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The effect of adding essential oils of cloves and thyme on the performance of local Iraqi goats, digestibility, and rumen fermentation

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Abstract

This study aimed to assess the impact of natural essential oils on the performance of native Iraqi goat youngsters, their feed intake, and apparent digestibility. The study comprised 20 male kids of indigenous Iraqi lineage. Their mean weight was 19.72 ± 2.09 kg at three months of age. They were allocated randomly and uniformly into four nutritional interventions. The subjects were provided with a standardized basic diet consisting of 40% alfalfa hay and 60% concentrated feed combination. The kids were nourished in cohorts for 195 days throughout the fattening experiment and for 10 days during the digesting experiment at the conclusion of the study. Nutritional groups comprised: control group on a basic diet, clove group on a basic diet supplemented with 2 ml clove oil, thyme group on a basic diet supplemented with 2 ml thyme oil, and a combined clove and thyme group on a basic diet supplemented with 1 ml clove oil and 1 ml thyme oil. The examined essential oils shown no substantial impact on kids' performance. Clove essential oil markedly enhanced the digestibility of dry matter, organic matter, crude protein, ether extract, acid detergent fiber, and nitrogen balance ratio. The incorporation of thyme oil resulted in a considerable increase in ammonia content within the rumen. Plasma creatinine and low-density lipoprotein concentrations elevated in the thyme group. Incorporating clove or thyme oil into the kids' diet did not enhance the animals' growth performance or blood metabolites. Clove oil exerted a substantial beneficial impact on nutrient digestion. Further investigation is required utilizing elevated doses of clove oil and extended treatment periods.

Keywords*: essential oil, kid, feed intake, digestion of nutrients, blood plasma, rumen parameters*

1- Introduction:

The fundamental premise in animal nutrition is the incorporation of natural additives to maintain the health of consumers of animal products, particularly to avoid the use of antibiotics that may leave residues in meat or milk, thereby posing health risks to consumers [1]. Consequently, natural additives have health advantages for both humans and animals. Numerous prior studies have examined the antibacterial, antifungal, and antioxidant properties of plant extracts and volatile oils in animal production [2].

The trials utilizing thyme and clove oils yielded the most favorable outcomes, evidenced by significant enhancements in nutrient fermentation processes within the rumen. Jahani-Azizabadi et al. [3] reported an

elevation in the propionate to acetate ratio alongside a reduction in methane emissions and ammonia nitrogen (N) content. Roy et al. [4] determined that thyme and clove oils at elevated dosage (600 ppm) significantly($p<0.05$) decreased gas production, degradability, ammonia nitrogen (NH3-N), volatile fatty acids, and the acetate to propionate ratio. Hernandez et al. [5] shown that essential oils from herbs reduce methane production as well as protozoal count and activity. A 1:1 mixture of thyme and garlic oil, administered at 2 ml per goat per day, enhanced growth by 10%, improved antioxidant status (MDA by 50%), liver enzyme levels (AST by 33% and ALT by 38%), renal function (creatinine by 88%), feed conversion ratio (by 17.4%), and net farm revenue (by 21%) in Damascus goats [6].

Clove oil comprises over 28 components, consisting of 84–95% phenols (mostly eugenol, with around 3% acetyl eugenol), sesquiterpenes (α- and β-caryophyllenes), and trace amounts of esters [7]. Thirty components of thyme oil were identified, with the principal chemicals comprising 79.91%, including thymol (39.44%), P-cymene (23.6%), γ-terpinene (12.51%), ledol (2.24%), and Aromadendrene (2.12%) [8].

This study aims to ascertain the efficacy of clove and thyme essential oils as feed supplements for fattening young goats, evaluating their impact on feed consumption, growth gain, and blood parameters to enhance animal performance and productivity.

2- **Materials and Methods**

The study was conducted in one of the private fields in Suq Al-Shuyoukh District/Dhi-Qar Governorate.

