Effect of different levels of Sage (*Salvia officinalis*) essential oil drenching on blood parameters, growth and reproductive performance of Saanen goat does

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Abstract

The current investigation examined the impact of different doses of Sage extract on the complete blood count, body weight, and reproductive performance of Saanen goat does administer weekly over a 12-week period. Blood was collected third from 15 Saanen goat does and divided into three groups of five replicates. Fifteen adult Saanen goat does, aged 1 to 1.5 years and averaging 72 kg in body weight, were utilized in this investigation. T1 was administered 2 ml of distilled water per head, T2 received 40 mg/kg, and T3 received 80 mg/kg. The findings imply that after two months, Sage essential oil drenching at the tested levels did not substantially change the haematological parameters of Saanen does. Over the course of three months, Sage essential oil drenching significantly increased body weight in Saanen does, especially at the T2 level, by the end of the measurement, the effects were statistically noticeable. Although there were no notable variations in the size of the litters (T1:2.0, T2:1.6, and T3:1.5) or the rates of twinning, T2 showed the best reproductive results, with 100% conception and fertility rates (compared to 80% in T1 and T3) and 0% barrenness (compared to 20% in controls).

Keywords: *Salvia officinalis*, blood parameters, growth traits, reproductive performance, Saanen doe.

Introduction

Animals serve a vital function as an essential component of agriculture and rural existence globally, supplying sustenance and a crucial financial reserve and revenue for farmers. The insufficiency of adequate feed to satisfy the nutritional needs of the current animal population is a major issue in animal agriculture [1]. Java is home to the Saanen goat, a dairy breed. The Saanen goat farm serves as a diversification option for milk-producing livestock, complementing dairy cows to meet Indonesia's milk demand [2]. Studies have evaluated goat milk's therapeutic properties against various ailments, demonstrating its numerous advantages for human health. Saanen goats raised in tropical climates can yield milk ranging from 1,000 to 3,800 ml per head per day [3].

The Sage (*Salvia officinalis*) plant is a highly regarded, fragrant herb known for its extensive therapeutic properties. Rosmarinic acid and the diterpene phenolics carnosol and carnosic acid primarily contribute to *Salvia officinalis's* antioxidant activity [4]. Furthermore, flavonoids and other phenolic acids derived from *Salvia officinalis* may enhance its overall antioxidant potential [5]. Essential oils are intricate combinations of volatile, lipophilic chemicals derived from plants. Due to their lipophilicity, they exhibit favourable intestinal and percutaneous absorption characteristics. Following oral consumption, they promote the secretion of digestive enzymes and enhance gastric and intestinal motility [6]. The purpose of this study was to examine the effects of Sage essential oil drenching on the blood cells, growth traits and reproductive performance after Saanen's parturition.

Materials and Methods

The study was carried out at the Rasan farm located in Halabja, Iraq. Fifteen Saanens were used in the study. Each animal was given a different dose of Sage essential oil time per week for three months. Doses were aged 1-1.5 years, divided randomly into three main groups and received one of the following treatments: T1 (control) (n=5): 2 ml of distilled water; T2 (n=5): Sage essential oil at a dose of 40 mg/kg body weight; and T3 (n=5): Sage essential oil at a dose of 80 mg/kg body weight one time per week for three months. Blood samples were collected three times, of the jugular vein, and transferred to tube containing EDTA to measure number of white blood cells (WBCs), haemoglobin concentration (Hb), the number of red blood cells (RBCs), the mean corpuscular haemoglobin concentration (MCHC), the mean corpuscular volume (MCV), and the mean cell haemoglobin (MCH). An automated Veterinary analyser (Hemato Analyser) was used to perform the calculations. Does were weighed four times during the experiment (0, 1, 2, and 3 months of the experiment) [7]. All does were assessed with an ultrasonic diagnostic device 45 days from mating to determine their pregnancy status. Litter size, conception rate, twinning rate, fertility rate, and barrenness rate are calculated according to [8], and the weight at birth is assessed at birth using scale (1-50 kg) [7]. All animals were on a uniform diet, with concentrated feed supplied daily. The formulation of the ration included 39.5% wheat bran, 30% barley, 15% yellow maize, 12% soybean meal, 1% tricalcium phosphate, 1% table salt, and 1.5% mineral and vitamin mixture. Alfalfa hay, was supplied in adequate amounts for all does. Water was perpetually accessible to the animals.

