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Research Article

Meat quality of west african dwarf goat fed with some selected african herbs

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Abstract: This study investigated the effects of feeding West African dwarf goats with selected herbs (Scent leaf, Indian gooseberry and Wild lettuce). Twenty goats in five treatments of four each were fed hygienically at approved experimental site. The goat meat samples obtained were labeled thus: T1 (no herbs included in feed), T2 (goat fed with scent leaf), T3 (goat fed with Indian gooseberry), T4 (goat fed with wild lettuce) and T5 (goat fed with combination of scent leaf, Indian gooseberry and wild lettuce). The samples were evaluated for texture profiling, total protein, Malondialdehyde (MDA), colour profile characteristics and sensory properties. The sensory properties result of the samples indicated commendable ratings for all the evaluated properties. Also, T2, T4 and T5 were tender than other goat meat samples, with total protein (TP) and Malondialdehyde (MDA) of the goat meat samples increasing with longer storage periods. Furthermore, T2 and T3 had the best lightness (L*), redness (a*) and yellowness intensity (b*) while T5 had the best overall sensory ratings. In conclusion, , West African Dwarf goat fed with combination of Scent leaf, Indian gooseberry and Wild lettuce (sample T5) was the best in terms of textural and sensory properties.

Keywords: West African dwarf goats, herbs, texture profiling, colour characteristics, storage

1. Introduction

Goats have been identified as one of the most prolific and resilient small ruminant livestock with wide ecological adaptations. However, their production and consumption are low despite their importance as a potential source for the growing human population (Webb et al., 2005). Goats considerably contribute to the health and nutrition of many people in developing countries. Goat rearing provides an important supply of animal proteins of high biological value, with important minerals and fat–borne vitamins that are greatly significant for pregnant woman, nursing mothers and young children (Okoruwa et al., 2012). Goat is regarded as a multi-functional ruminant because of its ability to efficiently utilize forages and agro-industrial by-products as feeds (Aye & Adegun, 2010). Goats are also easy to manage with significant profit margin under an intensive rearing system (Okoruwa et al., 2012; Daramola et al., 2021). Since goat meat quality is largely influenced by nutrition (Eneji et al., 2012; Ocheja et al., 2016), feeding goats with nutrient-dense and phyto-energy feed diets is advisable, as diets from alternative feed sources have been reported to improve the sensory properties of goat meat.

Synthetic antibiotics, used as a growth promoter, have been found to cause unwanted results in chicken (Botsoglou Fletouris, 2000) and other livestock (Cantón et al., 2022). Therefore, animal nutritionists are being challenged to develop alternative feed supplements that will replace synthetic ones. An utmost attention has been given to medicinal herbs as replacements for

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antibiotic growth promoters (El-Faham et al., 2014; Ibrahim, 2016). Scent leaf (Ocimum gratissimum), Indian gooseberry (Phyllanthus amarus) and Wild lettuce (Launaea taraxacifolia) are nutrient dense and phyto-energy sources that are readily available, cheap and can be used in ruminant feeding. The scent leaf (Ocimum gratissimum) is from the family "Lamiaceae", which is also called the "mint family" (Winifred & Alexander, 2018). It is called "Efirin" in Yoruba. It is a good source of alkaloids, tannins, flavonoids, phytates and oligosaccharides. However, the leaf is rich in volatile aromatic compounds such as thymol, eugenol, xanthones, terpenes and lactones (Nte et al., 2016).

Indian gooseberry (Phyllanthus amarus) is widely found in all tropical and subtropical regions of the planet (Edeoga et al., 2006). Locally, it is called "Oyomokeisoamank edem" in Efik, "Eyin Olobe" in Yoruba and "Ebebenizo" in Bini. It is also rich in alkaloids, flavonoids, hydrolysable tannins, major lignans, sterols, tetracyclic, triterpenoids volatile oil, polyphenols (Verma et al., 2014). Wild Lettuce (Launaea taraxacifolia) belongs to the family Asteraceae (Compositae), it is a leafy vegetable that can be found in several African countries including Ghana, Senegal, Benin and Nigeria (Bello et al., 2018). It is called "Efo Yarin" in Yoruba, and it is ranked among the most important ten (10) less utilized plants in Benin and constitutes a high priority for research (Dansi et al., 2012). Several studies reveal that wild lettuce have high vitamins, minerals, proteins, essential fatty acids and fibre contents (Namrata et al., 2010; Arawande et al., 2013). Hence, the influence of inclusion of selected herbs in animal feed on African dwarf goat meat quality should be studied.

