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Original article

# A comparative study among dietary supplementations of antibiotic, grape seed and chamomile oils on growth performance and carcass properties of growing rabbits

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## ABSTRACT

The main objective of this study was to evaluate the effect of chamomile oil (Ch), grape seed oil (GS), their mixture and antibiotic (colistin) (AN) as feed additives on the productivity of growing rabbits as well as *in vitro* study to evaluate the antimicrobial activity of both Ch and GS oils. To achieve this objective, a total of 96 New Zealand (NZW) weaned rabbits, 5 weeks-old were randomly allotted into eight groups. Rabbits were kept under observation for eight weeks and the trial ended at thirteen weeks-old. The experimental treatments were: 1) Basal diet (BD); 2) BD + antibiotic; 3) BD + 0.5 ml GS/ kg diet; 4) BD + 1.0 ml GS/ kg diet; 5) BD + 1.5 ml GS/ kg diet; 6) BD + 0.5 ml Ch/ kg diet; 7) BD + 1.0 ml Ch/ kg diet and 8) BD + 1.5 Ch/ kg diet. Live body weight (LBW) was markedly elevated ( $p < 0.05$ ) in groups fed on ration included feed additives compared with the control at weeks 9 and 13 of age. Cumulative body weight gain (BWG) and feed intake (FI) increased ( $p < 0.05$ ) throughout 5–9 and 5–13 weeks of age in rabbits fed rations plus the studied additives. Feed conversion ratio (FCR) was insignificantly altered by dietary feed additives. Spleen and intestine relative weights reduced ( $p < 0.05$ ) in groups treated with different studied additives. In view of the experiment findings, it could be concluded that dietary supplementation of GS and Ch have a positive impact on the productivity of growing rabbits than that of the control and antibiotic-treated groups.

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## 1. Introduction

The rabbit industry plays an important role in providing humans with a low-cost and high-quality animal-protein source (Khelfa et al., 2012) and plays a particular role in solving the meat deficiency problem in developing countries (Khelfa et al., 2012a). Rabbit occupies an important midway place between monogastric and ruminant animals (Saleh et al., 2010). Infectious diseases such as viral (Salem et al., 2019), bacterial (Khelfa et al., 2012b; Khelfa

et al., 2015) and parasitic infections (Morsy et al., 2020) have negative impacts on rabbit industry revealing severe economic losses. The bacterial multiplication in the caecum regulates rabbit digestive physiology, which includes caecotrophy, or the reusing of microbial protein from the caecum (Abecia et al., 2005) and this process unlike that occurs in the other animals gut (Lu et al., 2003; Edwards et al., 2004). Due to the digestive infections risk in industrial rabbit production, antibiotics were frequently used, either as treatments or to promote growth (Kumar et al., 2020). Colistin is a common feed additives used to prevent clinical and subclinical diseases in livestock (Kumar et al., 2020). This practice is being revisited due to recent EU regulations banning antibiotic use (Abecia et al., 2002). The grape seed extract obtained from the *Vitis vinifera* seed is a good source of plant flavonoids and proanthocyanidins oligomers. Antioxidants are considered the first line of defense against free radical damage and are serious for maintaining the optimum health condition (Percival, 1998). Oxidative stress is known as over synthesis of oxygen-free-

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radical precursors and/or decreased efficiency of the antioxidants (Baynes, 1991).

Chamomile is a herb that has been used for centuries due to its numerous benefits as antioxidant, anti-inflammatory, anti-bacterial and anti-fungal agent (Al-Bahtiti, 2012). Chamomile could show potent antioxidant activity because of its contents of flavanols, flavones, flavonoids, isoflavones, anthocyanin, tannins acid, isocatechins and coumarin (Svenningsen et al., 2006). Raal et al. (2013) found that Estonia from chamomile flowers could treat the common cold and flu. Therefore, the current trial aimed to compare the effects of Ch, GS or AN as growth promoters on growth performance and carcass characteristics of growing rabbits.