Steam extraction is a widespread and established technology for the extraction of essential oils from plant-based sources. This extraction process involves subjecting plant material to a stream of steam without prior maceration. The applied heat deteriorates the cells of the plant material, releasing the essential oil. The steam infused with volatile compounds, is then condensed, and the essential oil is obtained by decanting the water/oil mixture [9]. The primary advantage of steam extraction is that the absence of direct contact between water and plant material, along with the separation of water from aromatic molecules, prevents hydrolysis or degradation of essential oil [10]. The

"head" fractions, comprising the most volatile molecules, can be collected in as few as thirty minutes, encapsulating 95% of the volatile chemicals [11]. The method operates by sustaining the combined vapor pressure at around 100°C, facilitating the evaporation of volatile components with boiling points ranging from 150 to 300°C at a temperature close to that of water. This method may also be conducted under pressure, depending on the challenges associated with the extraction of essential oils.

The statistical analysis was conducted with a completely randomized design and SAS [12] software. The disparities among care means of haematological parameters and body weight were evaluated using the Duncan Test [13], and the reproductive performance parameters were analyzed using Chi square.

Results and Discussion

The hematological parameters measured in Saanen does after one month of drenching with Sage (*Salvia officinalis*) essential oil indicated numerous major results about its physiological effect, as shown in table 1. All erythrocyte-related indicators (PCV, HB, RBC, HCT) remained within normal caprine reference limits and exhibited no significant variations ($P \geq 0.05$) throughout treatment groups. Although not statistically significant, certain patterns in erythrocyte indicators deserve consideration; the reduced MCV in treatment group T1 was 33.62 to 27.15 and 28.58 in T2 and T3 respectively. Simultaneous MCH reduction in T1 from 9.23 to 7.43 and 8.44 in T2 and T3 respectively, may signify modified haemoglobin synthesis. White blood cell counts (WBCs) indicated an insignificant increase in the control group; T1 was 10.37, and the highest WBC range was 12.14 in T3.

Table (1): Effect of different levels of Sage (*Salvia officinalis*) essential oil drenching on complete blood count (CBC) after one month (M±SE) in Saanen does

T.	PCV %	HB (g/dL)	RBC (×1012/µL)	HCT %	MCH (Pg)	MCV (fL)	MCHC (g/dL)	WBC (×109/µL)
T1	30±1.60a	10.01±0.53a	9.60±0.86a	32.88±3.05a	9.23±1.27a	33.62±5.99a	32.01±2.86a	10.37±0.36a
T2	28.4±1.50a	9.46±0.50a	10.54±1.32a	28.31±1.6a	7.43±0.52a	27.15±4.18a	35.11±4.10a	12.14±2.41a
T3	30.2±1.22a	10.06±0.41a	10.39±1.23a	30.16±3.20a	8.44±1.11a	28.58±7.71a	34.64±4.68a	10.55±0.64a

- Means with different superscripts in the same column differ significantly ($p \leq 0.05$)
- T1 control (2 ml of distilled water), T2 (40 mg of Sage oil/kg body weight), and T3 (80 mg of Sage oil/kg body weight)

The table 2 presents the haematological parameters of Saanen does after two months of treatment with different levels of Sage (*Salvia officinalis)* essential oil drenching. The results are expressed as mean ± standard error (S.E), all parameters had no significant differences between groups and include the following parameters:

Packed Cell Volume (PCV %) increased in the range of 26.2% from T1 (control) to (27.8 and 27.6)% in T2 and T3 respectively, while the Red Blood Cells (RBCs) increased from 11.02 in T1 (control) to (10.85 and 10.24) in T2 and T3 respectively, HCT % parameter, the highest percentage was 28.82 % in T1, while the lowest percentage in T3 was 26.69 %. The White Blood Cells (WBCs) had a maximum mean of 10.04 in T2, while the minimum was 9.64 in T1 and T3 respectively.