2-1 Growth experiment

The goat youngsters were acquired from local markets at three months of age, with an average weight of 19.51 ± 2.00 kg. The study spanned 150 days, comprising an initial 15 days for acclimatization, the final 10 days for a digestive trial, and 125 days dedicated to a growth experiment. A total of 20 male kids were randomly assigned to four homogenous groups, each consisting of 5 individuals. Each group was assigned to a barn (4 m × 4 m) and randomly received one of the four experimental diets. The control group animals were administered a basic diet devoid of essential oil supplementation, including 60% concentrated feed mix (CFM) and 40% alfalfa hay (AH). CFM comprises 10% yellow maize, 5% soybeans, 45% barley, 38% wheat bran, 1% salt, and 1% blend of vitamins and minerals. The remaining three groups received the identical baseline diet supplemented with either 2 ml/kid/day of clove, 2 ml/kid/day of thyme, or a combination of 1 ml of clove and 1 ml of thyme oil. The required nutrient intake for the kids was determined based on the nutritional guidelines established by the National Research Council [9]. The quantity of feed administered to the animals was measured daily and adjusted biweekly based on variations in body weight until the conclusion of the experiment. Designated feed was administered bi-daily to all groups. Accessible tap water for potable consumption. Daily feed consumption was documented following the measurement of the residual feed the subsequent morning. Table (1) presents the chemical analysis of the diet. Kids were weighed biweekly before to morning feeding during the trial to determine average daily gain (ADG) and feed conversion efficiency (FC: grams of body weight increase per kilogram of feed). Feed consumption and utilization, along with daily weight increase, were documented.

Table (1): Chemical analysis of concentrated feed and alfalfa hay

Treatments	Dry matter	Alfalfa hay	60%CFM+ 40%AH
Dry matter	89.75	91.55	90.47
Organic matter	86.25	80.25	83.85
Crude protein	12.65	10.60	11.83
Ether extract	3.41	1.90	2.81
Crude fiber	4.48	28.10	13.93
Ash	3.50	11.30	6.62
Free nitrogen extract	71.78	39.65	58.93

Metabolizable energy MJ/kg	12.84	8.82	11.23
NDF	29.67	54.14	39.46
ADF	12.81	44.89	25.64

Metabolizable Energy (MJ/kg DM) = 0.012 CP + 0.031 EE + 0.005 CF + 0.014 NFE [10]

2-2. Digestion experiment

During the final ten days of the experimental period, three kids from each dietary group participated in a digestive trial to assess the digestibility of various nutrients. Kids were housed separately in cages for a duration of 10 days, comprising 5 days for acclimatization and 5 days for sample assortment. Kids have been provided with the similar nutritional categories as in the prior period. The daily water consumption of each kid was documented. Urine and feces samples were collected and measured. A representative sample of 10% of the total samples was allocated for subsequent analysis. Nutrient digestibility and nitrogen balance were assessed at the conclusion of the period.

2.3. Feed chemical composition

A proximate chemical analysis was directed on demonstrative feed samples, excrement, muscle, and nitrogen in urine [11]. The ANKOM automated fiber analyzer was utilized to measure neutral detergent fiber (NDF) and acid detergent fiber (ADF) as outlined by Goering and Van Soest [12].

2.4. Essential oils analysis

Essential oils were providing from Barij Essence Pharmaceutical Company, Kashan, Iran. The compounds of essential oils and their vigorous ingredients are listed in Table (2) as described by the company.

Table 2: The major active ingredients of essential oil of thyme and clove

EO	Main components	%	company
Clove (*Syzygium aromaticum*)			**Barij Essence Pharmaceutical Company, Kashan, Iran**
	Eugenol	**73.40**	
	Beta-caryophyllene	**12.20**	
	Acetyl Eugenol	**8.99**	
Thyme (*Thymus vulgaris*)			
	α-Pinene	**3.50**	
	Thymol	**41.80**	
	p-Cymene	**24.85**	
	γ-Terpinene	**9.90**	

2.5. Rumen fluid analysis

Rumen fluid was extracted via stomach tube from each kid previously to the morning feeding. Rumen fluid pH was promptly measured with a numerical pH meter. All rumen fillings were filtered through four sheets of cheesecloth then subsequently freezing till analysis for NH3-N [11] and TVFA [13]. The microbial crude protein (MCP) was quantified utilizing Perez's purine derivative technique [14].

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2.6. Biochemical blood analysis

Blood samples were obtained from every kid in each group participating in the digestion trial through the jugular vein using heparin-filled tubes prior to morning meal. All samples underwent centrifugation at 3000 rpm for 15 minutes, and the resultant plasma was preserved at −20°C for further study. Measurement of total cholesterol, triglycerides, high-density lipoprotein, low-density lipoprotein, total lipids, creatinine, alanine aminotransferase, aspartate aminotransferase, and total antioxidant capacity with special kits.

