Table 4.3 Mean ± SD birth and weaning weights of male and female lambs born from ewes supplemented with different dietary oils

	Sunflower oil	Olive oil	Fish oil	Palm oil	Control*	Difference
Birth weight (kg) Male	4.85 ± 0.70	5.6 ± 0.84	5.5 ± 0.49	5.4 ± 0.33	5.6 ± 1.19	NS
Birth weight (kg) Females	5.70 ± 0.61	5.8 ± 0.70	5.8 ± 0.74	4.9 ± 0.50	5.41 ± 0.87	NS
Weaning weight (kg) Male	25.5 ± 8.13	29.0 ± 4.88	30.2 ± 4.59	28.8 ± 5.03	28.8 ± 4.93	NS
Weaning weight (kg) Females	28.3 ± 3.81	25.8 ± 6.93	28.9 ± 4.51	27.6 ± 2.46	28.5 ± 4.58	NS

*Control: no oil (sunflower oil, olive oil, fish oil, or palm oil)

4.2.3. Growth rate (% increment and ADG) over time of lambs born from Döhne Merino ewes supplemented with different dietary oils

When an animal grows up, two things are experienced: firstly, BW increases until maturity is reached, and this is called growth; secondly, the body reaches its full function and shape, and this is called development. Growth is demonstrated in quantitative terms phenotypic characteristics such as height, length, girth, and volume. Development consists of qualitative characteristic; these characteristics may also be referred to as genotypic characteristics.

Growth and development of the entire animal rely on processes taking place at a tissue and cellular level (Batt, 1980). These processes include: (a) increase in cell size (hypertrophy); (b) net increase in cell number (hyperplasia) by motorised cell division; (c) differentiation of cells into type, which gives rise to tissues of differing structure and function (including extra-cellular material such as collagen and elastin); and (d) organisation of hypertrophy, hyperplasia, and differentiation. Development is thus linked closely with the growth of tissue (Batt, 1980).

Batt (1980) indicates that the growth rate differs in various tissues and regions of the body. Graphically, these rates tend to go up in regular succession known as growth waves. Growth waves are there for the placement of tissue, for tissue is not laid down at a uniform rate throughout. Kidney fat is the first to be developed and intramuscular (marbling) fat the last. The deterioration in animal growth curve is due to reduced cell number in tissues rather than to a difference in cell size. Animals and children will continue to develop even when presence of food is insufficient for growth (Batt, 1980).

Table **4.4** below illustrates lambs' percentage increment in weight over time, from birth to weaning. This percentage increment showed improvement or significance ($P < 0.05$) in weeks 5, 9, and 11. Fast growth (growth spurt) may follow sufficient feeding, depending on the level to which the animal's growth has deteriorated and the stage at which deterioration occurred, which varies with species. A growth spurt entails an increase in mitotic rate of cells. This may be adequate to lead to complete compensation for the deterioration; however, a growth spurt cannot compensate adequately where there has been early and continuous underfeeding (Batt, 1980).

A growth spurt was experienced in week four, during which time it was important to feed lambs sufficiently. This helps to sustain the growth of lambs, which results in better weaning weights.

Table 4.4 The mean ± SD percentage (%) increment in weight over time (in weeks) from birth until weaning of lambs from ewes supplemented differed dietary oils