Table (2): Effect of different levels of Sage (*Salvia officinalis*) essential oil drenching on complete blood count (CBC) after two months (M±SE) in Saanen does

T.	PCV %	HB (g/dL)	RBC (×1012/µL)	HCT %	MCH (Pg)	MCV (fL)	MCHC (g/dL)	WBC (×109/µL)
T1	26.2 ±1.31a	8.99 ±0.34a	11.02 ±0.52a	28.82 ±0.50a	8.08 ±0.44a	26.80 ±0.89a	33.41 ±0.79a	9.64 ±1.66a
T2	27.8 ±1.19a	9.26 ±0.40a	10.85 ±0.35a	27.13 ±1.62a	8.57 ±0.43a	26.95 ±1.80a	32.94 ±1.15a	10.04 ±0.15a
T3	27.6 ±1.32a	9.17 ±0.42a	10.24 ±0.66a	26.69 ±1.48a	8.33 ±0.39a	25.61 ±2.83a	32.96 ±0.42a	9.64 ±0.71a

- Means with different superscripts in the same column differ significantly (p≤0.05)
- T1 control (2 ml of distilled water), T2 (40 mg of Sage oil/kg body weight), and T3 (80 mg of Sage oil/kg body weight)

No significant differences were observed in all haematological parameters across treatment groups after 3 months, as shown in table 3. The values of PCV, HB, and RBC were uniform across each of the treatment groups. MCH lessened marginally from T1 (control) 10.34 to 8.27 in T3. The MCV value also decreases from 34.40 in T1 (control) to 22.15 in T3. The MCHC (g/dL) increased from 27.99 in T1 (control) to 37.17 in T3. The White Blood Cells (WBCs) had the highest mean of 9.52 in T1 (control), while the lowest was 8.62 in T2.

Table (3): Effect of different levels of Sage (*Salvia officinalis*) essential oil drenching on blood complete count (CBC) after three months (M±SE) in Saanen does

T.	PCV %	HB (g/dL)	RBC (×1012/µL)	HCT %	MCH (Pg)	MCV (fL)	MCHC (g/dL)	WBC (×109/µL)
T1	25±1.73a	8.33±0.58a	8.51±0.58a	31.11±3.55a	10.34±1.16a	34.40±5.44a	27.99±1.98a	9.52±0.85a
T2	25.4±1.49a	8.50±0.50a	9.79±1.24a	27.07±3.05a	9.12±1.17a	26.66±5.57a	32.19±3.89a	8.62±1.25a
T3	27.8±2.02a	9.26±0.66a	11.27±0.28a	24.78±2.19a	8.27±0.72a	22.15±2.35a	37.17±0.73a	9.19±1.19a

- Means with different superscripts in the same column differ significantly (p≤0.05)
- T1 control (2 ml of distilled water), T2 (40 mg of Sage oil/kg body weight), and T3 (80 mg of Sage oil/kg body weight)

Table 4 presents the effect of different levels of Sage (*Salvia officinalis*) essential oil drenching on the body weight of Saanen does over three months. Each group (T1, T2, and T3) commenced with statistically comparable body weights. The mean body weight varied from 33.16 to 33.28 kg, demonstrating initial uniformity. After 1 month, there were no notable variations between the groups; T2 showed the largest numerical increase at 37.54 kg, while the lowest body weight was T1 (control) at 36.46 kg. After 2 months, there are still no notable changes, although T2 (40.22 kg) exhibited the greatest amount. After 3 months of Sage essential oil drenching, significant variations ($P \leq 0.05$) for T2 were 44.7 kg, while the lowest was T1 (control) at 41.08 kg.

