**Title:** Effect of essential oils when supplied in feed or via a slow-release rumen bolus on the health and performance of high yielding dairy cows in early lactation

**Application:** The inclusion of essential oils in the feed increases milk yield and milk protein content, whilst the provision via a slow-release rumen bolus decreases DM intake and milk fat content, and increases food conversion efficiency in early lactation, high yielding dairy cows. Essential oils do not decrease the risk of ketosis when blood ketone concentrations are already low.

**Introduction:** Ketosis is a major health problem in the dairy industry, with the prevalence of subclinical ketosis being as high as 28.5% in early lactation in UK herds (Macrae et al., 2019). The development of this disease can cause health, production, and welfare problems in cows, as well as having a substantial negative economic impact (Cainzos et al., 2022). Essential oils are plant-derived bioactive compounds containing volatile compounds that can beneficially manipulate rumen fermentation, reducing the risk of ketosis and increasing performance (Da Silva et al., 2019). Providing essential oils in a slow-release rumen bolus may reduce the potential loss of volatiles and is an easier means to administer to extensively grazing ruminants. There have however been no studies undertaken to determine the effect of essential oils when included in a slow-release bolus compared with inclusion in the diet in cattle. The objective of the study was to examine the effect of an essential oil blend when supplied in a slow-release rumen bolus or in the diet on performance parameters and blood ketones in dairy cows in early lactation.

**Materials and Methods:** Forty-Five multiparous Holstein Friesian dairy cows that were (mean ± SE) 11 ± 0.6 d post calving, yielding 38 ± 0.9 kg/d and weighing 697 (± 10.7) kg were randomly allocated to one of three dietary treatments: C: basal total mixed ration (TMR; containing on a DM basis: 0.33 maize silage, 0.21 grass silage, and 0.46 concentrates), TO: basal TMR + essential oil (Agolin, Switzerland fed at 0.9 g/cow/day), or BO: basal TMR + intra-ruminal boluses containing essential oils to provide the same daily rate of release of essential oils as TO. The cows were group housed in the same shed and remained on study for 10 weeks, with individual intake measured daily using roughage intake control feeders, milk yield recorded daily, and milk samples collected weekly for analysis by National Milk Laboratories, Wolverhampton, UK. Live weight (LW) and body condition score (BCS) were recorded fortnightly, and blood plasma samples taken via the jugular vein at 1100 h during weeks 0, 2, 4, 6, 8 and 10 for subsequent analysis of β-hydroxybutyrate (BHB), and non-esterified fatty acids (NEFA). The data was analysed by Reml using time, treatment, previous 305-day lactation yield, lactation number (2 and 3+), and days post calving as fixed effects, and cow as a random effect using Genstat (v. 22). The results are provided as the least square mean (LSM) and standard error of the difference (SED). P values ≤ 0.05 were considered as significant, and P ≤ 0.10 as a tendency.

**Results:** The DM intake was 1.3 kg/d lower in cows receiving BO compared to C or TO (P<0.001; Table 1). Milk yield was 1.1 kg/d higher (P<0.001) in cows receiving TO than C, with those receiving BO being intermediate. Mean milk fat concentration was 35.2 g/kg and was lower (P<0.001) in cows fed BO than C, with TO being intermediate. Milk protein content was highest in cows fed TO compared to either C or BO (P<0.001). There was no effect of treatment on BCS (P>0.05), however, LW was lower (P<0.001) in cows on BO compared to TO or C. The feed correction efficiency (FCE) was highest in cows fed BO compared to either C or TO (P<0.001). There was no effect of treatment on plasma BHB or NEFA concentrations (P>0.05), with mean values of 0.522 and 0.222 mmol/l respectively.

**Conclusions:** Feeding essentials oils in the feed increased milk yield and milk protein content but had no effect on live weight. In contrast, providing essential oils in a slow-release rumen bolus decreased DM intake and milk fat content, and resulted in a lower LW and higher FCE. The provision of essentials oils in the feed or in a bolus did not affect plasma ketone concentrations, although concentrations were low throughout the study across all treatments.

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| **Table 1:** Performance of dairy cows fed either a control diet (C), essential oils in the TMR (TO) or essential oils in a slow-release rumen bolus (BO). | | | | | | |
|  | **Treatment** | | |  | **Significance** | |
|  | **C** | **BO** | **TO** | **SED** | **Treatment** | **Time** |
| **DMI (kg/d)** | 24.6b | 23.3a | 24.5b | 0.315 | <0.001 | <0.001 |
| **Milk yield (kg/d)** | 48.9a | 49.7ab | 50.0b | 0.498 | <0.001 | <0.001 |
| **Milk Fat (g/kg)** | 35.9b | 34.3a | 35.4ab | 0.960 | <0.001 | <0.001 |
| **Milk Protein (g/kg)** | 30.7a | 30.3a | 31.1b | 0.225 | <0.001 | <0.001 |
| **BCS (1-5 scale)** | 3.09 | 3.09 | 3.07 | 0.049 | 0.576 | 0.489 |
| **LW (kg)** | 666b | 655a | 673b | 4.02 | <0.001 | 0.009 |
| **FCE (kg milk/kg DMI)** | 1.99a | 2.17b | 2.04a | 0.030 | <0.001 | 0.630 |
| **Plasma BHB (mmol/l)** | 0.527 | 0.562 | 0.477 | 0.062 | 0.241 | 0.382 |
| **Plasma NEFA (mmol/l)** | 0.235 | 0.210 | 0.221 | 0.046 | 0.779 | 0.921 |
| a-b Means within a row with different superscripts differ (P<0.05). There was no treat x time interaction. | | | | | | |

**Acknowledgements:** The authors would like to thank Agrimin Ltd., for funding the study, and providing the rumen boluses.

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