2. Materials and methods

2.1. Experimental site and housing facilities

The experiment was carried out at Teaching and Research Farm, Kwara State University, Malete (KWASU) (Lat 8º 71ᐟN and Long 4º 44ᐟE), Moro Local Government, Kwara State, Nigeria. For this study, 20 West African dwarfs (WAD) goats of about 10-12 months of age were sourced from local markets in Kwara and kept in a pen at the KWASU, Malete. The research was carried out following the guidelines of the Kwara State University Research Ethical Review Committee on Experimental Animal Ethics. Prior to the arrival of the animals to the experimental site, pens were washed thoroughly and cleaned using disinfectant. The animals were neck-tagged for identification and given prophylactic treatment on their arrival to the farm. At the beginning of the experiment, the WAD goat was randomly assigned to each treatment group ensuring that all the treatments were balanced by body weight. The experimental animals were given a prophylactic treatment against both internal parasites and ecto-parasites (tick, mite and mange) using Ivermectin 2% L.A subcutaneously at 0.25ml/10kg body weight. Oxytetracycline injection 20% L.A and injectable multivitamin was also administered intramuscularly at 1ml/10kg body weight. The goat was housed one animal per pen per diet in an open sided, well-ventilated pen which was equipped with feed and water troughs. Each experiment was replicated four times.

2.2. Experiential feed materials preparation and composition

The experimental feed materials are Scent leaf (Ocimum gratissimum), Indian gooseberry (Phyllanthus amarus) and Wild lettuce (Launaea taraxacifolia) and were sourced from local markets in Moro Local Government Area of Kwara State. Goat feed made from cassava peel, corn bran, soybean cheese waste, PKC, urea, maize, salt, oyster shell and bone meal served as the control for this study. The experimental diet which is a total of 100kg was composed as follows (Table 1):

Table 1: Components of the experimental diet

Components	Percentage
Cassava peel	45.0
Corn bran	20.0
Soybean cheese waste	15.0
Urea	4.0
Maize	2.5
Salt	1.0
Bone meal	2.0
Oyster shell	0.5

2.3. Plant materials and experimentation

All leaves were air-dried, milled and mixed thoroughly according to the treatment below, and added to the goat feed (control). One kilogram of each treatment contained 3g of herb as mentioned below except the control. Water was provided ad libitum.

Treatment 1 is control - No herbs included
Treatment 2 is Scent leaf (Ocimum gratissimum)
Treatment 3 is Indian gooseberry (Phyllanthus amarus)
Treatment 4 is Wild lettuce (Launaea taraxacifolia)

Treatment 5 is the combination of Scent leaf (Ocimum gratissimum), Indian gooseberry (Phyllanthus amarus) and Wild lettuce (Launaea taraxacifolia)

The groups were randomly assigned and fed with the five experimental diets (T1, T2, T3, T4 and T5), at 5% of their body weight and it changed according to their weekly weight gain. Each animal was housed individually in well-ventilated cement floored pen equipped with feeder and drinker. The animals received designated diets in the morning (9 am) and the evening (6 pm) for 120 days. Regular access to fresh drinking water was made available to the experimental animals as described in the guidelines of Kwara State University Animal Ethics Committee. Initial live weights of the animals were taken at the beginning of the feeding trial and on weekly basis. The final live weight was obtained by weighing the goats at the end of the experiment.

2.4. Meat quality attributes determination

At the end of the three months growth experiments, three goats from each treatment were fasted overnight with ad libitum access to water and they were slaughtered in accordance with the halal procedure (MS1500:2009) provided by Saidin and Rahman (Saidin et al., 2016). The meat (muscles from the fore limbs and hind limbs) obtained were subjected to the following analyses to establish the influence of different phytobiotics on the quality of their meats

2.5. Analyses

2.5.1. Texture profile analysis

Instrumental texture profile analysis (TPA) was conducted using Texture analyzer (TMS-PRO, Food Technology Corporation, USA). A sample size of 1.0cm x 1.0cm x1.0cm was subjected to pre-test speed (30mm/sec), post-test speed (100mm/sec) and test speed (100mm/sec) to a double compression cycle with a load cell of 2500 N. A compression platform of 25 mm was used as a probe. The TPA was performed as per the procedure outlined by Bourne et al. (1979). The peak force, yield force, peak stress, peak strain, yield strain, young modulus, width and thickness were calculated automatically by the preloaded software in the equipment from the force-time plot.

