



## SYSTEMATIC REVIEW

# REVISED The use of essential oils as a growth promoter for small ruminants: a systematic review and meta-analysis [version 2; peer review: 2 approved]

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## Abstract

**Background:** Due to their antimicrobial properties and safety, essential oils are currently proposed as a sustainable option for antibiotic alternatives in the livestock sector. This current systematic review and meta-analysis investigated the effects of dietary essential oil supplements on dry matter intake (DMI), average daily gain (ADG), and feed conversion ratio (FCR) of small ruminants.

**Methods:** A total of 12 studies (338 small ruminants) were included in this meta-analysis. The overall effect size was quantified using Hedges' *g* with 95% confidence interval (CI) using a fixed-effect model. Publication bias was inspected using Begg's and Egger's tests, followed by trim and fill method to detect the number of potential missing studies.

**Results:** Insignificant heterogeneity among studies was detected both on DMI (*P* of *Q* = 0.810; I-square = 0.00%), ADG (*P* of *Q* = 0.286; I-square = 17.61%), and FCR (*P* of *Q* = 0.650; I-square = 0.00%). The overall effect size showed that essential oils supplementation had no significant impact on DMI (Hedges' *g* = -0.12; 95% CI = -0.50 to 0.26; *P* = 0.429) and FCR (Hedges' *g* = -0.17; 95% CI = -0.55 to 0.22; *P* = 0.284), but had a significant positive impact on ADG (Hedges' *g* = 0.44; 95% CI = 0.12 to 0.76; *P* = 0.002). The result of publication bias analysis showed that DMI, ADG, and FCR did not present any significant biases (*P* > 0.10), and no potential missing studies detected.

**Conclusions:** Dietary essential oil could improve ADG of small ruminants, without any alteration on DMI and FCR. Further research in this topic is still required to provide stronger evidence of the potency of essential oil as a growth promoter for small ruminants.

## Keywords

Antibiotics alternative, Average daily gain, Goats, Natural feed additives, Protozoa, Secondary metabolites, Sheep.

## Open Peer Review

Reviewer Status  

Invited Reviewers

1

2

### version 2

(revision)

28 Aug 2020

### version 1

01 Jun 2020




report



report

1. **Linde du Toit**, University of Pretoria, Pretoria, South Africa

2. **Liang Chou Hsia** , National Pingtung University of Science and Technology, Pingtung, Taiwan

Any reports and responses or comments on the article can be found at the end of the article.

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**Author roles:** **Andri F:** Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Resources, Visualization, Writing – Original Draft Preparation; **Huda AN:** Conceptualization, Data Curation, Formal Analysis, Investigation, Writing – Review & Editing; **Marjuki M:** Conceptualization, Investigation, Supervision, Validation, Writing – Review & Editing

**Competing interests:** No competing interests were disclosed.

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*The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.*

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**REVISED Amendments from Version 1**

The manuscript was revised according to the comments from reviewers with the following details:

1. Indicated original words before using abbreviations.
2. Deleted the statement regarding the authors' duties in study selection and data extraction.
3. Included the discussion about why essential oils can be used as a growth promoter for small ruminants
4. Added data about the type of ration and experimental design in Table 3.

**Any further responses from the reviewers can be found at the end of the article**

## Introduction

In animal nutrition, antibiotics become the first choice of feed additive due to their substantial benefit toward health and productivity. However, the routine use of this chemical additive yields residues in livestock products, and is also responsible for the development of microbial antibiotic resistance<sup>1,2</sup>. These factors represent a dangerous risk to human health, which has led to the global drive to reduce antibiotic use in the livestock sector. As a result, several natural products have been proposed to be used as antibiotic alternatives<sup>3,4</sup>.

Among natural feed additives, essential oils have a unique mechanism of action in livestock production. They can manipulate rumen fermentation characteristics<sup>5,6</sup> and subsequently improve growth rate<sup>7,8</sup>. However, other findings showed no meaningful effect of this feed additive on productive performance<sup>9,10</sup>, while another study showed a negative impact<sup>11</sup>. The inconsistent results among studies requires an appropriate tool to quantify the overall effect. Therefore, this study was conducted to measure the quantitative effects of dietary essential oil supplementation on dry matter intake (DMI), average daily gain (ADG), and feed conversion ratio (FCR) of small ruminants using a systematic review and meta-analysis approach.