## 2. Materials and methods

### 2.1. Rabbits, experimental design and rations

The trial was performed at the Rabbit Unit, Poultry Department, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. Ninety-six, New Zealand (NZW) (5-week-old) rabbits, with a mean weight of  $707.50 \pm 3.14$  g were randomly allotted into eight groups; each of four replicates, three rabbits each. This work extended for eight weeks to be ended at thirteen weeks of age. The experimental treatments were: 1) BD; 2) BD + antibiotic; 3) BD + 0.5 ml GS/ kg feed; 4) BD + 1.0 ml GS/ kg feed; 5) BD + 1.5 ml GS/ kg feed; 6) BD + 0.5 ml Ch/ kg feed; 7) BD + 1.0 ml Ch/ kg feed and 8) BD + 1.5 Ch/ kg feed. Each replicate was housed in a wire cage (40 cm height  $\times$  30 cm width  $\times$  50 cm length). All animals were housed under the optimal management and hygienic circumstances. Rabbits were fed the basal diet according to the nutritional requirements of NRC (1977), being 10.85 MJ/kg digestible energy, 17.29% crude protein, calcium 0.87%, and 0.54% available phosphorus. Rabbits received their feed in two meals, besides the clean water on *ad libitum* basis.

### 2.2. Growth performance and carcass traits

The LBW, FI, BWG and FCR were assessed. At the end of the experiment, five rabbits from each group were weighed, slaughtered, and eviscerated to calculate carcass traits. Hot carcass weight including, the main body, heart, head, liver, kidneys, and lungs were determined. The dressing percentage was also estimated relative to pre-slaughter weight.

### 2.3. Statistical analysis

The statistical analysis of the results was carried out using the SAS (SAS Institute Inc., 2001) software. The body performance, carcass characteristics were estimated by one-way ANOVA (with the diet as the fixed factor) using the post hoc Newman-Keuls test. The significance was evaluated at  $p < 0.05$ .

## 3. Results

### 3.1. Growth performance traits

The growth performance is clarified in Tables 2, 3, 4 and 5. The antibiotic (AN) and grab seed oil (GS) levels increased LBW during the different experimental periods. Chamomile oil improved LBW ( $p < 0.001$ ) at 39 weeks of age during the fattening period. Whereas, the highest values of LBW were accompanied with the level of 0.5 ml g Ch /kg diet compared with the control or the other treatments (Table 1). Cumulative BWG improved in groups fed the basal diet supplemented with various levels of additives as presented in Tables 2 and 3. The chamomile oil at a level of

**Table 1**  
Basal dietary ingredients and chemical composition (%).

Ingredients	%
Yellow corn	9.50
Soybean meal (44%)	15.00
Wheat bran	17.00
Barley	21.70
Berseem hay	34.50
Di-calcium phosphate <sup>1</sup>	1.20
Limestone <sup>2</sup>	0.25
DL-Methionine	0.05
Salt	0.50
Vitamin + Mineral premix <sup>3</sup>	0.30
Total	100
<i>Chemical composition</i>	
Dry matter	87.80
Moisture	12.20
Crude protein	17.29
Crude fiber	13.80
Ether extract	3.60
Nitrogen-free extract <sup>4</sup>	42.80
Ash	9.80
DE (MJ /Kg) <sup>5</sup>	10.85

<sup>1</sup> Di-calcium phosphate: 20% phosphorus and 25% calcium.

<sup>2</sup> Limestone: contains 34% calcium.

<sup>3</sup> Every 1 kg ration contains vitamins and minerals of: vitamin A-12,000 IU; vitamin D3-900 IU; biotin-0.2 mg; pantothenic-20 mg; niacin-50 mg; folic acid- 5 mg; manganese-0.5 mg; zinc-70 mg; copper-5 mg; iodine-0.75 mg; selenium-0.1 mg; vitamin B2-2000 mg; vitamin B6- 2 mg; vitamin B12-900 IU, vitamin E-50 mg; vitamin B1-2 mg; vitamin B2-2 mg; vitamin E-50 mg.

<sup>4</sup> Nitrogen free extract (NFE)= 100 - (moisture % + CP% + EE% + CF% + Ash %).

<sup>5</sup> Digestible energy (DE) was calculated according to values given in the feed composition tables of the NRC (1977).

0.5 ml g/kg had the best cumulative body weight of rabbits compared with the other treatment groups.

From our observations, the growing rabbits received BD consumed less feed ( $p < 0.05$ ) than treated groups throughout the whole experimental period. The rabbits fed BD + 0.5 ml g/kg Ch had the highest feed intake during the whole period compared with the other groups.