2.5.2. Determination of total protein (TP)

The protein concentration in the serum and tissue homogenate was determined by the Biuret method of Elghazali et al. (2023). Exactly 20 µL of each sample was drawn into a test tube containing 1.0ml biuret reagent. The mixture was thoroughly mixed and allowed to stand for 30 minutes. Blank containing 20µL distilled water was also prepared. Thereafter, the absorbance of the sample was read against the blank at 550nm using spectrophotometer

2.5.3. Lipid peroxidation

Malondialdehyde (MDA) which is an index of lipid peroxidation was determined using the method of O'Grady et al. (2001). Exactly 1.0 ml of tissue homogenate supernatant was added to 2 ml of TCA-TBA-HCl reagent (thiobarbituric acid (0.37%), 0.24 N HCL and 15% TCA (1:1:1 ratio) and boiled at 100oC for 15 min. The mixture was allowed to cool. The flocculent was removed by centrifuging at 3000 rpm for 10 min, and the supernatant was obtained and its absorbance was read at 532 nm against a blank. MDA was calculated using the molar extinction coefficient for MDA TBA-complex of 1.56 X 105 M^{-1} cm^{-1}.

Concentration of MDA = $\Delta A \times TV/\varepsilon \times SV$

Where:
ΔA = change in absorbance
TV = total volume
SV = sample volume
E = molar extinction

2.5.4. Colour profile characteristics determination

Colour was analyzed using L*a*b* colour instrument CH SpecCS-260 Colorimeter Serial No A1111860329 as described by Hrušková et al. (2011). The instrument was first calibrated and the readings were taken from the samples.

2.6. Sensory evaluation

The samples were evaluated for flavour, juiciness, tenderness and overall palatability. Sensory evaluation was carried out by 20 panelists, using a 9-point Hedonic scale with value 1 representing the least score (dislike extremely) and value 9 as the highest score (like extremely).

2.7. Statistical analysis

Data were analyzed using analysis of variance (ANOVA), Duncan multiple range test was used to separate the means and level of significance was determined at $p<0.05$.

3. Results and discussion

3.1. Texture profiling of West African Dwarf goat meat samples reared with cultivated African herbs

The results for the texture profiling of West African Dwarf goat meat samples are presented in table 2. Tenderness is one of the most important quality attributes of meat (Lu et al., 1998). It is directly related to the ease of mastication during meat consumption and depends both on connective tissue and myofibre properties (Geay et al., 2001). The peak force of meat samples, which depicts the maximum force of torque developed during a muscle action ranged from 13.65 to 80.50 N with sample T3 (West African Dwarf goat fed with Indian gooseberry) significantly ($p < 0.05$) having the highest peak force (80.50 N), while the least value (13.65 N) was observed in sample T4 (West African Dwarf goat fed with Wild lettuce). Lower peak force is desirable as it contributes to ease of mastication and palatability during consumption (Geay et al., 2001). However, no significant differences ($p > 0.05$) were observed between sample T2 (West African dwarf goat meat fed with scent leaf) and T4 (West African Dwarf goat fed with Wild lettuce). Interestingly, only sample T3 of all the samples investigated has a peak force value (80.50 N) that is above the acceptable limit of 40.0N (Gawat et al., 2023).

Yield force measures the force or strength required for elastic deformation in foods (Sun and Gunasekaran, 2009). The yield force of the West African goat meat samples differed significantly at $p < 0.01$ with values varying from 3.10 to 62.85 N. West African Dwarf goat fed with Indian gooseberry (sample T3) significantly ($p < 0.05$) had the highest yield force (62.85 N), which is an indication of highest force required to effect deformation in the goat meat sample than other goat meat samples fed with other herbs, while the least value (3.10 N) was observed in sample T2 (West African Dwarf goat fed with Scent leaf). There were no significant differences ($p < 0.05$) between sample T2 (West African dwarf goat meat fed with scent leaf) and sample T4 (West African dwarf goat fed with wild lettuce).