## Methods

The systematic review and meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline<sup>12</sup>. A completed PRISMA checklist is available in *Reporting guidelines*<sup>13</sup>.

### Eligibility criteria

The inclusion and exclusion of the study were based on participants, interventions, comparisons, outcomes, and study design (PICOS) criteria as indicated in Table 1. Additionally, only publications written in English which was included in this study. All dates up until the date last searched were included.

### Literature search strategy

The literature search was carried out using the following electronic databases: Scopus, PubMed, and SciELO. The search was last performed on 30 April 2020. Table 2 shows the full electronic search strategy.

### Study selection

Results from the search were firstly checked for duplicates. After duplicate studies were removed, the titles and

**Table 1. PICOS criteria.**

	Inclusion criteria	Exclusion criteria
Participants	Sheep or goat	Other species
Interventions	Dietary essential oil supplementation	Irrelevant treatment
Comparisons	Control group (basal diet only)	
Outcomes	DMI, ADG, and FCR	No related outcome
Study design	Randomized controlled <i>in vivo</i> trials	<i>In vitro</i> trials

DMI: dry matter intake; ADG: average daily gain; FCR: feed conversion ratio.

**Table 2. Search strategy.**

Database	Search strategy
Scopus	(TITLE (oil) AND TITLE (growth OR performance) AND TITLE (sheep OR goat OR lamb OR kid))
PubMed	((oil[Title]) AND (growth[Title] OR performance[Title])) AND (sheep[Title] OR goat[Title] OR lamb[Title] OR kid[Title])
SciELO	(ti:(oil)) AND (ti:(growth OR performance)) AND (ti:(sheep OR goat OR lamb OR kid))

abstracts were screened using the eligibility criteria (Table 1). Full texts of the selected studies were then further examined to find eligible studies. The authors of the included studies were not contacted for further clarification.

### Data extraction

Data extracted included the following items: 1) authors; 2) animal species; 3) number of animals; 4) type of ration; 5) essential oil source; 6) experimental design, and 7) growth response variables. Growth response variables consisted of DMI, ADG, and FCR. Standard error or standard error of means were converted into standard deviation<sup>14</sup>. The data was pooled when a study used more than one dose of essential oils or tested both sexes of experimental animals<sup>15</sup>.

