**Crude olive cake as additive for corn and grass silage: aerobic stability**

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**Introduction** The olive crop in Brazil has experienced a huge development in the last years. The Rio Grande do Sul state is the largest producer, being responsible to 50% of the national production on 3,464 ha (IBGE, 2017; Secretaria da Agricultura do RS, 2019). A considerable part of the olive production is processed to extraction of olive oil. However, processing olive results in the production of crude olive cake (OC), a by-product that cannot be discarded in the environment because its polluter potential. The OC is rich in energy (~10% of ether extract) and because that, it also deteriorates quickly in the presence of oxygen (Hadjipanayiotou, 1999). Actually this by-product represents a problem for the olive industry, and therefore, finding a fate for OC is needed. The OC was previously assessed for animal feeding as *in natura* or ensiled, but no investigations have been conducted regarding its potential to be used as silage additive. Thus, our objective was to investigate the impact of OC as additive on aerobic stability of corn and grass silage.

**Material and methods** A corn hybrid (AS 1596, Agroeste, Cascavel, PR, Brazil) and Elephant grass cv. BRS Kurumi were grown in two commercial farms located at Pelotas - RS. Whole-crop corn (32.6% dry matter (DM)) and 4 h-wilted Elephant grass (22.9% DM) was cut to a theoretical length of 20–30 mm using a stationary chopper. Six piles of corn forage were individually treated with fresh OC (5% as fresh basis), and other six piles remained without OC (untreated). The same procedure was performed to the Elephant grass. The application of OC onto the forages was made under constant manual mixing. The OC (32.5% DM and 11.9% of ether extract) was obtained from an olive industry (Estancia Guarda Velha, Azeite Batalha, Pinheiro Machado, RS, Brazil) and stored at 4°C prior to application. Ensiling was performed using two mini-silos (PVC tubes with capacity for 2.5 L) per each statistical replicate ($n$ = 3) to have sufficient silage for measurement of aerobic stability. Mini-silos remained stored at room temperature (18.3 ± 1.22°C) for 99 d. After the silos were opened, a pooled portion of silage (2.24 ± 0.09 kg) from the two mini-silos of each replicate was removed from the silos and placed into plastic basins at room temperature (14.8 ± 0.54°C) to determine aerobic stability. Temperature of silages and of the ambient were recorded every half hour by dataloggers for 220 h. Aerobic stability was defined as the number of hours that the silage temperature remained stable before increasing more than 3°C above the ambient temperature. Additionally, the heating rate was calculated as the maximum recorded temperature divided by the time to reach the maximum temperature (Ruppel et al., 1995). The sum of accumulated daily temperatures was calculated as the sum of the difference between the silage and ambient temperatures (O'Kiely, 1999) after 5 d and at the end of aerobic exposure period (ADITE 5 and 10, respectively). Data ($n$ = 3) were analyzed as a completely randomized design under a 2 (two forages) × 2 (with or without OC) factorial arrangement using the MIXED procedure of SAS (v. 9.4). Differences between means were determined using the PDIFF option of LSMEANS at $P \leq 0.05$.

**Results and discussion** Although not directly studied to date as additive, we hypothesized that OC may have the potential to alter the fermentation end products of the ensiled forage crops through changing the microbial profile associated with this process, so that aerobic

stability might be affect. Changes in rumen bacterial community of an experimental diet treated with stoned olive pomace were previously reported under *in vitro* conditions (Pallara et al., 2014). However, the aerobic stability and temperature features of both corn and grass silages during the aerobic period were not changed by OC ($P \geq 0.18$). These results suggest that OC had probably no effect on fermentation patterns of silages, once improved aerobic stability has been associated with high concentration of acetic acid. Moreover, once the OC is recognized to have antimicrobial properties (Pereira et al., 2006), the OC level used at ensiling was likely quite low to detect any effect on aerobic stability. Conversely, corn silage had lowered ($P = 0.004$) aerobic stability as compared to grass silage, which was consistent with other temperature features ($P \leq 0.025$) during aerobic exposure. Corn silage is known to have low aerobic stability because of its usual homolactic fermentation and high nutritive value; spoilage microorganisms utilize residual sugars and lactic acid as substrate to grow.

**Table 1** Aerobic stability of corn and grass silage treated with 5% OC (as fresh basis).

| Item | Corn silage | | Grass silage | | SEM | *P*-value[3] | | |
|---|---|---|---|---|---|---|---|---|
| | U[1] | 5% OC | U | 5% OC | | C | OC | C × OC |
| Aerobic stability, h | 102 | 93.5 | 161 | >220 | 23.4 | 0.004 | 0.32 | 0.19 |
| ADITE 5, °C | 278 | 649 | 85.5 | –23.9 | 157 | 0.025 | 0.43 | 0.17 |
| ADITE 10, °C | 590 | 1363 | 188 | 68.9 | 290 | 0.019 | 0.29 | 0.16 |
| Maximum T[2], °C | 26.8 | 30.1 | 19.0 | 16.3 | 1.78 | >0.001 | 0.86 | 0.13 |
| Heating rate, °C/h | 0.119 | 0.139 | 0.055 | 0.012 | 0.021 | 0.002 | 0.61 | 0.17 |

[1]U = untreated; [2]T = temperature; [3]C = crop, OC = crude olive cake, C × OC = interaction between crop and olive cake.

**Conclusion** Partial results of this study indicated that OC has no effect on aerobic stability of corn and grass silages when used at 5% (as fresh basis). Thus, applying OC at ensiling of these crops can be a viable fate for its use from the olive industry.

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