How to improve food safety

in chicken and beef liver and milk

INTAQT partners have chosen several food safety traits that are expected to depend on agricultural practices: persistent organic pollutants, toxic metals, plant- and mycotoxins, pathogens and antibiotic resistance genes in chicken faecal samples as a proxy. A total of 91 chicken, 81 dairy and 55 beef farms, classified along a gradient of intensification, were sampled.
Overall, the results indicate no safety risk from any of the analysed products and no clear relation to husbandry systems.

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In the INTAQT project, different safety traits were analysed, including persistent organic pollutants (perfluorinated alkyl substances (PFAS), polychlorinated dibenzo-p-dioxins (dioxins), polychlorinated dibenzofurans (furans) and polychlorinated biphenyls (PCBs)), toxic metals, plant- and myco-toxins toxins and pathogens as well as antibiotic resistance genes in chicken faecal samples. Besides milk, analyses focused on liver samples in cattle and in chicken, as liver is known to play an important role in metabolic detoxification and to accumulate contaminants. Accordingly, concentrations in liver samples can be used as an indicator for possible contaminants in meat.

Measuring product safety in chicken samples

A total of 4,550 samples were collected on 91 farms. This farm network, distributed across different European regions, represents typical husbandry systems along a gradient of intensification. The chicken farms were separated in six typologies, from low to high intensification, based on the three indicators: outdoor range, genetics (growth rate) and slaughter weight (Fig. 1)

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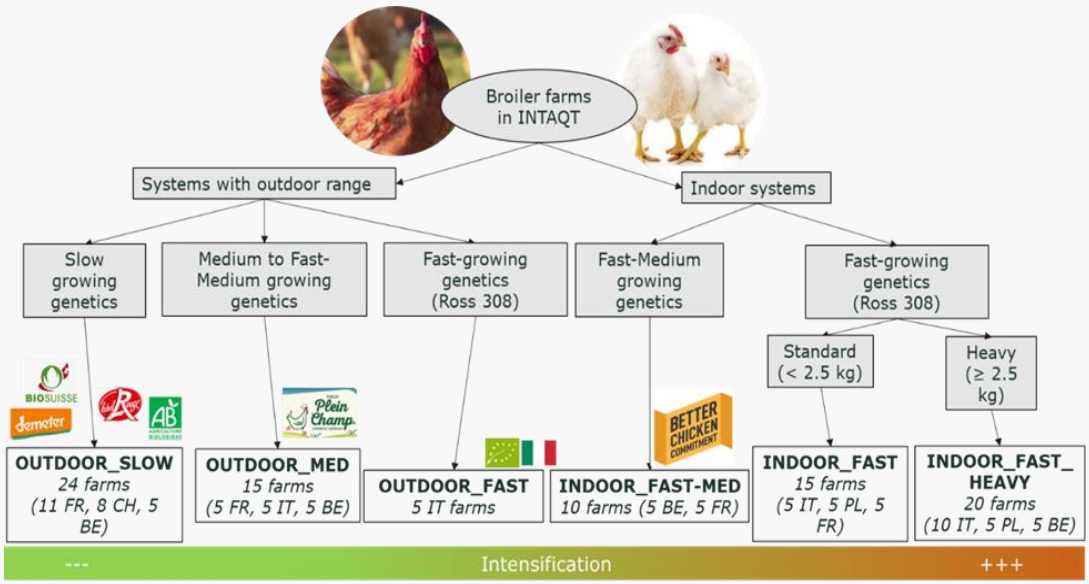

Fig. 1: Typology of chicken along a gradient of intensification

In chicken liver samples**, mycotoxins** were detected at relatively low concentrations and all samples were below the limit of quantification for the analysed **PFAS**. All results for the **heavy metals** arsenic, mercury and lead were below the detection limit. For nickel, cadmium and chromium no differences between typologies were found.

In chicken faecal samples, 37 % were positive for ***Campylobacter* spp**. (*C. larii*, *C. jejunii*, *C. coli*) and 6 % for ***Escherichia coli***. There was no clear pattern among farm typologies (Tab. 1). The samples were further analysed to map **antibiotic resistance genes** according to country of origin (Italy or Belgium), genotype (fast- versus slow-growing), diet and farming system. In silico analysis identified 265 genes encoding resistance to 16 antibiotic classes. The samples were grouped into three clusters (Cluster 1: fast- and medium-growing genotypes fed a conventional diet, Cluster 3: fast-growing genotypes reared outdoors fed a vegetable-based diet). In Cluster 2, diet did not appear to influence sample grouping. All analysed samples also carried genes associated with resistance to disinfectants commonly authorised for use in poultry farming.