### Effect size quantification

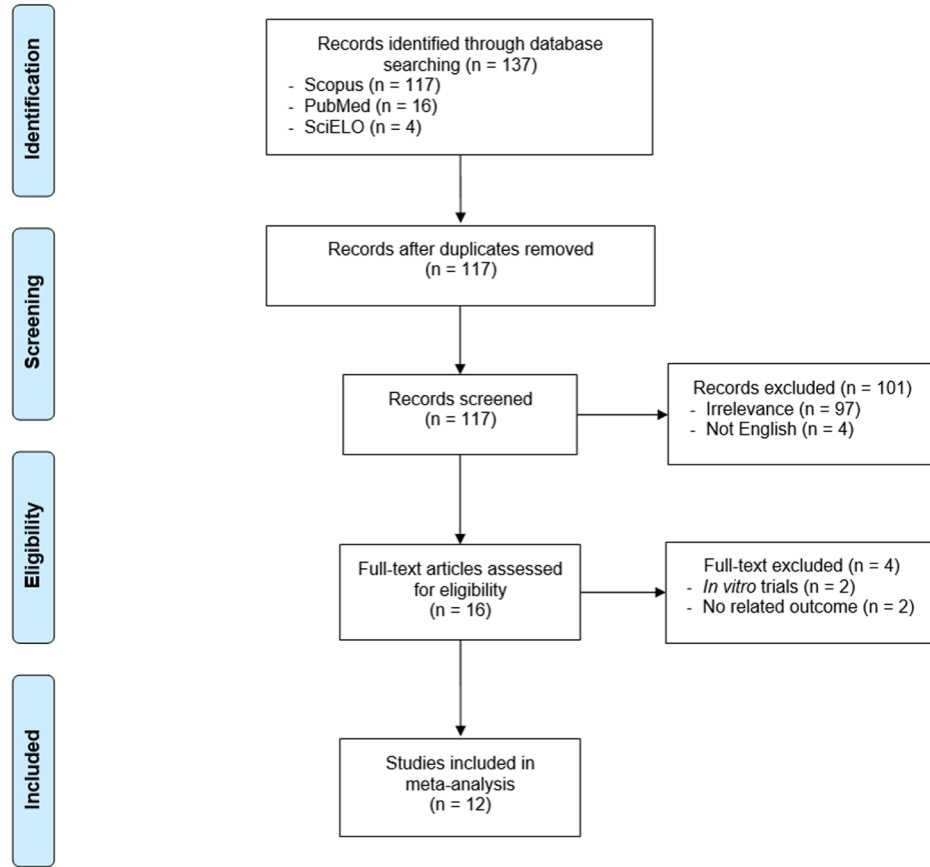
The overall effect size was quantified using Hedges'  $g$ <sup>16</sup> using a fixed-effect model. This model was chosen due to the insignificant heterogeneity among studies after checked using Cochran's  $Q$ <sup>16</sup> and I-square<sup>17</sup>.

### Publication bias analysis

Publication bias was inspected using Begg's<sup>18</sup> and Egger's tests<sup>19</sup>, with  $P < 0.10$  set to determine the existence of publication bias. The trim and fill method<sup>20</sup> was employed to detect the number of potential missing studies and to adjust the overall effect size. All meta-analysis procedures were performed using Meta-Essentials version 1.4<sup>21</sup>.

## Results

Figure 1 shows the PRISMA flow diagram. A total of 137 records were identified through database searching. Of these, 12



**Figure 1.** PRISMA flow diagram.

studies were eligible for the current meta-analysis. The essential oil sources included oregano<sup>11,22–24</sup>, thyme<sup>25,26</sup>, chavil<sup>27</sup>, juniper<sup>7,28</sup>, and mixed product<sup>9,29</sup>. Unfortunately, one study did not define the source of essential oil<sup>8</sup>. The main characteristics of the included studies are shown in [Table 3](#). Extracted data of outcome measures is available as *Extended data*<sup>30</sup>.

Data of ADG from two studies<sup>11,25</sup> were considered as outliers because their standardized residual was  $>|3|$  and thus were excluded from effect size quantification. Insignificant heterogeneity among studies was detected both for DMI ( $P$  of  $Q = 0.810$ ; I-square = 0.00%), ADG ( $P$  of  $Q = 0.286$ ; I-square = 17.61%), and FCR ( $P$  of  $Q = 0.650$ ; I-square = 0.00%). As can be seen in [Figure 2](#), the overall effect size showed that essential oil supplementation had no significant impact on DMI ( $P = 0.429$ ) and FCR ( $P = 0.284$ ), but had a significant positive impact on ADG ( $P = 0.002$ ). The result of publication bias analysis showed that DMI, ADG, and FCR did not present any significant biases ( $P > 0.10$ ) ([Table 4](#)). The trim and fill method also did not detect any potential missing studies for all parameters.

## Discussion

The current meta-analysis showed that dietary essential oils significantly increased ADG of small ruminants. This finding

probably related to the antimicrobial activity of essential oils, which could reduce ruminal protozoa population<sup>31,32</sup>. Protozoa population may represent up to 50% of the total biomass of rumen microbes<sup>33</sup>. They have a negative impact on nitrogen utilization by ruminants because they engulf and digest bacteria, thus reducing microbial protein flow to abomasum<sup>34</sup>. Additionally, the presence of protozoa is also associated with methane production, which is responsible for the loss of up to 12% of gross energy intake by ruminants<sup>35</sup>. Thereby, the reduction of the ruminal protozoa population by essential oil could increase microbial protein, as well as energy supply, which ultimately could improve the growth rate of small ruminants.