Table (4): Effect of different levels of Sage (*Salvia officinalis*) essential oil drenching on body weight (M±SE) in Saanen does

T.	At beginning	After 1 month	After 2 months	After 3 months
T1	33.16±0.35a	36.46±0.61a	38.12±1.25a	41.08±0.92b
T2	33.16±0.78a	37.54±1.14a	40.22±1.22a	44.7±1.25a
T3	33.28±0.62a	37.04±1.17a	39.26±1.13a	43.48±1.45ab

- Means with different superscripts in the same column differ significantly ($p \leq 0.05$)
- T1 control (2 ml of distilled water), T2 (40 mg of Sage oil/kg body weight), and T3 (80 mg of Sage oil/kg body weight)

The effect of different levels of Sage (*Salvia officinalis*) essential oil drenching on reproductive performance is presented in table 5. The number of does that became pregnant with the three treatments were 4, 5, and 4, respectively. Number of kids were 6, 8, and 6 for the control T1, 40 mg/kg T2, and 80 mg/kg T3, respectively. The reproductive performance of litter size, twinning rate, conception rate, fertility rate, and barrenness were not significantly different by treatments. T2 40mg/kg of Sage essential oil had recorded highest conception rate, and fertility of does, which were 100% as compared to control group and T3 80mg/kg of Sage essential oil. The bareness percentage, T2 40mg/kg of Sage essential oil was 0%, where as compared with control and T3 recorded 20%.

Table (5): Effect of different levels of Sage (*Salvia officinalis*) essential oil drenching on reproductive performance (M±SE) in Saanen does

T.	No. of does	No. of does pregnant	Total No. of kid born	Litter size	Twinning rate %	Conception rate %	Fertility %	Bareness %
T1	5	4	6	2	100	80	60	20
T2	5	5	8	1.6	60	100	100	0
T3	5	4	6	1.5	50	80	80	20
X2				2.11 NS	2.10 NS	1.14 NS	2.50 NS	1.15 NS

- Means with different superscripts in the same column differ significantly ($p \leq 0.05$)
- T1 control (2 ml of distilled water), T2 (40 mg of Sage oil/kg body weight), and T3 (80 mg of Sage oil/kg body weight)

This research investigation looks at how different dosages of Sage (*Salvia officinalis*) essential oil taken orally affect blood parameters, such as haematological, body weight and reproductive performance of Saanen does. The haematological profile of animals is essential for comprehending their entire health and wellbeing, including physiological state, disease diagnosis, treatment efficacy monitoring, and evaluation of environmental impacts on health [14,15].The findings of this investigation demonstrated that Sage essential oil had no influence on haematological parameters during the trial, however a significant improvement in body weight was observed with a dosage of 40 mg/kg of Sage essential oil administration. The results shown correspond with other recent investigations employing varying dietary inclusion rates. The values of WBC, RBC, Hb, PCV, MCV, MCH, and MCHC [16] were unaffected when sheep were provided with different dietary inclusions of various feedstuffs. Likewise, specific indicators like PCV, Hb, WBC, and RBC [17] remained unchanged when sheep were provided with different dietary inclusions of Artemisia sieberi leaves. Furthermore, the values of WBC, RBC, MCH, MCHC, Hb, and PCV [18] were unaffected by goats treated with Lablab purpureus and Vigna unguiculata.The alterations in RBC count, haematocrit, and haemoglobin concentration may be attributed to the presence of flavonoids, glycosides, and fumaric acid, compounds that have been shown to confer the majority of the bioactive activities of Sage oil, which are potent antioxidants. protect cells and tissues from oxidative damage, lipid peroxidation, and enhance haemostasis and resilience against stress [19]. Red blood cells are frequently exposed to oxygen more than other bodily tissues, making them more vulnerable to oxidative damage. The RBC membrane underwent haemolysis upon exposure to peroxidants. Furthermore, the haemoglobin in red blood cells serves as a potent catalyst that may trigger lipid peroxidation [20]. Their essential contributions lies in preserving the function of erythrocytes and the elevation of haemoglobin levels in the treated groups. The mechanism of improvement is attributed to the capacity of hydroxyl groups and other characteristics of the antioxidants present in Sage extract to scavenge harmful reactive