The peak stress of the West African Dwarf goat meat samples ranged from 0.12 – 0.49 N/mm2. The highest peak stress was observed in sample T2 (West African Dwarf goat fed with Scent leaf) while sample T5 (West African Dwarf goat fed with combination of Scent leaf, Indian gooseberry and Wild lettuce) had the least peak stress (0.12 N/mm2). No significant differences ($p < 0.05$) were observed between the peak stresses of the West African Dwarf goat meat samples. Yield stress is a well-recognized physical and rheological property in foods which depicts the minimum shear stress that must be applied to the food material to initiate flow or compression (Sun and Gunasekaran, 2009). The yield stress of the West African Dwarf goat meat samples varied from 0.02 to 0.21 N/mm2. The highest yield stress (0.21 N/mm2) was observed in sample T3 (West African Dwarf goat fed with Indian gooseberry) while sample T5 (West African Dwarf goat fed with combination of Scent leaf, Indian gooseberry and Wild lettuce) had the least yield stress (0.21 N/mm2). However, sample T3 exhibited better visco-elastic behavior than other goat meat samples.

The peak strain of the West African Dwarf goat meat samples ranged from 27.27 to 111.66% with sample T1 (West African Dwarf goat meat sample fed with no herb) having the highest peak strain (111.66%), while the least value (27.27%) was observed in sample T5 (West African Dwarf goat fed with combination of Scent leaf, Indian gooseberry and Wild lettuce). The yield strain of the West African Dwarf goat meat samples varied from 6.99 – 22.44%. Sample T3 (West African dwarf goat fed with Indian gooseberry) had the highest yield strain (22.44%), while the least yield strain (6.99%) was recorded in sample T2 (West African Dwarf goat fed with Scent leaf). Young's modulus is a key parameter that is used to describe texture (Kadowaki et al., 2016; Thussu and Datta, 2012), and it directly measures the stiffness of a material, which is crucial in describing the deformation behaviour of materials (Sinha and Bhargav, 2020). The young modulus of the West African Dwarf goat meat samples was of range 0.20 to 0.49 N/mm2 with sample T3 (West African Dwarf goat fed with Indian gooseberry) having the highest young modulus (0.49 N/mm2), while the least young modulus (0.20 N/mm2) was observed in sample T4 (West African dwarf goat fed with wild lettuce). Young modulus in food has been linked to mastication velocity (Takeshita and Nakazawa, 2007). Therefore, sample T3 had lower mastication velocity and highest stiffness than other meat samples due to its highest young modulus. Width is described as the measurement or extent of food materials from side to side (Vincent et al., 1991). There were no significant differences ($p > 0.05$) between the widths of the West African Dwarf goat meat samples. The width of the West African Dwarf goat meat samples was observed to be 24.50 mm. The thickness of the West African Dwarf goat meat samples, which measures the smallest dimension of a solid food, ranged from 2.75 to 11.75 mm. Sample with the highest thickness value was sample T3 (West African dwarf goat fed with gooseberry), while the least thickness (2.75 mm) was

Table 2: Texture profiling of meat samples from West African Dwarf Goats reared with cultivated African herbs

Parameters	T1	T2	T3	T4	T5	Mean	P level
Peak Force (N)	29.05±0.07^{b}	14.45±035^{d}	80.50±0.71^{a}	13.65±0.21^{e}	18.20±0.28^{c}	23.2	**
Yield Force (N)	6.15±0.35^{b}	3.10±0.14^{d}	62.85±0.35^{a}	3.35±0.35^{d}	4.20±0.28^{c}	15.93	**
Peak Stress (N/mm^2)	0.16±0.01^{c}	0.49±0.55^{a}	0.25±0.04^{b}	0.18±0.01^{c}	0.12±0.00^{c}	0.24	**
Yield Stress (N/mm^2)	0.03±0.01^{b}	0.02±0.00^{b}	0.21±0.01^{a}	0.04±0.01^{b}	0.02±0.01^{b}	0.06	**
Peak Strain (%)	111.66±0.72^{a}	49.57±0.80^{c}	48.66±0.93^{d}	88.26±0.37^{b}	27.27±0.38^{e}	65.08	**
Yield Strain (%)	13.59±0.84^{d}	6.99±0.70^{a}	22.44±0.62^{a}	7.84±0.47^{c}	7.78±0.71^{cd}	11.73	**
YoungModulus(N/mm^2)	0.25±0.07^{c}	0.21±0.02^{c}	1.08±0.11^{a}	0.20±0.03	0.49±0.05^{b}	0.45	**
Width (mm)	24.50±0.71^{a}	24.50±0.71^{a}	24.50±0.71^{a}	24.50±0.71^{a}	24.50±0.71^{a}	24.5	**
Thickness (mm)	6.75±0.35^{b}	5.75±0.35^{c}	11.75±0.35^{a}	2.75±0.35^{d}	5.75±0.35^{c}	6.55	**