2.7. Statistical analysis

Analysis of variance was performed to exam the data obtained through a one-way Anova procedure [15]. Duncan's [16] multiple comparison test. A significant level of $P < 0.05$ were applied within the same statistical program.

3- **Results and discussion**

3.1. Feed intake and digestibility

Table 3 and Table 4 showed nutrient and growth performance, respectively. Nutrients intake was unaffected by essential oils, which is consistent with Benetel *et. al.* [17] with essential oil in Nellor beef cattle, and El-Essawy *et. al.* [7] in ewes. Barreto-Cruz et al. [18] determined that the essential oils of thyme and cinnamon did not influence dry matter intake (DMI) or the performance of developing calves. Incorporation of clove essential oils enhanced dry matter digestibility, organic matter, lipoprotein, and dietary intake ($P<0.05$) (Table 3), corroborating the findings of El-Essawy et al. [7] with ewes.

Table (3): Mean of nutrients and digestibility coefficients of kid's due clove or thyme addition to their diet

Item	Treatments				SEM
	Control	Clove	Thyme	Clove plus Thyme	
Feed consumption, g/d					
D.M	634.55	657.21	652.68	652.68	24.58
OM	528.26	547.13	543.36	543.36	20.13
CP	73.80	76.43	75.91	75.91	4.76
EE	16.88	17.48	17.36	17.36	1.24
NDF	274.70	284.71	282.55	282.55	13.47
ADF	186.11	192.76	191.43	191.43	11.34
Digestibility, %					
DM	68.65ab	70.98a	66.45b	69.76ab	1.12
OM	70.27ab	73.01a	68.39b	71.24ab	1.10
CP	67.34bc	70.97a	65.41b	68.64ab	1.11
EE	67.45c	74.31a	70.53bc	71.49ab	1.13
NDF	57.39ab	60.30a	57.05ab	56.55b	1.10
ADF	46.38ab	48.11a	35.17c	44.09b	1.09

The enhancement in digestion is ascribed to the phenolic characteristics of eugenol and its efficacy in stimulating bacteria responsible for feed digestion [19]. Lupia *et al*. [20] declare that the influence of essential oils, including hemol and eugenol, on the efficacy of ingested nitrogen use is attributable to the suppression of some microbes' proliferation and activity. Thymol-rich essential oils influence rumen proteolysis by exhibiting toxicity to some rumen bacteria, hence inhibiting fiber degradation [21]. Nonetheless, Oliveira *et al*. [22] found no discrepancies in nutritional ingestion among lambs administered Copaiba oleracea and those receiving monensin. Table 4 indicates that kid's final weight, daily gain, daily intake, and feed conversion ratio remained unaffected throughout the trial. Consequently, incorporating essential oils into the diet during the fattening phase did not adversely affect growth performance relative to steers receiving a conventional diet. Comparable outcomes have been documented with the inclusion of a blend of essential oils (eugenol and thymol) in cows' diets [23], three essential oils capsule in cattle diets [24], and thymol and/or carvacrol of lamb diets [25]. Contrary some experiments indicate that the inclusion of active compounds from essential oils in lambs' diets [24] or cattle diets [26] did not influence nutritional digestibility.

Table (4) The performance of local goat goats due to clove or thyme addition to their diets

Elements	Groups				SEM
	Control	Clove	Thyme	clove+ Thyme	
IBW, kg	20.00	19.60	19.74	19.55	2.00
FBW, kg	38.76	39.07	38.06	38.47	3.37
ADG, g/ d	110.53	112.41	107.08	109.73	6.10
ADFI, g/ d	700	725	720	720	9.05
FCR, kg/ kg	6.33	6.45	6.72	6.56	0.368

3.2. Nitrogen retention

The incorporation of essential oils did not influence nitrogen intake (Table 5), however essential oil had a considerable ($P<0.05$) effect on nitrogen emission, equilibrium, and utilization. The kids administered clove essential oils exhibited negligible nitrogen loss, leading to optimal nitrogen stability and use. Ahmed *et al*. [27] shown that cloves enhance nitrogen retention owing to their elevated concentration of active phenolic compounds. Benetel *et al*. [17] concurred with the current findings, indicating that cloves can diminish nitrogen waste and enhance nitrogen retention of ruminants. Conversely, the addition of thyme to sheep produced a trend contrary to that of adding cloves. Enhanced nitrogen preservation occurs due to reduced nitrogen emission (Table 5) and improved the digestibility of nitrogen (Table 4). Rahman *et al*. [28] also showed enhanced nitrogen preservation in sheep due to rosemary supplementation, attributing their findings to the preservation of protein against ruminal breakdown, which mitigated nitrogen drops.

