental animals and management

A total number of 12 intensively managed WAD goats were used for the study. They were bought from the goat market in Oke Oka, some kilometers away from the experimental site. The 12 WAD goats comprised of six bucks and six does aged 5-6 months with an average live weight of 5.00 ± 0.9 kg. The pen was thoroughly cleaned and disinfected with Lysol® solution twice and allowance of two weeks was given before the arrival of the animals. The animals were allowed an adaptation period of four weeks during which they were given prophylactic treatments; Ivermectin® was administered subcutaneously to control worms at 0.5 ml per 25 kg bw, intramuscular application of tetranor® (1 ml / 10 kg bw) and multivitamin at a dosage of 5 ml per bw and also treated against mange and other ectoparasites with pour on® disinfectant. The animals were fed at 4 % of their body weight which was adjusted on weekly basis. Fresh water was made available *ad libitum*.

Experimental Material and Diet

The ACV solution was purchased from a commercial store in Ibadan. The concentrate, offered as supplement (Table 1), comprised of cassava peels procured from garri processing industry in Akungba-Akoko, sun-dried until crispy was achieved. Other ingredients; wheat offal, palm kernel cake (PKC), maize, rice bran, bone meal and salt were obtained from a reputable Feed Mill in Ikare-Akoko, Ondo State while *Panicum maximum* were collected around the farms and offered as basal diet.

Table 1. Ingredient composition (%) of the experimental concentrate diet

Ingredients	Composition (%)
Maize	23.00
Cassava peel	10.00
Palm kernel cake	24.00
Rice bran	15.00
Wheat offal	25.00
Bone meal	1.50
Salt	1.50
Calculated Nutrients	
Crude protein	13.26
Crude fibre	8.15
ME (MJ/KgDM)	2387.26

ME = Metabilizable energy

Experimental Design

The 12 experimental animals were grouped into three treatments, with four (4) animals per treatment balanced for sexes and

weight, where each animal was an experimental unit. The animals were randomly assigned to the three treatments designated as T1 - T3 where animals in T1 had 0 ml of ACV, T2 were drenched with 1 ml of ACV and T3 were drenched with 2 ml of ACV in a completely randomized design (CRD).

Data collection

Blood samples were collected from the jugular vein of each animal using hypodermic needle and syringe at the end of a 70- day feeding trial. This was done in the morning prior to feeding and average of 10 ml blood was collected from each goat. About 5 ml of the blood collected was released into plain blood sample bottle for the determination of the serum biochemical parameters while the remaining 5 ml was dispensed into blood sample bottles containing Ethylenediamine tetraacetic acid (EDTA) as anticoagulant for the determination of the haematological parameters. The blood samples collected were kept in an ice pack which was used to transport it to the laboratory for immediate analysis.

A portion of experimental concentrate feed sample was taken, oven-dried, ground and sieved through a 2- mm sieve and stored in airtight containers for proximate analysis according to AOAC (2007).

Statistical analysis

The data obtained were subjected to one-way Analysis of Variance using SPSS 2015 Version 23. Means among treatments showing significant differences were separated using the Duncan's multiple range test of the same package at $P<0.05$.

RESULTS AND DISCUSSION

Table 2 showed proximate composition of the experimental diet to contain ash, ether extract, crude fibre, dry matter and carbohydrate with the following values: 8.40, 6.55, 10.42, 14.64, 86.50 and 46.69 %, respectively.

Table 2. Proximate composition of the experimental diet

Parameter	Composition (%)
Ash	8.40
Ether Extract	6.55
Crude Fibre	10.42
Crude Protein	14.64
Dry Matter	86.50
CHO	46.69

Results obtained on the influence of varied level of ACV on haematological status of WAD goats is presented in Table 3. Packed cell volume (PCV) and haemoglobin (Hb) concentration were significantly ($P<0.05$) influenced by the ACV drench. Higher comparable PCV values of 29.25 and 27.67 % were obtained in animals in T2 and T3, respectively while the least value of 21.80 % was obtained in T1. Haemoglobin concentration followed similar trend with PCV. The PCV values obtained in this study were within the range of 21.0 - 36.9 % reported for clinically healthy WAD goats (Merck, 2011; Yusuf et al., 2012) and lower than the values of35.40 - 36.77 % reported by Odoemelam *et al*. (2014). Aikhumobhogbe and Orheruata (2006) asserted that lower PCV results in anaemia. The higher values observed in this study might be due to the influence of ACV which has assisted the animals to better utilize the protein in the diet but animals in T1 did not receive ACV! This is related to the work of Radostis *et al*. (2006) that stated that high protein metabolism of diet increases PCV of animals.

Haemoglobin is a protein found in animals' red blood cells that transports oxygen and contains iron. The haemoglobin concentration had least value (8.33 g/dl) in T1 while highest similar values (10.25 and 10.69 g/dl) were obtained in T2 and T3, respectively. The values obtained in this study were within the physiological range of 8.0-12.0 g/dl reported by Radostis *et al*. (2006), suggesting the absence of microcytic hypochromic anaemia which could had been induced by iron deficiency and inadequate formation of haemoglobin. Low haemoglobin concentration, according to Jiwuba *et al*. (2016), results in anaemia which reduces blood oxygen-carrying capacity, thereby increase pulse rate and consequently leads to heart failure.