This study provides insight of the potency of essential oil as a growth promoter for small ruminants. However, the current findings should be interpreted with caution due to the limited data available. Moreover, the literature search only covers published literature, which could lead to publication bias. For that reason, further research in this topic is highly encouraged to provide stronger evidence.

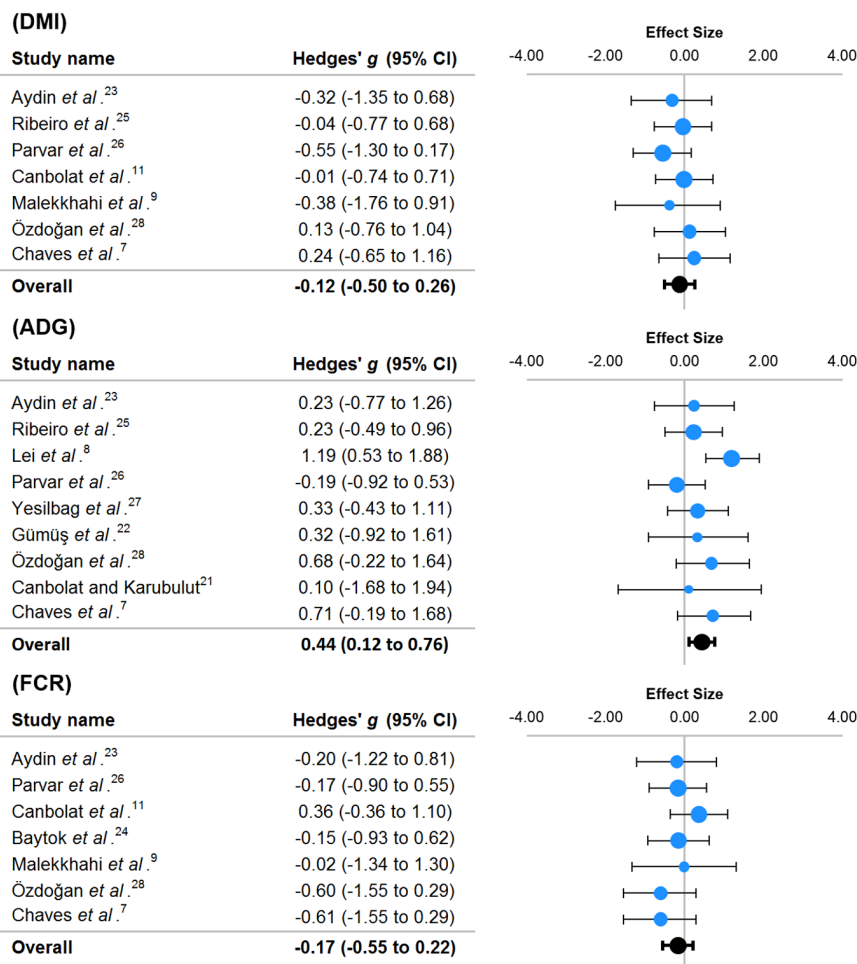
## Conclusions

The current meta-analysis reveals that dietary essential oil could improve ADG of small ruminants, without any alteration

