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Using Science as a Tool for Shaping Political Opinion

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Low amounts of THCA and THC in hemp

With much effort, more than five years of work and eight cows, Wagner et al.[i] used hemp to contaminate milk with delta-9-tetrahydrocannabinol (THC). This achievement invites a critical reconsideration of this work and questions its relevance. Hemp varieties of Cannabis sativa L. produce low amounts of delta-9-tetrahydrocannabinolic acid (THCA), which can be decarboxylated to THC. While THCA is poorly absorbed and not psychoactive, THC is readily absorbed and psychoactive at sufficient dosages. Consequently, hemp-derived foods contain low amounts of THCA and THC, and hemp food producers successfully began to reduce these contaminants by the mid-1990s.

More recently, and without direct evidence to link trace amounts of THC with specific health risks, some government agencies imposed food THC limits that are disproportional to the assumed risk of adverse effects. For example, in March of 2000 the German Federal Institute for Risk Assessment announced the world's lowest guidance values for THC in foods[ii], and in August of 2022 the European Commission announced with the world's second lowest set of values[iii]. In some risk analyses, inactive THCA was assumed to have the same risk potential as THC, which obviously inflated THC levels in foods and blurred subsequent discussions.

THC in silage

Hemp silage has been safely fed to cows for more than a decade in Europe[iv]. The low amounts of THCA and THC in silage are not sufficient to cause adverse effects, unless extra efforts are made to 1) decarboxylate the THCA and 2) somehow concentrate the THC. Wagner et al. managed to combine both of these requirements in two different silage products. Silage A was correctly made from immature whole hemp plants "in the seed formation stage", and was low in THC (58 mg/kg dry matter, DM, Table 1), while pseudo silage E was made from a special cannabinoid-rich biomass composed of "leaves, flowers, and seeds" from mature plants, which was much higher in THC (1255 mg/kg DM). Whole hemp plants may be used in the production of silage, but the European Commission's Feed Catalogue 2022/1104 does not allow for the addition of isolated hemp flowers and leaves[v]. By using special equipment and biomass from a late harvest, a THC-rich silage may be produced from hemp if EC regulations are ignored.

Pseudo silage E

Results from the silage quality analysis (Table 6 Supp.) clearly show that "silage" E was, in fact, not silage. We do not know if this biomass was harvested late or very late for this particular crop, because the authors did not report specific sowing and harvest dates. The first and corresponding author (BW) did not respond to a request for that information. However, the high protein and lipid values (lipids measured as ether extract, Table 6 Supp.) provide clear indications that significant amounts of mature seed were present in the harvested biomass for E, and more than just "the first fully mature seeds", as noted at the bottom of page 927. This is not a trivial point, since THCA increases as the hemp plant matures[vi]. Also, mature seeds are not beneficial in silage because the added protein decreases palatability[vii], which was clearly noticed by cows fed “silage” E (Fig 1B, Table 2 Supp.).

Moreover, late harvested crops will naturally be more contaminated with other microbes that may inhibit the growth of Lactobacillus, which apparently happened with “silage” E[viii]. Unfortunately, no data were included to identify potential microbial contaminations; e.g., testing for mycotoxins that could explain some of the abnormal behaviours ascribed to THC[ix x].

Usable silage has a pH of 4.5 or less, and certainly no more than pH 5, yet E had a reported alkaline pH of 8.3 (Table 6 Supp.). As a consequence of successful ensilation, lactic acid is typically 4-7% of the dry mass in good quality silage. For silage A, the lactic acid content was 4.52% DM, while “silage” E had only 1.29% lactic acid/DM. Also, a lactic acid/acetic acid ratio below 1 is another indication of failed ensilation, and this ratio was 0.57 for E. Surprisingly, a lactic acid value for the control silage is missing from this Table. The higher ash content of E further indicates contamination by undesirable microbes, favoured by high pH. Taken together, these results indicate that the biomass for E was not successfully fermented or preserved by Lactobacillus. Perhaps excess terpenes[xi] from the cannabinoid-rich biomass, the removal of carbohydrate-rich stalks and stems, and/or contamination from unwanted microbes caused the failed ensilation of “silage” E.

In any case, the false equivalence drawn between A and E represents a significant blind spot for this study [I]. This is not like comparing apples to oranges, but more like comparing apples to mouldy orange peels, while pretending that these peels are equivalent to oranges.

Decarboxylation of cannabinoids during ensilation

Most of the THCA in the hemp biomass was already decarboxylated to THC by the time it was fed to cows. This novel finding has been known to at least some of these researchers since 2017, but was not mentioned or discussed in this report [I], and only represented by numbers for both A and E in Table 1. Microbial actions could explain this reaction[xii], especially after 14 months of ensilation [I]. For now we are left to wonder if normal ensilation times of four to six months might have preserved more THCA in the silage, and reduced THC as a consequence.

Missing analytical methodology

The authors promoted a new methodology for the analysis of cannabinoids, with boastful claims, but without the customary verification and validation data[xiii]. Instead, they referenced a 2016 master’s thesis[xiv], which is not publicly available. The University of Münster denied our request for this thesis for reasons of “data protection”.

Conclusions drawn from this work [I] depend on a reliable measure of THC and other cannabinoids, which ranged over 10 orders of magnitude in four different matrices. No one should be expected to accept these results without credible assurance of their accuracy and precision.

Practical outcomes

Four cows showed signs of inebriation after receiving the highest exposure of “silage" E. They secreted THC into their milk, but not enough to cause adverse effects in humans[xv]. For example, two litres of the most contaminated milk would only provide 404 µg of THC, according to the highest mean value in Table 2. This amount of THC is nearly six times below the lowest observed adverse effect level (LOAEL). At some point, a full feeling from several litres of milk becomes a practical impediment to achieving inebriation.

It is a pity that the authors worked so hard to prove so little with so few cows. They did not even bother to mention a few basic tips that are already used to produce good quality silage and reduce THC; e.g., 1) harvest early to avoid seeds and unwanted microbial contaminants, 2) ensile the whole plant, instead of a "cannabinoid-rich" concentrate, and 3) apply normal ensilation times.

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