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Aerobic stability of crimped wheat grain manipulated by additive treatments detected using different methods

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Introduction

- Crimped grain preservation is based on lactic acid fermentation by anaerobic lactic acid bacteria
- Recommended grain moisture content (MC) is 300 – 400 g/kg
- In crimped grain with MC between 200 and 300 g/kg, fermentation is restricted so that efficient protection is needed against aerobic deteriorating organisms

Objective: to evaluate the fermentation quality, microbial composition and aerobic stability of dryer than optimal crimped wheat grain ensiled with different additives and to compare three methods in evaluating the aerobic stability: 1) increase in temperature, 2) measurement of CO_2 produced by aerobic bacteria 3) visual appearance of mould

Materials and Methods

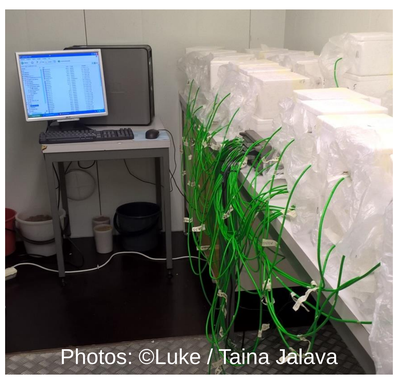
- Crimped wheat grain: 270 g/kg MC
- Eight additive treatments:

1. Control (C) without additive
2. FA1 (80% formic acid [FA]; 5 l t^{-1})
3. FA2 (58% FA, 20% propionic acid [PA], 2.5% potassium sorbate, 5.2% sodium formate [SF]; 5 l t^{-1})
4. FA3 (FA2 at 7 l t^{-1})
5. FA4 (76% FA, 5.5% SF; 7 l t^{-1})
6. FA5 (37% FA, 22% SF, 18% PA, 7.3% sodium, 1% sorbic acid; 5 l t^{-1})
7. PA1 (54% PA; 5 l t^{-1})
8. PA2 (37% PA, 14% sodium benzoate, 10% FA, 11% sodium propionate; 4 l t^{-1})

- Three replicates per treatment
- Glass jars were opened after 57 days of ensiling: fermentation quality and microbial quality

Aerobic stability:

1. Temperature rise
2. 50 g of sample was put into 0.5 l glass bottles: headspace gas was sampled once daily and analysed for CO_2 using a gas chromatograph
3. Visual appearance of mould in the glass bottles once a day using a score scale: 0 = no mould; 1 = slight mouldiness; 2 = moderate mouldiness; and 3 = severe mouldiness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Results

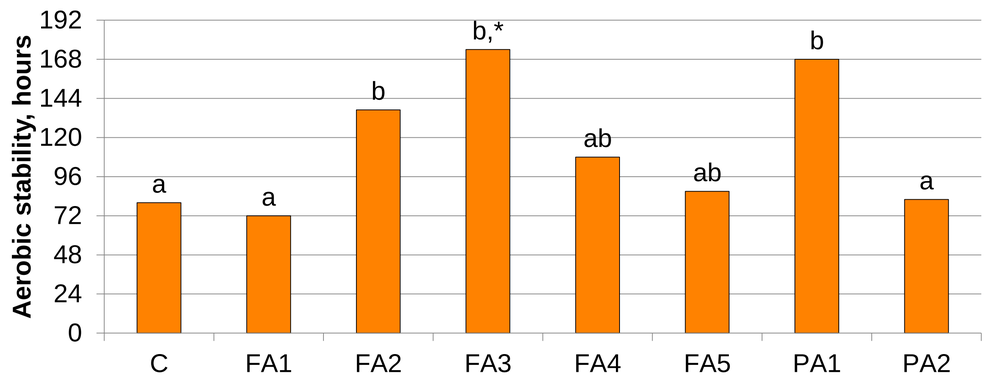

Figure 1 Aerobic stability of crimped wheat grain according to additive treatments. *Treatment did not reach the threshold during the evaluation period.

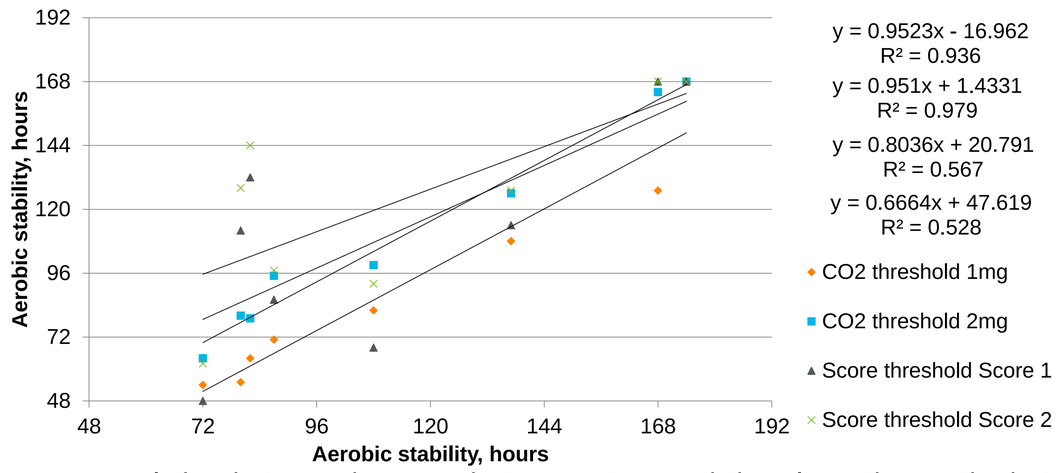

Figure 2 Correlation between increase in temperature and the alternative methods to evaluate aerobic stability.