**p<0.01

Values are mean ± standard deviation. Data with different superscripts in the same column are significantly different at $p < 0.05$

Keys:

T1 is control - No herbs included

T2 = West African Dwarf goat fed with Scent leaf (Ocimum gratissimum)

T3 = West African Dwarf goat fed with Indian gooseberry (Phyllanthus amarus)

T4 = West African Dwarf goat fed with Wild lettuce (Launaea taraxacifolia)

Treatment 5= West African Dwarf goat fed with combination of Scent leaf (Ocimum gratissimum), Indian gooseberry (Phyllanthus amarus) and Wild lettuce (Launaea taraxacifolia)

observed sample T4 (West African dwarf goat fed with wild lettuce).

3.2. Total protein (TP) and Malondialdehyde (MDA) results of West African Dwarf goat meat samples at different periods of storage

The results for total protein (TP) and Malondialdehyde (MDA) of West African Dwarf goat meat samples at different days of storage are presented in table 3. The total protein contents of the West African Dwarf goat meat samples ranged from 5.45 to 7.27 mg/dl. However, insignificant ($p < 0.05$) increase in total protein (TP) of the West African Dwarf goat meat samples were observed at the 3rd and 6th days of storage respectively. The highest total protein (TP) (7.27 mg/dl) was observed in sample T2 at 3rd day of storage while sample T5 had the least total protein (TP) (5.45 mg/dl) at the zero (0) day of storage. The result of the current study is an indication that increases in storage days up till the 6th day is capable of slightly improving the total protein (TP) of the meat samples. This is beneficial as the meat samples might cover for the nitrogen expenditure caused by the renewal of tissues and the synthesis of some compounds involved in the proper body functioning (enzymes, hormones) (Ponka et al., 2016).

The Malondialdehyde (MDA), which is an index of peroxidation of the West African dwarf goat meat samples were of range 0.30 to 3.28 mg/L. No significant differences ($p > 0.05$) were observed between the meat samples at different periods of storage. The highest MDA (3.28 mg/L) and the least MDA (0.30 mg/L) were observed in sample T5 at the 9th day and 0th day of storage respectively. Although not significant ($p< 0.05$), the result indicated increase in MDA of the meat samples as the storage days progressed. This is attributed to the increased total protein, moisture content and high pH close to neutral of the meat samples. According to Kostaki et al. (2009), secondary products of lipid oxidation such as MDA could result into improper sensory characteristics of meat products. Our findings are in tandem with those of Masoumi et al. (2022) whose study reported increase in MDA of yogurt-marinated chicken fillets as storage periods progressed.

Table 3: Total protein (TP) and Malondialdehyde (MDA) results of West African Dwarf goat meat samples at different periods of storage