		Outdoor Slow	Outdoor Medium	Outdoor Fast_Heavy	Indoor Fast-med	Indoor Fast	Indoor Fast_Heavy
Campylobacter spp	present	6	7	0	4	3	9
	absent	17	7	5	5	7	8
Escherichia coli	present	1	1	0	2	0	1
	absent	22	13	5	7	10	16

Tab. 1: Number of positive and negative samples of Campylobacter spp. and Escherichia coli in poultry faecal samples

No sample surpassed the limits established by EFSA as safe for human consumption for the measured parameters for chicken, beef and dairy samples.

Measuring product safety in beef samples

A total of 550 liver samples (2-8 animals per farm in 55 farms, summer and winter season) were collected. The various cattle farms were classified into 6 groups according to the type of farm (suckler or fattening), the age of the animals (at fattening and slaughter), whether or not the animals grazed, and the proportion of concentrate feed and maize silage in their diet (Fig. 2).

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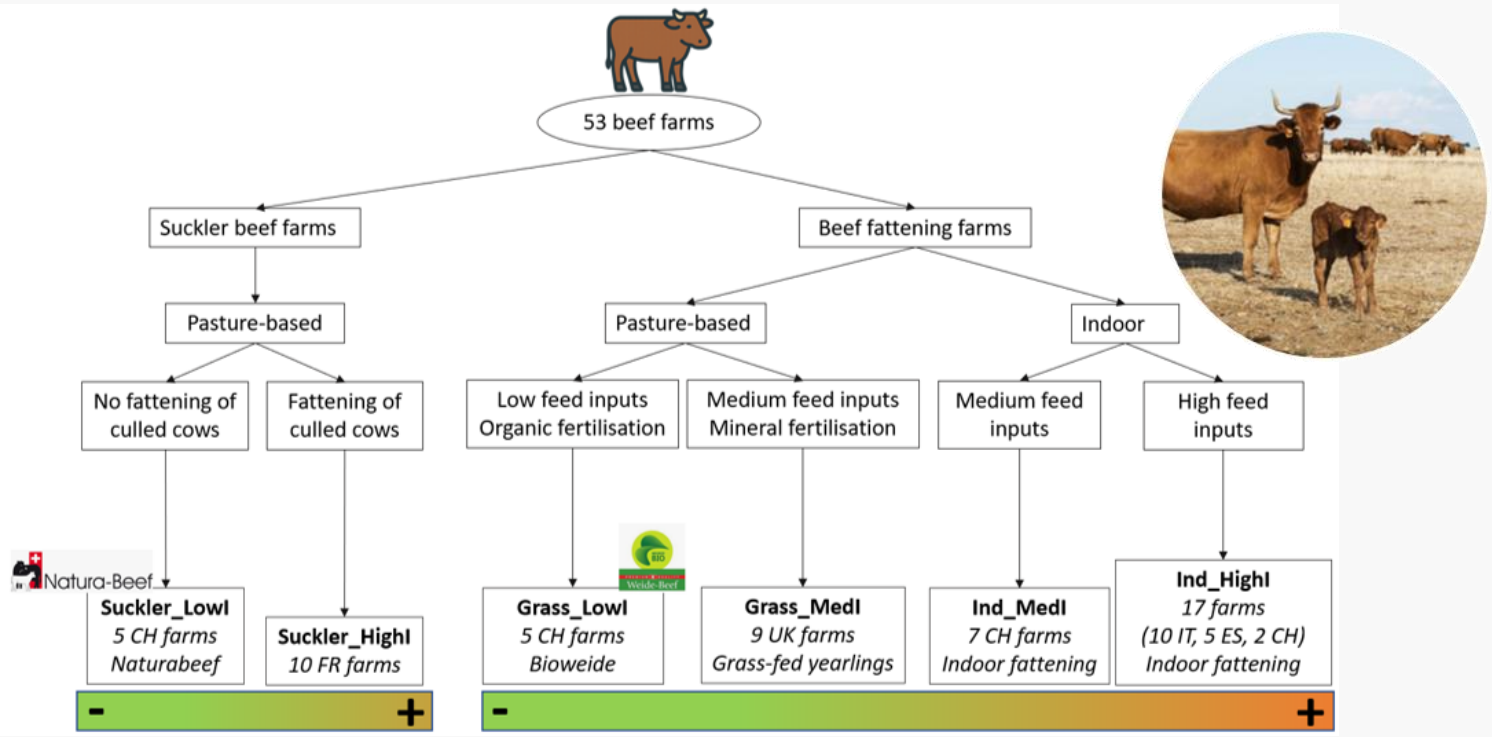

Fig. 2: Typology of beef samples along a gradient of intensification

All beef liver samples were analysed for **heavy metals**, which showed differences between locations, farm practices, feeding backgrounds and in typologies, especially in cadmium, copper (Fig. 3) and nickel. **Mycotoxins** were detected, again at relatively low concentrations. Analyses could not prove a clear connection between the type of farming and the amount of persistent organic pollutants in the liver of beef (**dioxins, furans, PCB, PFAS**). All beef meat samples were negative for the detection of ***Escherichia coli*** O157 H7 and other shiga toxin *E. coli* strains.