Animals fed the basal diet recorded better FCR than groups received the feed additives during 5–9 and 9–13 weeks of age. However, rabbits received 0.5 ml GS/kg recorded the best FCR than the control and the other groups throughout 5–13 weeks of age (Tables 2, 3, 4 and 5). Colistin, Ch oil, GS oil treated groups revealed improvement in growth performance compared with the control.

### 3.2. Carcass traits

The impacts of dietary enriched diets with AN, GS and Ch on the carcass traits of rabbits are illustrated in Table 6.

Most carcass measurements were insignificantly impacted by the addition of AN, GS and Ch, except the relative weight of kidney which increased ( $p < 0.05$ ). Meanwhile, spleen and intestine weights percentages were reduced ( $p < 0.05$  or 0.01) by diet additives compared to the control.

## 4. Discussion

Growing rabbit's health should be improved to increase meat productivity (Abou-Kassem et al., 2021). A variety of dietary factors plays a particular role in animal survival by influencing health and productivity. Recently, many researchers suggested the usage of nanotechnology (Abd El-Ghany et al., 2021; Abd El-Hack et al., 2021a; El-Saadony et al., 2021) side by side with natural products as prebiotics (Abd El-Hack et al., 2021b; Yaqoob et al., 2021), probiotics (Abd El-Hack et al., 2020; Alagawany et al., 2021a;

**Table 2**

Live body weight ( $\bar{X} \pm SE$ ) of growing rabbits as affected by the dietary supplementation of antibiotic, grape seed oil or chamomile oil during the different experimental periods.

Items	Live body weight (g) at								
	Initial (5 wks) NS			9 wks *			13 wks *		
Control	734.00	±	43.54	1296.00 <sup>b</sup>	±	45.56	1874.50 <sup>b</sup>	±	76.07
Antibiotic, colistin (0.5 g/kg diet)	726.00	±	30.76	1451.00 <sup>ab</sup>	±	71.30	2072.00 <sup>ab</sup>	±	71.53
Grape seed oil (ml/ kg diet)									
0.5	698.00	±	39.64	1543.00 <sup>a</sup>	±	90.29	2142.00 <sup>ab</sup>	±	78.15
1.0	779.00	±	37.16	1548.00 <sup>a</sup>	±	61.58	2194.00 <sup>ab</sup>	±	78.95
1.5	716.00	±	26.57	1569.00 <sup>a</sup>	±	47.47	2194.00 <sup>ab</sup>	±	85.46
Chamomile oil (ml/ kg diet)									
0.5	741.00	±	22.49	1616.00 <sup>a</sup>	±	61.53	2265.00 <sup>a</sup>	±	82.13
1.0	738.00	±	40.17	1471.00 <sup>ab</sup>	±	42.17	2098.00 <sup>ab</sup>	±	61.66
1.5	727.00	±	29.61	1519.00 <sup>a</sup>	±	68.40	2201.40 <sup>ab</sup>	±	68.70

<sup>a,b,c</sup>, Means in the same column within each classification bearing different letters are significantly different. \* = significant (P < 0.05) and NS = not significant.

**Table 3**

Cumulative body weight gain ( $\bar{X} \pm SE$ ) of growing rabbits as affected by the dietary supplementation of antibiotic, grape seed oil or chamomile oil during the different experimental periods.

Items	Cumulative body weight gain (g) during								
	5–9 wks *			9–13 wks NS			5–13 wks *		
Control	562.00 <sup>b</sup>	±	92.91	578.50	±	79.76	1140.50 <sup>b</sup>	±	166.36
Antibiotic, colistin (0.5 g/kg diet)	725.00 <sup>ab</sup>	±	48.45	621.00	±	94.16	1346.00 <sup>ab</sup>	±	88.87
Grape seed oil (ml/ kg diet)									
0.5	845.00 <sup>a</sup>	±	76.76	599.00	±	63.59	1444.00 <sup>ab</sup>	±	105.98
1.0	769.00 <sup>a</sup>	±	40.94	646.00	±	56.71	1415.00 <sup>ab</sup>	±	77.80
1.5	853.00 <sup>a</sup>	±	26.49	625.00	±	55.92	1478.00 <sup>ab</sup>	±	76.69
Chamomile oil (ml/ kg diet)									
0.5	875.00 <sup>a</sup>	±	39.53	649.00	±	48.10	1524.00 <sup>a</sup>	±	65.01
1.0	733.00 <sup>ab</sup>	±	65.55	627.00	±	55.26	1360.00 <sup>ab</sup>	±	81.59
1.5	792.00 <sup>a</sup>	±	59.76	682.40	±	104.22	1474.40 <sup>ab</sup>	±	158.80

