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Key words : fermentation ,plant extract ,ruminants ,silage quality

Introduction Numerous silage additives are marketed with primary aims of improving the fermentation process (microbial inoculants) or aerobic stability . Product claims are often made for improved silage quality , but responses are variable . Objective here was to verify if essential oils (EO) at different concentrations have potential to be used as a silage stabilizing additive .

Material and methods Whole barley plant (*Hordem vulgare* L .) was harvested on mid-dough stage on May 2005 and chopped with forage harvester to a 1-2 cm length . The chopped barley was sprayed with pure ethanol (control) or essential oils dissolved in ethanol providing 10 treatments . The inoculated and un-inoculated (control) barley were ensilaged into PVC mini silos with four replicates for treatments (40 mini-silos) . Silos were weighed after sealing as well as before opening for silage evaluation . Essential oils [cinnamon (CIN) , oregano (ORE) or sweet orange (SO)] were dissolved in 70% ethanol for application (100 mL/18 kg silage fresh weight) at 125 , 250 and 400 mg EO per kg of silage (fresh weight) . The control silage was treated with an equivalent amount of 70% ethanol . Silo contents were packed to an equal density (~240 kg/m^3) by weighing a known amount of forage into each silo and packing with a hydraulic press equipped with a pressure gauge . Four silos of each treatment were opened a year later for silage analyses . Silage samples were dried and or processed for pH determination , chemical analysis , isolation and enumeration of microorganisms (*Lactobacillus* , yeast and mold) according to the methods described by Zahiroddini et al . (2004) . Data were analysed using the MIXED procedure of SAS (SAS Inst . Inc . , 2007) .

Results

DM and chemical composition Upon aperture of the mini-silos (day 0) dry matter contents and pH of barley silages were similar among treatments (341 .9 g/kg and 4 .0 , respectively $P>0$ .10) and also no differences on these parameters among silos ($n=4$) within treatments were found ($P>0$ .10) . All silages treatments appeared to be of good quality , as evidenced by pH values , high concentration of lactic acid and low concentrations of butyric acid . Crude protein (CP) and fibre (neutral and acid detergent fibre [NDF and ADF] , and hemicellulose) concentrations (g/ kg DM) significantly differed among treatments and also among silos within treatment . Least square means for the treatments show higher CP concentrations in barley silages inoculated with CIN and SO compared to control (no EO) . Both NDF and ADF concentrations were higher in CIN 400 compared to control although differences among silos within treatment (interaction for treatment x silo) was significant ($P<0$. 01) . The concentration of water soluble carbohydrates (WSC) exhibited a large variation among treatments and ranged from 31 .2 (g WSC/g DM) for SO 250 to 59 .8 for barley silage CIN 250 . Silage CIN 125 and 250 were the only silages which differed from the silage control ($P<0$ .01) .

Silage fermentation parameters Lower acetic acid and total volatile fatty acids (VFA) concentrations were presented on barley silages treated with CIN 250 compared to no EO treatment ($P<0$ .05) . Propionic , butyric and other VFA concentrations on barley silage treated with EO did not differ from control when silos were open ($P>0$ .10) . Amount of lactic acid among treatments were similar (76 .4±4 .45 g lactic acid/kg silage DM ; mean±SE) but succinic acid showed higher concentration on control and ORE 125 (5 .88 and 5 .42 g/kg , respectively) compared to the others treatments ($P<0$ .05) . Ratio lactic :acetic , where higher values indicates good quality of fermentation for the silage , theoretically demonstrated better fermentation on barley treated with CIN 250 and SO 400 (6 .53 and 5 .87 , respectively) compared to other silages treated or not with EO .

Enumeration of microorganisms For microbial enumerations on day 0 , only total flora differed among treatments where concentrations of 250 and 400 mg EO/kg for treated silages decreased the number of bacterial colonies compared to control (P <0 .01) . There was a tendency of smaller growth of yeast population on ORE 400 compared to control (0 .61 vs . 3 .51 $\log_{10}$ cfu/ g silage , respectively ; $P<0$ .08) . Mold and *Lactobacillus* had similar population numbers among treatments upon silos aperture (6 .97 and 1 .38 $\log_{10}$ cfu/ g silage , respectively ; $P>0$ .10) . During assessment of aerobic stability up to 72 hours , EO trended to prevent yeast would grow on barley silage and allowed better development of *Lactobacillus* population , which are beneficial for silage quality .

Conclusion Those findings show that depending on concentrations and type of essential oils used , treated barley may have beneficial effects on silage fermentation and on aerobic stability .

References

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