oxygen species and free radicals, thereby protecting erythrocytes from oxidative damage [21]. The advantageous impact of Sage oil on oxidative damage to haemoglobin induced by hydroperoxides may be attributed to the capacity of flavonoids to neutraliseferrylhaemoglobin, Sage oil possesses significant antioxidant and free radical scavenging activities, which may preserve cellular and tissue integrity while replenishing haemoglobin levels [22]. Numerous studies have shown that adding essential oil (EO) from *Salvia officinalis* to goats' diets affects their white blood cells (WBCs) counts in a dose-dependent way. Doses of 200–400 mg/day raised WBC counts, especially lymphocytes and neutrophils, indicating immunostimulatory effects, according to research by [23]. In a similar vein goats provided 300 mg/kg of Sage EO showed increased leukocyte levels, which [24] attributed to improved immune function. Though [25] warned that high doses (>400 mg/kg) may suppress immunity due to thymol toxicity, [26] noted that 150–300 mg/day normalised stress-induced leukocytosis, highlighting its anti-inflammatory properties. By the completion of the three-month trial, Sage oil drenching had a significant impact on body weight ($p < 0.05$). In contrast to T1 (41.08) and not T3 (43.48), which displayed intermediate results, T2 had the highest final weight (44.7), the higher T2 growth points to Sage oil's dose-dependent effectiveness, which may be related to improved nutrient uptake or antimicrobial activity. Nonetheless, a non-linear response is implied by the absence of difference between T2 and T3. Bioactive substances like 1,8-cineole, camphor, α-thujone, and rosmarinic acid, which have antibacterial, anti-inflammatory, and antioxidant qualities, are found in Sage essential oil [27]. By modifying oxidative stress, immunological responses, and metabolic processes, these substances may affect blood parameters. Sage essential oil, improving metabolism (enzyme activity, bile secretion), changing the gut microbiota (increasing SCFAs, decreasing pathogens), lowering inflammation and oxidative stress and boosting metabolic efficiency and consumption of feed [28].

Numerous pharmacological mechanisms seem to be involved in the reproductive-enhancing effects of Sage essential oil (SEO) in goats. Consistent with several recent phytogenic supplementation studies in small ruminants, the current findings show that moderate-dose SEO supplementation (40 mg/kg) increased conception rates without significantly affecting litter size. With the highest conception rate (100%), all does become pregnant with T2 (40 mg/kg). With one non-pregnant doe per group, the conception rates for T1 (Control) and T3 (80 mg/kg) were marginally lower at 80%. Due to its estrogenic or ovulation-stimulating qualities, 40 mg/kg of Sage oil may increase fertility; however, the higher dose (80 mg/kg) did not produce any better effects. Compounds found in Sage may mimic estrogen, which could enhance ovulation and uterine receptivity. By lowering oxidative stress, Sage oil may improve embryo survival. With 100% conception and 0% barrenness, T2 (40 mg Sage oil/kg body weight) demonstrated the best reproductive performance, indicating that it might be a useful supplement for enhancing does' fertility. The increased conception rate at 40 mg Sage oil/ kg body weight is encouraging for goat reproduction management, even though litter size and twinning rates were not substantially impacted. Due to its phytoestrogenic and

antioxidant qualities [29], Sage oil at 40 mg/kg may optimize hormonal balance, as evidenced by the lack of barrenness in T2. [30] reported similar results, showing that moderate herbal supplementation increased goat conception rates without influencing litter size. By lowering oxidative stress during embryo implantation, the antioxidant properties of SEO's 1,8-cineole and camphor [31] may have helped maintain pregnancy in our study. [32] reported that were no significant effects of concentration supplementation on fertility, twinning rate, litter size, growth rate from birth to weaning of does. [33] also reported that the effect of flushing not effecting on reproductive performances except bareness rate.

The present study is to evaluate the effects of Sage essential oil on haematological indicators, body weight, and reproductive performance in Saanen does. Consumption of Sage essential oil at evaluated levels did not alter haematological markers in Saanen does for a period of three months, so affirming its safety as a phytogenic additive. Insignificant trends in erythrocyte indices (e.g., MCV, MCHC) may inform future dose-response investigations. The body weight findings indicate that Sage essential oil supplementation can markedly enhance growth performance in Saanen does, with moderate doses (40 mg/kg BW) yielding best outcomes.

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