**Table 3. Main characteristics of the studies included in the meta-analysis.**

Authors	Species	n	Type of ration	EO source	Experimental design	Response variables
Aydin <i>et al.</i> <sup>24</sup>	Sheep	18	Pasture grass + CF	Oregano	CRD	DMI, ADG, FCR
Ribeiro <i>et al.</i> <sup>26</sup>	Sheep	40	TMR	Thyme	RBD	DMI, ADG
Lei <i>et al.</i> <sup>8</sup>	Goats	45	TMR	NI	CRD	ADG
Parvar <i>et al.</i> <sup>27</sup>	Sheep	40	TMR	Chavil	CRD	DMI, ADG, FCR
Canbolat <i>et al.</i> <sup>11</sup>	Sheep	40	TMR	Oregano	CRD	DMI, ADG, FCR
Yesilbag <i>et al.</i> <sup>28</sup>	Goats	18	TMR	Juniper	CRD	ADG
Gümüş <i>et al.</i> <sup>23</sup>	Sheep	24	Wheat straw + CF	Oregano	CRD	ADG
Baytok <i>et al.</i> <sup>25</sup>	Sheep	15	Lucerne hay + CF	Thyme	RBD	ADG, FCR
Malekkhahi <i>et al.</i> <sup>9</sup>	Sheep	10	TMR	Mix A	CRD	DMI, FCR
Özdoğan <i>et al.</i> <sup>29</sup>	Sheep	20	Alfalfa hay + CF	Mix B	RBD	DMI, ADG, FCR
Canbolat and Karabulut <sup>22</sup>	Sheep	48	TMR	Oregano	FD	ADG
Chaves <i>et al.</i> <sup>7</sup>	Sheep	20	TMR	Juniper	RBD	DMI, ADG, FCR

n: number of experimental animals; CF: concentrate feed; TMR: total mixed ration; EO: essential oil; NI: no information; Mix A: a mixture of thymol, carvacrol, eugenol, limonene, and cinnamaldehyde EO; Mix B: a mixture of thyme leaf, daphne leaf, sage tea leaf, fennel seed, orange cortex, and myrtle leaf EO; CRD: completely randomized design; RBD: randomized block design; FD: factorial design; DMI: dry matter intake; ADG: average daily gain; FCR: feed conversion ratio.



**Figure 2. Forest plot of the effect of essential oil supplementation on growth response of small ruminants.** DMI: dry matter intake; ADG: average daily gain; FCR: feed conversion ratio.

**Table 4. Summary of publication bias analysis of the effect of dietary essential oil intervention on growth response of small ruminants.**

Parameters	P of Begg's test	P of Egger's test	Missing studies
DMI	0.652	0.879	0
ADG	1.000	0.605	0
FCR	0.652	0.463	0

DMI: dry matter intake; ADG: average daily gain; FCR: feed conversion ratio.

on DMI and FCR. However, further research in this topic is still highly recommended to provide more robust evidence.

### Data availability

#### Underlying data

All data underlying the results are available as part of the article and no additional source data are required.

#### Extended data

Figshare: Extended data for 'The use of essential oils as a growth promoter for small ruminants: a systematic review and meta-analysis'. <https://doi.org/10.6084/m9.figshare.12298913.v3><sup>30</sup>.

This project contains extracted data of outcome measures (dry matter intake, average daily gain, and feed conversion ratio).

### Reporting guidelines

Figshare: PRISMA checklist for 'The use of essential oils as a growth promoter for small ruminants: a systematic review and meta-analysis'. <https://doi.org/10.6084/m9.figshare.12298034.v2><sup>13</sup>.

Data are available under the terms of the [Creative Commons Zero "No rights reserved"](https://creativecommons.org/licenses/by/4.0/) data waiver (CC0 1.0 Public domain dedication).