Table (5): Nitrogen utilization in kids trial diets provided

Item	Groups				SEM
	Control	Clove	Thyme	Clove+ thyme	
Nitrogen consumption g/head/day	28.35	27.82	28.32	27.88	0.51
Total excretion g/head/day	21.50ab	19.93b	23.01a	20.82ab	0.80
Nitrogen balance (NB) g/day	6.85ab	7.89b	5.31b	7.07ab	0.87
Nitrogen balance % of intake	21.69ab	25.51b	16.85b	22.77ab	2.14
N-utilization % of digested	31.25ab	34.86b	24.67b	31.98ab	3.46

3.3. Rumen fermentation parameters

Rumen fluid pH and total volatile fatty acids (TVFA) remained unaffected due to the addition of essential oils (Table 6). The concentration of ammonia nitrogen (NH3-N) improved ($P < 0.05$) the three treatments added to essential oils. Zhou *et. al*. [29] showed that essential oils affect the activity of microbes and fermentation in the rumen. The alleviated in ammonia concentration in the current study is consistent with that found by Rahman *et. al*. [28] used the similar essential oils in sheep. e Silva *et al*. [30] confirmed that aniseed extract catalyzes peptidol hydrolysis and deamination and as a result ammonia nitrogen accumulation. Essential oils had varying effects on rumen ammonia nitrogen concentration in different studies. Earlier research suggests that essential oils increase ammonia concentration in the rumen [28], and others have reported no effects [31] with essential oils of thyme and cinnamon.

Table (6) Impact of adding clove, thyme and clove oils on kids' ruminal fermentation

Elements	Groups				SEM
	Control	Clove	Thyme	Clove+ thyme	
pH value	5.81	6.03	6.07	5.99	0.10
Ammonia-N, mg /dl	16.25	17.76	19.56	17.98	0.71
VFA, mg/ dl	9.03	8.38	8.59	9.42	0.40

3.4. Blood parameters

Table (7) illustrates the impact of essential oils on various blood parameters. The examined essential oils significantly influenced blood plasma creatinine, total lipids (TL), low-density lipoprotein (LDL), and total cholesterol (TC), as these parameters increased markedly ($P<0.05$) in kids administered essential oils compared to the control group. Plasma concentrations of urea, total protein, globulin, albumin, triglyceride, HDL, total antioxidant volume, ALT, and aspartate are noted. The addition of essential oils did not influence aminotransferase (AST) enzyme levels. The ineffectiveness of essential oils on certain blood parameters aligns with the findings of Cobellis *et. al*. [31], who incorporated thyme oil into the diets of calves. Du *et. al* [32] observed no influence to the thyme on TC, TG, HDL, and LDL in sheep. Additionally, Imbabi *et al.* [6] reported that serum concentrations of TC, TP, albumin, BUN, AST, and ALT remained unchanged with the inclusion of a combination of essential oils comprising thyme and garlic essential oil. Yang *et al*. [33] stated that triglyceride levels impacted by essential oil supplementation through modifications in feed consumption; thus, the comparable consumption among groups in the present investigation resulted in analogous blood triglyceride levels. Plasma creatinine concentration is an indicator of muscle [34]; thus, elevated creatinine levels

associated with the incorporation of essential oils, particularly thyme or clove oil, signify greater muscle mass in the lambs studied. This conclusion is corroborated by the muscle area results. In terms of composition and fattening percentage (Table 8). Consequently, including essential oils for kids during the growth phase induces alterations in blood metabolism that could enhance output.

4- **Conclusions**

The current study attempts to estimate the probable usage of clove and thyme oils of the nutrition of local Iraqi goats. Clove displayed higher digestibility of dry matter, organic matter, and total protein content compared to the control. There was no change in weight in all experimental treatment. Also, the group fed with clove excreted the least amount of nitrogen, which led to an increase in nitrogen retention and balance. An increase in ammonia level with the addition of essential oils, especially cloves. General results of the current study showed that essential oils had no negative impact on growth performance and blood parameters and further research with higher concentrations of essential oils for a longer period of supply is needed.

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