<sup>a,b,c</sup>, Means in the same column within each classification bearing different letters are significantly different. \* = significant (P < 0.05) and NS = not significant.

**Table 4**

Feed intake ( $\bar{X} \pm SE$ ) of growing rabbits as affected by the dietary supplementation of antibiotic, grape seed oil or chamomile oil during the different experimental periods.

Items	Feed intake (g/ day) during								
	5–9 wks *			9–13 wks *			5–13 wks **		
Control	79.49 <sup>b</sup>	±	6.21	104.87 <sup>c</sup>	±	8.56	85.51 <sup>c</sup>	±	8.67
Antibiotic, colistin (0.5 g/kg diet)	87.84 <sup>ab</sup>	±	3.46	124.63 <sup>bc</sup>	±	10.55	106.23 <sup>ab</sup>	±	7.00
Grape seed oil (ml/ kg diet)									
0.5	94.02 <sup>a</sup>	±	9.38	133.56 <sup>ab</sup>	±	7.76	113.79 <sup>ab</sup>	±	8.57
1.0	93.41 <sup>a</sup>	±	0.39	135.35 <sup>ab</sup>	±	7.91	114.38 <sup>ab</sup>	±	3.97
1.5	83.69 <sup>a</sup>	±	2.82	126.86 <sup>ab</sup>	±	4.31	105.28 <sup>ab</sup>	±	3.53
Chamomile oil (ml/ kg diet)									
0.5	94.56 <sup>a</sup>	±	2.12	148.25 <sup>a</sup>	±	7.57	121.41 <sup>a</sup>	±	4.85
1.0	79.93 <sup>b</sup>	±	5.46	117.68 <sup>bc</sup>	±	8.84	98.81 <sup>bc</sup>	±	6.50
1.5	91.94 <sup>ab</sup>	±	5.25	134.52 <sup>ab</sup>	±	12.18	113.23 <sup>ab</sup>	±	8.37

<sup>a,b,c</sup>, Means in the same column within each classification bearing different letters are significantly different. \* = significant (P < 0.05), \*\* = significant (P < 0.01).

El-Saadony et al., 2021a), plants and their active compounds (El-Saadony et al., 2021b; Abd El-Hack et al., 2021c; Reda et al., 2021), bioactive peptides (El-Saadony et al., 2021c, 2022), essential oils (Abd El-Hack et al., 2021d; Alagawany et al., 2021b; El-Tarabily et al., 2021), and herbal extracts (Abd El-Hack et al., 2021e,f; El-Shall et al., 2021; Swelum et al., 2021) to improve animals' productivity and health. The grape is a rich resource of natural antioxidants such as polyphenols and anthocyanins (Orak, 2007).

Many natural feed additives were incorporated with rabbits' diet to improve their performance and increase their diseases resistance (Abdelnour et al., 2020a,b). From our findings, colistin and different levels of GS increased the live body weight during the experimental period. These results are in line with those of the study conducted by Brenes et al. (2010), when GS was added at 3.6 g/kg broiler chicken feed with no effect on broiler productivity. Also, Brenes et al. (2010) concluded that polyphenols found in

**Table 5**Feed conversion ratio ( $\bar{X} \pm SE$ ) of growing rabbits as affected by the dietary supplementation of antibiotic, grape seed oil or chamomile oil during the different experimental periods.