## References

- Ben Y, Fu C, Hu M, *et al.*: **Human health risk assessment of antibiotic resistance associated with antibiotic residues in the environment: A review.** *Environ Res.* 2019; **169**: 483–493.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- He Y, Yuan Q, Mathieu J, *et al.*: **Antibiotic resistance genes from livestock waste: occurrence, dissemination, and treatment.** *npj Clean Water.* 2020; **3**(1): 4.  
[Publisher Full Text](#)
- Oh J, Hristov AN: **Effects of plant-derived bio-active compounds on rumen fermentation, nutrient utilization, immune response, and productivity of ruminant animals.** *ACS Symp Ser.* 2016; **1218**: 167–186.  
[Publisher Full Text](#)
- Dhanasekaran DK, Dias-Silva TP, Filho ALA, *et al.*: **Plants extract and bioactive compounds on rumen methanogenesis.** *Agrofor Syst.* 2019; **6**.  
[Publisher Full Text](#)
- Lin B, Lu Y, Salem AZM, *et al.*: **Effects of essential oil combinations on sheep ruminal fermentation and digestibility of a diet with fumarate included.** *Anim Feed Sci Technol.* 2013; **184**(1–4): 24–32.  
[Publisher Full Text](#)
- Poudel P, Froehlich K, Casper DP, *et al.*: **Feeding essential oils to neonatal holstein dairy calves results in increased ruminal prevotellaceae abundance and propionate concentrations.** *Microorganisms.* 2019; **7**(5): 120.  
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Chaves AV, Stanford K, Dugan MER, *et al.*: **Effects of cinnamaldehyde, garlic and juniper berry essential oils on rumen fermentation, blood metabolites, growth performance, and carcass characteristics of growing lambs.** *Livest Sci.* 2008; **117**(2–3): 215–224.  
[Publisher Full Text](#)
- Lei Z, Zhang K, Li C, *et al.*: **Dietary supplementation with Essential-oils-cobalt for improving growth performance, meat quality and skin cell capacity of goats.** *Sci Rep.* 2018; **8**(1): 11634.  
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Malekshahi M, Tahmasbi AM, Naserian AA, *et al.*: **Effects of essential oils, yeast culture and malate on rumen fermentation, blood metabolites, growth performance and nutrient digestibility of Baluchi lambs fed high-concentrate diets.** *J Anim Physiol Anim Nutr (Berl).* 2015; **99**(2): 221–229.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- Pukrop JR, Campbell BT, Schoonmaker JP: **Effect of essential oils on performance, liver abscesses, carcass characteristics and meat quality in feedlot steers.** *Anim Feed Sci Technol.* 2019; **257**: 114296.  
[Publisher Full Text](#)
- Canbolat O, Filya I, Kamalak A: **Effect of oregano oil on growth performance, rumen fermentation parameters and blood metabolites of growing lambs.** *Livest Res Rural Dev.* 2018; **30**(4): 59.  
[Reference Source](#)
- Moher D, Liberati A, Tetzlaff J, *et al.*: **Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.** *PLoS Med.* 2009; **6**(7): e1000097.  
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Andri F, Huda AN, Marjuki M: **PRISMA checklist for 'The use of essential oils as a growth promoter for small ruminants: a systematic review and meta-analysis'.** 2020.  
<http://www.doi.org/10.6084/m9.figshare.12298034.v2>
- Greig JD, Waddell L, Wilhelm B, *et al.*: **The efficacy of interventions applied during primary processing on contamination of beef carcasses with *Escherichia coli*: A systematic review-meta-analysis of the published research.** *Food Control.* 2012; **27**(2): 385–397.  
[Publisher Full Text](#)
- Higgins JPT, Li T, Deeks JJ: **Choosing effect measures and computing estimates of effect.** In: *Cochrane Handbook for Systematic Reviews of Interventions.* 2019; 143–176.  
[Publisher Full Text](#)
- Hedges LV, Olkin I: **Statistical Methods for Meta-Analysis.** San Diego, CA USA: Academic Press; 1985.  
[Reference Source](#)
- Higgins JPT, Thompson SG: **Quantifying heterogeneity in a meta-analysis.** *Stat Med.* 2002; **21**(11): 1539–1558.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- Begg CB, Mazumdar M: **Operating characteristics of a rank correlation test for publication bias.** *Biometrics.* 1994; **50**(4): 1088–1101.  
[PubMed Abstract](#) | [Publisher Full Text](#)
- Egger M, Smith GD, Schneider M, *et al.*: **Bias in meta-analysis detected by a simple, graphical test.** *BMJ.* 1997; **315**(7109): 629–34.  
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)