Table 3. Haematological status of West African Dwarf goats administered varied levels of apple cider vinegar

Parameter	T1 (0 ml)	T2 (1.0 ml)	T3 (2.0 ml)	SEM	P- Value
Packed cell volume (%)	21.80^{b}	29.25^{a}	27.67^{a}	1.203	0.009
Haemoglobin (g/dl)	8.33^{b}	10.25^{a}	10.69^{a}	0.412	0.024
White blood cell ($\times10^{12}$/L)	11.16	15.83	11.40	1.067	0.127
Red blood cell ($\times10^{12/L}$)	11.22	14.55	13.57	0.706	0.138
Neutrophil (%)	29.29	24.00	29.00	1.576	0.325
Lymphocytes (%)	64.18	70.50	66.00	1.585	0.265
Monocytes (%)	2.125	3.750	3.00	0.462	0.393
Eosinophil (%)	2.375	1.250	1.667	0.284	0.287
Basophil (%)	0.00	0.50	0.32	0.128	0.296

Values are means and SEM (Standard Error of Means). Means on the same row with different superscripts are significantly (P < 0.05) different.

Results obtained on the influence of varied level of ACV on blood serum biochemical parameters of West African Dwarf goats were showed in Table 4. Among the parameters obtained only total protein (TP) and aspartate aminotransferase (AST) were significant (P<0.05). Highest similar TP values of 69.20 and 71.88 g/l were obtained for animals in T2 and T3, respectively while the least value of 62.57 g/l was obtained for those in T1.

Ikhimioya and Imasuen (2007) elucidated on the importance of serum proteins in osmotic regulation, immunity and transport of several substances in the body. The values obtained for TP in this study were higher than values (59.93 - 60.38 and 47.3 - 54.5 g/l) reported by Ogunbosoye *et al.* (2018) and Yakubu *et al*. (2021). This variation might be due to the nutrient availability in the diet used in this study as shown in all the treatment. In the like manner, significantly (P<0.05) higher TP

Table 4. Influence of varied level of apple cider vinegar on serum biochemistry of WAD Goats

Parameter	T1 (0 ml)	T2 (1.0 ml)	T3 (2.0 ml)	SEM	P- Value
Total protein (g/l)	62.57^{b}	69.20 ^{ab}	71.88^{a}	1.75	0.06
Albumin (g/l)	43.70	39.73	41.93	0.83	0.14
Alanine aminotransferase (IU/L)	20.68	21.78	19.00	1.51	0.79
Aspartate aminotransferase (IU/L)	100.18^{a}	76.20^{b}	105.30^{a}	4.59	0.05
Alanine phosphate (IU/L)	142.50	135.05	150.57	5.98	0.62
Cholesterol (mg/dl)	106.58	98.65	95.88	2.70	0.27

Values are means and SEM (Standard Error of Means). $^{a,b:}$Means on the same row with different superscripts are significantly (P < 0.05) different.

values obtained in groups treated with ACV could be due to the influence of organic acids, amino acids and vitamins present in ACV (Stornik *et al*., 2016) which better influenced the digestion and utilization of protein in the diet and consequently resulted in increased TP levels in the blood. Also, higher TP levels obtained might be due to elevated level of haemoglobin in the treatment groups. Highest significant ($P<0.05$) values of 100.18 and 105.30 IU/L for AST were obtained in TI and T3, respectively while the least value of 76.20 IU/L was obtained in T2. Aspartate aminotransferase values obtained across the treatments were higher than the range values (55.17 and 60.38 IU/L) reported by Olafadehan (2011) for WAD goats as well as values reported by Oloche *et al.* (2019) when Kano brown goats were fed with diets containing water-soaked sweet orange (*Citrus sinensis*). Variation in these values might be due to difference in diets, age and most importantly, *response of the animals to the effect of the ACV.* Cholesterol had least numerical values (98.65 and 95.88 mg/dl) in T2 and T3, respectively, while the highest value (106.58 mg/dl) was obtained for T1. The reduction in the values of cholesterol obtained in the group drenched with 1.0 and 2.0 ml ACV suggested that ACV supplementation had tendency to reduce cholesterol as opined by Naziroğlu *et al*. (2014) when offered to animals and would consequently not lead to its elevation in consumers as suggested by Igwebuike *et al*. (2008).

CONCLUSION

The results from this study showed that for healthy goat production, drenching of WAD goats with up to 2.0 ml of ACV will not pose any health challenge to the animals since the parameters measured in the blood of the animals under the study conditions, were within normal blood ranges for a healthy animal. Also, consumption of products obtained from WAD goats drenched with ACV will not constitute any health challenge on the consumer since there was reduction in cholesterol level in the treated groups. However, similar research should be conducted on animals like pig which has high fat deposition.

Conflict of Interest: The authors state that no commercial funding was acquired for this study that may be construed as potential conflict of interest.

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