Items	Feed conversion ratio (g feed/ g gain) during		
	5–9 wks	9–13 wks	5–13 wks
	NS	NS	NS
Control	3.02 ± 0.06	3.52 ± 0.50	3.42 ± 0.50
Antibiotic, colistin (0.5 g/kg diet)	3.38 ± 0.13	4.30 ± 0.08	3.72 ± 0.08
Grape seed oil (ml/ kg diet)			
0.5	3.08 ± 0.28	4.36 ± 0.19	3.27 ± 0.19
1.0	3.36 ± 0.31	4.45 ± 0.51	3.91 ± 0.51
1.5	2.76 ± 0.10	4.09 ± 0.19	3.82 ± 0.19
Chamomile oil (ml/ kg diet)			
0.5	3.11 ± 0.14	4.53 ± 0.48	3.61 ± 0.48
1.0	3.14 ± 0.17	4.08 ± 0.19	3.76 ± 0.19
1.5	3.46 ± 0.38	4.07 ± 0.05	3.84 ± 0.05

<sup>a,b,c</sup> Means in the same column within each classification bearing different letters are significantly. NS = not significant.**Table 6**Carcass traits ( $\bar{X} \pm SE$ ) of growing rabbits as affected by the dietary supplementation of antibiotic, grape seed oil or chamomile oil during the different experimental periods.

Items	Carcass traits (relative to pre-slaughter weight, %)				
	Carcass NS	Dressing NS	Liver NS	Heart NS	Kidney *
Control	53.91 ± 0.44	58.94 ± 0.31	3.10 ± 0.36	0.25 ± 0.02	0.68 <sup>ab</sup> ± 0.05
Antibiotic (0.5 g/kg diet)	54.39 ± 2.37	58.83 ± 2.03	2.73 ± 0.40	0.27 ± 0.03	0.77 <sup>ab</sup> ± 0.04
Grape seed oil (ml/kg diet)					
0.5	55.25 ± 1.28	59.98 ± 1.06	3.05 ± 0.22	0.23 ± 0.01	0.74 <sup>ab</sup> ± 0.08
1.0	54.85 ± 0.96	59.87 ± 0.51	3.37 ± 0.45	0.28 ± 0.01	0.84 <sup>ab</sup> ± 0.03
1.5	56.32 ± 1.94	60.99 ± 1.39	3.17 ± 0.47	0.25 ± 0.01	0.65 <sup>b</sup> ± 0.09
Chamomile oil (ml/kg diet)					
0.5	55.06 ± 0.96	59.70 ± 0.69	3.26 ± 0.37	0.27 ± 0.02	0.68 <sup>ab</sup> ± 0.06
1.0	53.86 ± 0.86	59.04 ± 0.45	3.61 ± 0.48	0.26 ± 0.02	0.66 <sup>ab</sup> ± 0.05
1.5	55.01 ± 0.86	60.16 ± 0.60	3.29 ± 0.42	0.29 ± 0.03	0.86 <sup>a</sup> ± 0.02
Items	Carcass traits (relative to pre-slaughter weight, %)				
	Spleen **	Lungs NS	Intestine *	Head NS	
Control	0.06 <sup>ab</sup> ± 0.01	0.79 ± 0.13	15.99 <sup>a</sup> ± 0.35	4.70 ± 0.17	
Antibiotic (0.5 g/kg diet)	0.07 <sup>a</sup> ± 0.01	0.61 ± 0.08	15.64 <sup>a</sup> ± 0.64	5.62 ± 0.12	
Grape seed oil (ml/kg diet)					
0.5	0.07 <sup>a</sup> ± 0.01	0.64 ± 0.11	13.64 <sup>ab</sup> ± 0.74	5.44 ± 0.22	
1.0	0.05 <sup>ab</sup> ± 0.01	0.64 ± 0.04	14.15 <sup>ab</sup> ± 0.81	5.30 ± 0.21	
1.5	0.03 <sup>c</sup> ±	0.56 ± 0.04	14.45 <sup>ab</sup> ± 0.96	5.20 ± 0.17	
Chamomile oil (ml/kg diet)					
0.5	0.04 <sup>bc</sup> ± 0.00	0.38 ± 0.21	13.80 <sup>ab</sup> ± 0.54	5.19 ± 0.27	
1.0	0.05 <sup>ab</sup> ± 0.00	0.61 ± 0.04	14.80 <sup>ab</sup> ± 0.25	5.54 ± 0.14	
1.5	0.04 <sup>bc</sup> ± 0.01	0.68 ± 0.11	12.62 <sup>b</sup> ± 1.11	5.98 ± 0.84	

<sup>a,b,c</sup> Means in the same column within each classification bearing different letters are significantly different. \* = significant (P < 0.05), \*\* = significant (P < 0.01) and NS = not significant.