20. Duval S, Tweedie R: **A nonparametric "trim and fill" method of accounting for publication bias in meta-analysis.** *J Am Stat Assoc.* 2000; **95**(449): 89–98. [Publisher Full Text](#)
21. Suurmond R, van Rhee H, Hak T: **Introduction, comparison, and validation of Meta-Essentials: A free and simple tool for meta-analysis.** *Res Synth Methods.* 2017; **8**(4): 537–553. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
22. Canbolat Ö, Karabulut A: **Effect of urea and oregano oil supplementation on growth performance and carcass characteristics of lamb fed diets containing different amounts of energy and protein.** *Turk J Vet Anim Sci.* 2010; **34**(2): 119–128. [Publisher Full Text](#)
23. Gümüş R, Erol HS, İmik H, et al.: **The effects of the supplementation of lamb rations with oregano essential oil on the performance, some blood parameters and antioxidant metabolism in meat and liver tissues.** *Kafkas Univ Vet Fak Derg.* 2017; **23**(3): 395–401. [Publisher Full Text](#)
24. Aydın ÖD, Merhan O, Yıldız G, et al.: **The effect of oregano oil (*Origanum vulgare*) on the fattening performance and blood oxidant-antioxidant balance in post-weaned tuj lambs.** *Kafkas Univ Vet Fak Derg.* 2020; **26**(1): 59–64. [Publisher Full Text](#)
25. Baytok E, Kara K, Aksu T, et al.: **The effect of Mediterranean thyme (*Thymbra spicata* L. var. *spicata*) essential oil on fattening performance and ruminal parameters in lamb.** *J Anim Feed Sci.* 2017; **26**(4): 319–325. [Publisher Full Text](#)
26. Ribeiro ADB, Ferraz Junior MVC, Polizel DM, et al.: **Thyme essential oil for sheep: Effect on rumen fermentation, nutrient digestibility, nitrogen metabolism, and growth.** *Arq Bras Med Vet e Zootec.* 2019; **71**(6): 2065–2074. [Publisher Full Text](#)
27. Parvar R, Ghoorchi T, Kashfi H, et al.: **Effect of *Ferulago angulata* (Chavil) essential oil supplementation on lamb growth performance and meat quality characteristics.** *Small Rumin Res.* 2018; **167**: 48–54. [Publisher Full Text](#)
28. Yesilbag D, Biricik H, Cetin I, et al.: **Effects of juniper essential oil on growth performance, some rumen protozoa, rumen fermentation and antioxidant blood enzyme parameters of growing Saanen kids.** *J Anim Physiol Anim Nutr (Berl).* 2017; **101**(5): e67–76. [PubMed Abstract](#) | [Publisher Full Text](#)
29. Özdoğan M, Öneç SS, Öneç A: **Fattening performance, blood parameters and slaughter traits of Karya lambs consuming blend of essential oil compounds.** *African J Biotechnol.* 2011; **10**(34): 6663–6669. [Reference Source](#)
30. Andri F, Huda AN, Marjuki M: **Extended data for 'The use of essential oils as a growth promoter for small ruminants: a systematic review and meta-analysis'.** 2020. <http://www.doi.org/10.6084/m9.figshare.12298913.v3>
31. Patra AK, Yu Z: **Effects of essential oils on methane production and fermentation by, and abundance and, diversity of, rumen microbial populations.** *Appl Environ Microbiol.* 2012; **78**(12): 4271–4280. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
32. Soltan YA, Natel AS, Araujo RC, et al.: **Progressive adaptation of sheep to a microencapsulated blend of essential oils: Ruminal fermentation, methane emission, nutrient digestibility, and microbial protein synthesis.** *Anim Feed Sci Technol.* 2018; **237**: 8–18. [Publisher Full Text](#)
33. Sylvester JT, Karnati SKR, Yu Z, et al.: **Evaluation of a real-time PCR assay quantifying the ruminal pool size and duodenal flow of protozoal nitrogen.** *J Dairy Sci.* 2005; **88**(6): 2083–2095. [PubMed Abstract](#) | [Publisher Full Text](#)
34. Newbold CJ, De la Fuente G, Belanche A, et al.: **The role of ciliate protozoa in the rumen.** *Front Microbiol.* 2015; **6**: 1–1313. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
35. Wanapat M, Cherdthong A, Phesatcha K, et al.: **Dietary sources and their effects on animal production and environmental sustainability.** *Anim Nutr.* 2015; **1**(3): 96–103. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)