	Treatments groups					
	Control group	**Sunflower oil**	**Olive oil**	**Fish oil**	**Palm oil**	**Difference**
% Increment Week 1	30.93 ± 19.71	44.68 ± 13.19	45.98 ± 18.59	28.62 ± 11.63	39.83 ± 11.31	NS
% Increment Week 2	39.68 ± 9.31	34.34 ± 5.01	35.54 ± 4.26	39.48 ± 12.77	36.70 ± 5.02	NS
% Increment Week 3	28.86 ± 10.07	26.11 ± 7.14	20.53 ± 4.97	25.85 ± 3.35	39.21 ± 39.04	NS
% Increment Week 4	45.82 ± 16.23	54.14 ± 14.92	59.50 ± 19.80	50.44 ± 4.59	60.42 ± 20.71	NS
% Increment Week 5	-4.60 ± 4.52^{b}	15.39 ± 28.87^{a}	0.29 ± 7.14	-1.99 ± 4.45	-1.93 ± 7.17	0.05
% Increment Week 6	10.07 ± 3.98	0.99 ± 12.55	6.49 ± 9.33	8.45 ± 6.58	10.79 ± 7.84	NS
% Increment Week 7	5.75 ± 4.16	5.74 ± 5.18	4.39 ± 3.04	4.25 ± 3.05	4.09 ± 4.10	NS
% Increment Week 8	7.03 ± 2.38	10.52 ± 6.02	10.26 ± 3.39	8.19 ± 5.88	11.39 ± 3.62	NS
% Increment Week 9	4.60 ± 5.16^{b}	9.14 ± 3.83^{a}	4.59 ± 2.44	4.56 ± 3.97^{b}	8.09 ± 1.65^{b}	0.05
% Increment Week 10	6.48 ± 4.29	8.24 ± 9.27	9.13 ± 6.18	9.84 ± 3.48	5.49 ± 8.24	NS
% Increment Week 11	6.99 ± 4.64^{a}	2.13 ± 5.01^{b}	6.07 ± 2.95	4.33 ± 2.58	5.92 ± 4.51	0.05
% Increment Week 12	2.81 ± 21.92	2.59 ± 2.54	1.00 ± 2.24	3.00 ± 3.44	1.64 ± 3.89	NS
% Increment Week 13	7.33 ± 3.06	7.11 ± 2.89	7.56 ± 2.38	6.43 ± 2.06	7.67 ± 2.42	NS

*Control: no oil (sunflower oil, olive oil, fish oil, or palm oil)

$^{a, b}$ Values with different superscripts in the same row differ significantly ($P < 0.05$)

Table **4.5** below illustrates the ADG of lambs from ewes supplemented with different dietary oils and a control group. There were significance differences ($P < 0.05$) in ADG of lambs among the groups in weeks 5, 6, 10, 11, and 13. Changes in performance of suckling lambs are mostly associated to variance in milk yield as well as milk fat and protein levels (Manso *et al.*, 2011). Some studies (Zhou *et al.*, 2020; Wang *et al.*, 2022) report that essential oils expand the proportional abundance of bacterial families (*Lachnospiraceae*, *Rikenellaceae,* and *Chistensenellaceae*) that are positively correlated with ADG and negatively correlated with FCR (Yang *et al.*, 2018; Li *et al.*, 2022). Wu *et al*. (2021) report that dietary inclusion of low doses (50, 80, and 250mg/kg DM) of essential oils improves serum levels of IGF-1 (insulin-like growth factor 1) in lambs, which is positively correlated with ADG in sheep. Supplementation of essential oils improves the abundance of *Lachnospiraceae* bacteria in bovine rumen fluid (Zhou *et al.*, 2020), which has a positive correlation with the length of papillae in sheep (Yang *et al.*, 2018; Mao *et al.*, 2021).

Table 4.5 The mean ± SD average daily gain (kg) over time (in weeks) from birth until weaning of lambs from ewes supplemented with different dietary oils

	Treatments groups					
	Control group*	**Sunflower oil**	**Olive oil**	**Fish oil**	**Palm oil**	**Difference (P-Value)**
ADG Week 1	0.24 ± 0.15	0.34 ± 0.09	0.36 ± 0.14	0.23 ± 0.09	0.31 ± 0.10	NS
ADG Week 2	0.39 ± 0.79	0.47 ± 0.19	0.54 ± 0.23	0.40 ± 0.09	0.40 ± 0.7	NS
ADG Week 3	0.40 ± 0.13	0.35 ± 0.8	0.30 ± 0.14	0.38 ± 0.05	0.36 ± 0.14	NS
ADG Week 4	0.80 ± 0.19	0.79 ± 0.24	0.89 ± 0.10	0.92 ± 0.10	0.89 ± 0.83	NS
ADG Week 5	-0.11 ± 0.10^{b}	0.20 ± 0.35^{a}	0.01 ± 0.17	-0.05 ± 0.12	-0.04 ± 0.18	0.01
ADG Week 6	0.25 ± 0.12^{a}	0.01 ± 0.29^{b}	0.14 ± 0.10	0.22 ± 0.18	0.24 ± 0.13	0.05
ADG Week 7	0.15 ± 0.10	0.14 ± 0.12	0.12 ± 0.09	0.12 ± 0.89	0.10 ± 0.12	NS
ADG Week 8	0.20 ± 0.08	0.26 ± 0.89	0.29 ± 0.10	0.26 ± 0.19	0.31 ± 0.12	NS
ADG Week 9	0.14 ± 0.17	0.27 ± 0.10	0.14 ± 0.09	0.14 ± 0.12	0.25 ± 0.04	NS
ADG Week 10	0.21 ± 0.14	0.22 ± 0.18	0.26 ± 0.14	0.34 ± 0.12^{a}	0.17 ± 0.22^{b}	0.05
ADG Week 11	0.24 ± 0.16	0.08 ± 0.16^{b}	0.21 ± 0.09^{a}	0.16 ± 0.10	0.19 ± 0.12	0.05
ADG Week 12	0.09 ± 0.07	0.10 ± 0.08	0.02 ± 0.18	0.11 ± 0.12	0.06 ± 0.15	NS
ADG Week 13	0.38 ± 0.12	0.35 ± 0.17	0.3 ± 0.17^{b}	0.38 ± 0.10^{a}	0.35 ± 0.17	0.05