Treatments/ Samples	Days	Total Protein (TP) (mg/dl)	Malondialdehyde (MDA) (mg/L)
T1	0	5.87±0.35^{a}	0.74±0.14^{a}
	3	6.36±0.71^{c}	1.26±0.36^{c}
	6	6.91±0.58^{ab}	2.21±0.79^{a}
	9	5.78±1.10^{d}	2.77±0.39^{d}
T2	0	5.63±0.53^{c}	0.59±0.21^{c}
	3	7.27±0.38^{a}	1.50±0.35^{b}
	6	6.90±0.78^{ab}	1.92±0.21^{b}
	9	5.89±0.56^{c}	2.93±1.04^{c}
T3	0	5.79±0.35^{b}	0.65±0.21^{b}
	3	6.85±0.49^{b}	1.67±0.38^{a}
	6	7.04±0.23^{a}	1.80±0.35^{a}
	9	5.75±1.06^{d}	3.10±0.85^{b}
T4	0	5.76±0.43^{b}	0.68±0.35^{b}
	3	6.44±0.62^{c}	1.54±0.48^{b}
	6	7.05±0.43^{a}	2.15±0.57^{ab}
	9	6.40±0.84^{a}	2.38±0.40^{e}
T5	0	5.45±0.71^{d}	0.30±0.07^{d}
	3	6.40±0.71^{c}	1.46±0.02^{bc}
	6	6.84±0.83^{b}	1.95±0.49^{b}
	9	6.28±0.39^{b}	3.28±0.40^{a}
Mean	-	6.33	1.74
P level	-	NS	NS

**p<0.01

Values are mean ± standard deviation. Data with different superscripts in the same column are significantly different at p < 0.05. TP: Total Protein; MDA: Malondialdehyde

Keys:

T1 is control - No herbs included

T2 = West African Dwarf goat fed withScent leaf (Ocimum gratissimum)

T3 = West African Dwarf goat fed withIndian gooseberry (Phyllanthus amarus)

T4 = West African Dwarf goat fed withWild lettuce (Launaea taraxacifolia)

Treatment 5 =West African Dwarf goat fed with combination of Scent leaf (Ocimum gratissimum), Indian gooseberry (Phyllanthus amarus) and Wild lettuce (Launaea taraxacifolia)

3.3. Colour profile of West African Dwarf goat meat samples reared with cultivated African herbs

Table 4 shows the results for the colour profile of West African Dwarf goat meat samples. The L* value, which is an indication of lightness, indicated no significant differences ($p < 0.05$) between the samples with values ranging from 22.74 to 47.63. T2 (West African dwarf goat meat fed with scent leaf) had the highest lightness intensity (L*) (47.63) while the least value (22.74) for L* was observed in sample T5 (West African Dwarf goat fed with combination of Scent leaf, Indian gooseberry and Wild lettuce). The average value of lightness observed in this study was in tandem with the values reported by Ahmed et al. (2015) who researched on the influence of green tea bye product supplementation on the quality of goat meat. The redness index (a*) of the West African Dwarf goat meat samples ranged from -0.03 to 6.20 with sample T2 having the highest a* (6.20) while the least a*(-0.03) was observed in sample T4. The redness index (a*) of the West African Dwarf goat meat samples differed significantly at ($p < 0.05$). The yellowness index (b*) index of the West African Dwarf goat meat samples varied from 2.56 to 10.11 with sample T3 significantly ($p < 0.05$) having the highest yellowness index (b*) while the least b* was noted in sample T1.

Table 4: Colour profile of West African Dwarf goat meat samples reared with cultivated African herbs

	Colour profile characteristics		
Treatments /Samples	L* value (Lightness)	a* (Redness)	b* (Yellowness)
T1	44.82±8.46^{a}	-1.06±3.10^{a}	2.56±0.76^{a}
T2	47.63±3.55^{a}	6.20±0.11^{c}	7.45±2.16^{bc}
T3	39.57±1.64^{a}	3.89±1.81^{bc}	10.11±1.59^{c}
T4	43.97±0.00^{a}	-0.03±1.18^{ab}	5.46±1.95^{ab}
T5	22.74±22.97^{a}	3.54±0.28$_{bc}$	6.28±0.31^{abc}
Mean	39.75	2.51	6.37
P level	**	**	**

**p<0.01

Values are mean ± standard deviation. Data with different superscripts in the same column are significantly different at p < 0.05.