# Open Peer Review

Current Peer Review Status:  

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Version 1

Reviewer Report 01 July 2020

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Liang Chou Hsia 

Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Pingtung, Taiwan

The main purpose of this paper tries to investigate whether essential oils have any positive or negative effects on growth performance, such as dry matter intake (DMI), average daily gain (ADG), and feed conversion ratio (FCR). The results shown that the essential oils provided for sheep and goats in 12 studies. Most experiments shown the essential oils can improve the above performance. The present study used the Begg's and Egger's tests which were meta-analysis procedures. Please indicate the original words and then can put abbreviations. It is not necessary to point out the authors' duties in study selection and data extraction. The authors need to make clarification from the literature on why the essential oils can be used as a growth promoter for small ruminants.

**Are the rationale for, and objectives of, the Systematic Review clearly stated?**

Yes

**Are sufficient details of the methods and analysis provided to allow replication by others?**

Yes

**Is the statistical analysis and its interpretation appropriate?**

Yes

**Are the conclusions drawn adequately supported by the results presented in the review?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Agricultural production; Aquaculture production; Ecologic system; Conservation; Rural education and extension; Reproduction of animal (ex AI for animals); Nutrition



on poultry, pigs, cattle, sheep, goat, dog and cat, etc.; Management for animal production; Animal house design and arrangement; Animal behavior and welfare; Feed processing; Animal waste management; Extension education.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Author Response 20 Aug 2020

**Faizal Andri**, Gadjah Mada University, Yogyakarta, Indonesia

We would like to thank the reviewer for his helpful comments and suggestions. Please see our responses and changes as detailed below.

*1. Please indicate the original words and then can put abbreviations.*

We have made sure that the original words have indicated before using abbreviations.

*2. It is not necessary to point out the authors' duties in study selection and data extraction.*

We have deleted the statement regarding the authors' duties (see Study Selection and Data Extraction sections).

*3. The authors need to make clarification from the literature on why the essential oils can be used as a growth promoter for small ruminants.*

We have included the clarification about why essential oils can be used as a growth promoter for small ruminants (see Discussion section).

**Competing Interests:** No competing interests were disclosed.

Reviewer Report 17 June 2020

<https://doi.org/10.5256/f1000research.26610.r64169>

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**Linde du Toit**

Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria, South Africa

In this article the researchers conducted a meta analysis on the effects of essential oils on production parameters of small ruminants.

This is a well written article. The objective and methods employed are suitable and clearly defined within the text. The authors could have included the experimental design in the selection criteria as well s the type of rations used in the various studies. The researchers could have broadened the criteria to include more studies in the Meta analysis. Less than 20 studies were

included but the authors did discuss this and the need for further research in their discussion. The quality of the article is acceptable for indexing.

**Are the rationale for, and objectives of, the Systematic Review clearly stated?**

Yes

**Are sufficient details of the methods and analysis provided to allow replication by others?**

Yes

**Is the statistical analysis and its interpretation appropriate?**

Yes

**Are the conclusions drawn adequately supported by the results presented in the review?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Small ruminant nutrition and livestock GHG emissions

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Author Response 20 Aug 2020

**Faizal Andri**, Gadjah Mada University, Yogyakarta, Indonesia

We are grateful to the reviewer for his valuable comments and suggestions. Please see our responses and changes as detailed below.

*1. The authors could have included the experimental design in the selection criteria as well as the type of rations used in the various studies.*

The use of experimental design and type of ration as selection criteria will left only a small number of eligible studies for synthesis, therefore we do not consider these elements as selection criteria. However, we showed these information as additional study characteristics (see Table 3).

*2. The researchers could have broadened the criteria to include more studies in the Meta-analysis. Less than 20 studies were included but the authors did discuss this and the need for further research in their discussion.*

The studies in this aspect is currently still very limited and we have addressed this issue (see Discussion section).

**Competing Interests:** No competing interests were disclosed

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