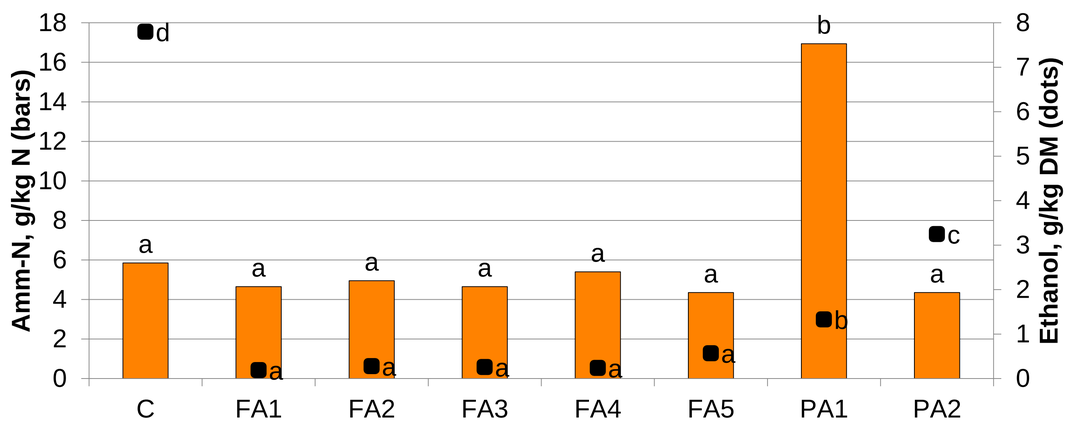

Figure 3 Ammonia-N and ethanol of crimped wheat grain according to additive treatments.

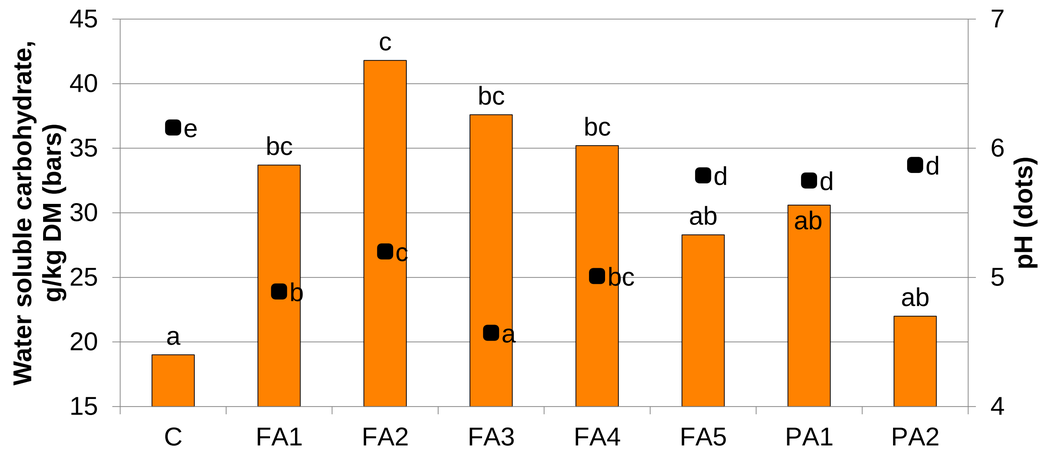

Figure 4 Water soluble carbohydrate and pH of crimped wheat grain according to additive treatments.

Table 1 Microbial composition of crimped wheat grain according to additive treatments.

	C	FA1	FA2	FA3	FA4	FA5	PA1	PA2
Yeasts, CFU/g	2.7×10^3	$<1\times10^1$	$<1\times10^1$	$<1\times10^1$	$<1\times10^1$	1.5×10^3	4.2×10^3	4.1×10^4
Moulds, CFU/g	9×10^2	4.3×10^5	1.2×10^5	1.7×10^2	3.7×10^5	6.1×10^4	7.2×10^5	5.5×10^4

Conclusions

- There were clear differences in the efficacy of additives in improving the aerobic stability of relatively low moisture crimped wheat grains, with FA3 (high dose of additive including several ingredients) being the most efficient
- All methods used to evaluate aerobic stability provided useful information of the efficacy of the additives
- The correlation between temperature and CO_2 production was very high indicating that CO_2 produced by aerobic bacteria can be used as a method to evaluate aerobic stability, while visual appearance ranked the additives slightly differently