Keys:

T1 is control - No herbs included

T2 = West African Dwarf goat fed withScent leaf (Ocimum gratissimum)

T3 = West African Dwarf goat fed withIndian gooseberry (Phyllanthus amarus)

T4 = West African Dwarf goat fed withWild lettuce (Launaea taraxacifolia)

Treatment 5 =West African Dwarf goat fed with combination of Scent leaf (Ocimum gratissimum), Indian gooseberry (Phyllanthus amarus) and Wild lettuce (Launaea taraxacifolia)

The report of the current study is in consonance with the findings of Zeola et al. (2011) whose study

Table 5: Sensory evaluation of West African Dwarf goat meat samples reared with cultivated African herbs

Samples	Colour	Taste	Aroma	Juiciness	Tenderness	Overall Acceptability
T1	7.20±0.76^{a}	7.00±0.00^{a}	6.80±0.76^{a}	6.60±1.04^{a}	6.60±1.53^{a}	6.80±0.76^{a}
T2	7.40±1.04^{ab}	7.40±0.82^{b}	7.40±0.82^{b}	6.80±1.19^{a}	7.40±0.50^{b}	7.00±1.12^{a}
T3	7.80±1.19^{bc}	7.60±0.82^{bc}	7.80±0.41^{b}	7.40±0.50^{bc}	7.60±0.82^{bc}	8.00±0.65^{b}
T4	8.20±0.76^{c}	8.60±0.50^{d}	7.60±0.50^{b}	7.00±0.65^{ab}	8.00±0.65^{c}	8.20±1.00^{b}
T5	7.80±0.76^{bc}	7.80±0.76^{c}	7.81±0.76^{b}	7.80±041^{c}	7.40±1.04^{b}	8.21±0.41^{b}
Mean	7.68	7.68	7.48	7.12	7.40	7.64
P level	**	**	**	**	**	**

**p<0.01

Values are mean ± standard deviation. Data with different superscripts in the same column are significantly different at $p < 0.05$.

Keys:
T1 is control - No herbs included
T2 = West African Dwarf goat fed withScent leaf (Ocimum gratissimum)
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Treatment 5 =West African Dwarf goat fed with combination of Scent leaf (Ocimum gratissimum), Indian gooseberry (Phyllanthus amarus) and Wild lettuce (Launaea taraxacifolia)

affirmed that colour profiling values between 31.36 and 38.0 for L*, 12.27 and 18.01 for a* and 3.34 to 5.65 for b* are considered normal for a ruminant. Frasson et al. (2022) quoted that the value of b* agrees to the yellow content that is normally influenced by the presence of β-carotene in meat fats. However, the content of a colour profile especially yellowness intensity which is related to β-carotene, is largely dependent on the diet provided. Therefore, West African Dwarf goat fed with Indian gooseberry (sample T3) had the β-carotene than other West African Dwarf goats fed with other herbs in the current study.

3.4. Sensory properties of West African Dwarf goat meat samples reared with cultivated African herbs

The sensory evaluation results for the West African dwarf goat meat samples are presented in table 5. No significant differences ($p < 0.05$) were observed between the sensory attributes of the goat meat samples. However, the highest sensory ratings for colour (8.20), taste (8.60) and tenderness (8.00) were observed in sample T4 (West African dwarf goat fed with wild lettuce). However, sample T5 (West African Dwarf goat fed with combination of Scent leaf, Indian gooseberry and Wild lettuce) had the best sensory ratings for aroma (7.81), juiciness (7.80) and overall acceptability (8.21). The results for the sensory evaluation of West African dwarf goat meat samples indicated that West African dwarf goat fed with varieties or combination of herbs including Scent leaf, Indian gooseberry and Wild lettuce had the capability of being more acceptable in respect to sensory properties ratings than West African dwarf goat fed singly with an herb.

4. Conclusion

The study revealed that feeding West African dwarf goats with the selected herbs had significant ($p > 0.05$) effect on the texture profiling of their respective meat samples. However, West African Dwarf goat fed with Wild lettuce (sample T4), scent leaf (sample T2) and combination of scent leaves, Indian gooseberry and wild lettuce (sample T5) had better texture profiling properties, which is directly related to tenderness, than other goat meat samples. Progression in storage days of the goat meat samples resulted in increase in total protein and lipid peroxidation. The herbs fed to the West African Dwarf goats had no significant ($p > 0.05$) effect on the colour profiling of their respective meat samples. However, West African Dwarf goat fed with scent leaf exhibited the best lightness intensity which is directly linked to β-carotene. Conclusively, West African Dwarf goat fed with combination of herbs including Scent leaf, Indian 5gooseberry and Wild lettuce (sample T5) had the best overall sensory properties ratings.

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