*Control: no oil (sunflower oil, olive oil, fish oil, or palm oil)

$^{a, b}$ Values with different superscripts in the same row differ significantly ($P < 0.05$)

ADG: average daily gain (kg)

5. CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. CONCLUSION

Globally, livestock producers, including sheep producers, face various challenges such as high input costs, diseases, and global warming and thus are under pressure in all fronts to farm sustainably and viably. In order to maximise the economic return from sheep farming, farmers have to optimise their reproductive efficiency. The use of dietary oils has been shown to improve reproductive efficiency and fecundity and accelerate lamb growth in different species.

The aim of this study was to investigate the effect of various dietary oils (sunflower oil, olive oil, fish oil, palm oil) on the reproductive efficiency and lamb growth performance in Döhne Merino ewes as compared to a control group where no oil was supplemented. The Döhne Merino is known to be fertile and have a high libido (Delport, 2019).

The conception rate through LAI and the use of a follow-up ram was 88%.The aim of the current study was not to compare the LAI and natural mating; thus, it is impossible to recommend to farmers which of these methods to use. There was no significant difference ($P > 0.05$) in gestation length between any of the groups. Therefore, the oral supplementation of dietary oils had no effect on shortening or extending the gestation length of Döhne Merino ewes. Gestation length was also not affected by birth status (single vs twins), sex of the lambs, age of ewes, management, or nutrition.

There were no differences in fecundity, litter size, lamb sex, and ratio of male to female lambs between any of the groups in the present study. The percentage increment in lambs' weight over time, from birth to weaning, showed improvement or significance ($P < 0.05$) in weeks 5, 9 and 11. Brand *et al*. (2014) report an annual fecundity (lambs born/ewes lambing) of 262%, whereas the average fecundity rates for the different treatment groups in this study ranged from 100% to 133%.

Furthermore, the oral supplementation of dietary oils to ewes used in this study made no positive contribution to birth weight, weaning weight, or mortality rate of lambs born from supplemented ewes. However, significant differences ($P < 0.05$) in lamb ADG

were observed in weeks 5, 6, 10, 11, and 13. The results of this study were obtained from supplementation of ewes before mating until weaning of lambs.

The overall and general conclusion that can be made based on the results of this study is that oral supplementation of dietary oils – namely, sunflower, olive oil, fish oil, and palm oil – did not significantly affect the reproductive performance of ewes. In addition, oral supplementation of dietary oil to ewes had no positive effect on the growth performance of lambs, as all treatment groups performed similarly to the control group.

It should be noted that the variation between groups is an indication that significant differences may have been found between groups if more uniform or more animals were used in the study.

5.2. RECOMMENDATIONS

- Due to increased pressure to produce high-yielding lambs in a shorter period, farmers are often advised on supplementation. Preliminary results from this study shows that oral supplementation of dietary oils to Döhne Merino ewes is expensive and does not appear to be an effective way to improve the reproductive performance of ewes or the growth performance of their offspring.
- It is recommended that farmers follow good farming practices that include a proper feeding programme, management of mating season, and a vaccination programme in order to ensure the profitability of their farming enterprise.
- It is recommended that a follow-up study be undertaken, which will investigate puberty in small rams and milk solids in ewes.

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