GS stimulate the antioxidant activity in growing chickens. Also, Liu et al. (2011) found that the inclusion of tannins in rabbit feed improved daily weight gain ( $p \leq 0.05$ ). Similar results were observed by Hassan et al. (2014a) as they indicated that average daily feed intake for rabbit bucks was significantly improved in rabbits fed grape seeds extract orally ( $p < 0.05$  than control ones).

On the contrary, Choi et al., (2010) found that the BWG of NZW rabbits fed 0.1%, 0.2% GS and 0.1%, 0.2% grape peels extract showed no significant difference compared with the control. Later, Hassan et al. (2014a) concluded that rabbits exposed to summer stress and fed 1.0% GS in the ration had the highest ( $p \leq 0.05$ ) final BWG (2.436 kg) and higher daily BWG (29.9 g/rabbit) than rabbits fed 0.5% GS, 1.5% GS. Authors attributed their findings to the presence of procyanidin, which reduced stress effects and improved rabbits' health (Garcia et al. 2002). Chen et al., (2013) confirmed that procyanidin extract from grape seed has biologically active substances

with antioxidative activity. Also, Brenes et al. (2008) noticed that procyanidins might have biological impacts in saving tissues from oxidative destruction and eliciting antioxidant activity.

From our results, Ch improved LBW ( $p < 0.001$ ) at 9 and 13 weeks of age, whereas the highest values of LBW were obtained by rabbits fed 0.5 ml g/kg level of Ch compared with the control or the other treatment groups. Chamomile oil improved ( $p < 0.001$ ) LBW at nine and thirteen weeks of age during the fattening period of rabbits, whereas the highest values of live body weight occurred with a level of 0.5 ml g/kg Ch compared with the control or the other treatment groups. These findings are supported by those conducted by Hanna et al., (2008); Skomorucha and Sosnowka-Czajka (2013). They reported that the body weight gain and feed consumption of fattening rabbits were significantly increased by 1.0% fennel or 0.75% chamomile inclusion in feed. The rabbits fed BD + 0.5 ml g/kg Ch had the highest feed intake during the whole

period compared with the other groups. Our findings agree with those of Simonová et al. (2007), who found that Ch is a promising alternative for preventing and controlling bacterial and parasitic infections and improving the general health of rabbits. From our results, colistin improved rabbits' performance when compared with control ones. Our result is parallel to that conducted by Kumar et al., (2020) who confirmed that colistin as a dietary supplementation improved the productivity of livestock.

The carcass traits were markedly affected by the addition of AN, GS and Ch, except the kidney %, while spleen and intestine weights % were lowered ( $p < 0.05$  or  $0.01$ ) compared with the control. These results concur with Hajati et al. (2015), who concluded that GS dietary inclusion has no impact on the carcass properties of broiler chickens exposed to thermal stress. However, Brenes et al. (2010) noticed a marked decrease in the intestinal length of broiler chickens supplied with GS at 0.6, 1.8 and 3.6 g/kg feed. Also, Hassan et al. (2014b) found that the estimated carcass traits with the dietary GS inclusion of 1.0% GS increased only the weights before slaughter ( $p \leq 0.05$ ). Hassan et al. (2016) found that dietary GS increased carcass weight, hot carcass, and edible contents %, while non-edible contents were lowered ( $p \leq 0.05$ ) compared with control ones. Spleen and intestine weight % were lowered ( $p < 0.05$ ) in rabbits fed Ch compared with control rabbits. These findings are in concur with El-Adawy et al. (2015), who found that the giblets weight% was not improved by the addition of medical and aromatic herbs, while liver weight significantly increased ( $p < 0.05$ ). Radwan and Khalil (2002) and Hassan et al. (2004) concluded that the carcass properties differed between different treatments upon feeding rations with medical and aromatic herbs.

## 5. Conclusions

Our results concluded that the dietary inclusion of grape seed oil and chamomile oil improved the productivity of growing rabbits than the control and antibiotic-treated groups. Grape seed and chamomile oils are recommended to be used as dietary supplementation for rabbits.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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