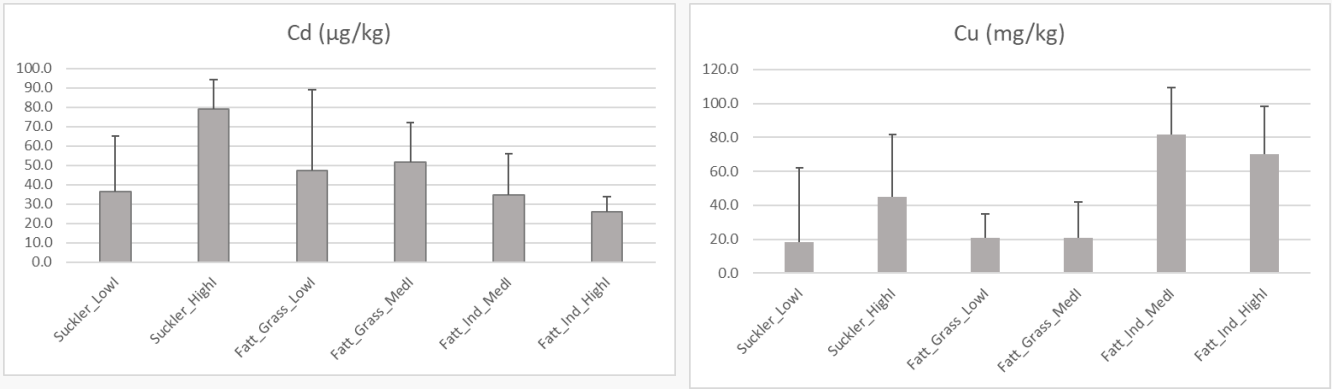

Fig. 3: Results of cadmium (Cd; in µg/kg) and copper (Cu; in mg/kg) for beef liver (n=5-24 depending on typology)

Measuring product safety in dairy samples

In total, 81 farms were sampled for the dairy value chain by collecting 394 tank milk samples over a span of around 2 years to obtain representative samples from the grazing season in summer and the winter indoor season. Two areas of intensification were considered for dairy: the inputs to animals (for example amounts of concentrates or silage maize) and the inputs to cultivated land used for feed production (for example nitrogen fertilizer or pesticides) (Fig. 4).

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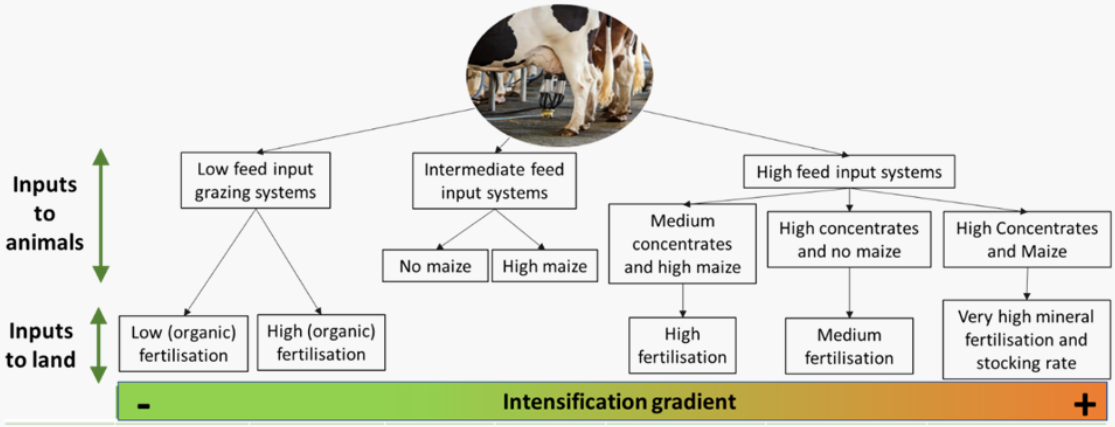

Fig. 4: Typology of milk samples along a gradient of intensification

For **heavy metals** (chromium, nickel, arsenic, cadmium, mercury, lead, iodine) certain differences were found between locations, farm practises and feeding backgrounds, but none of the samples surpassed the limits established by EFSA as safe for human consumption. The quantification of 72 **mycotoxins** and 38 **plant toxins** in milk showed traces of Aflatoxin M1 in samples from the farms using the highest amounts of maize silage and concentrates, but no samples surpassed the maximum level (Fig. 5). Other toxins showed no unexpected results.

None of the safety traits analysed in chicken, milk and beef samples surpassed the limits established by the competent health authority EFSA as safe for human consumption. All samples were either below the limit of quantification or were only found in relatively low concentration, which indicate, that the analysed products (liver in beef and chicken; milk) are safe for human consumption. No clear influence of farming system was found, thus, it can be concluded that there is no difference in the safety of food produced from more extensive or more intensive farming systems.

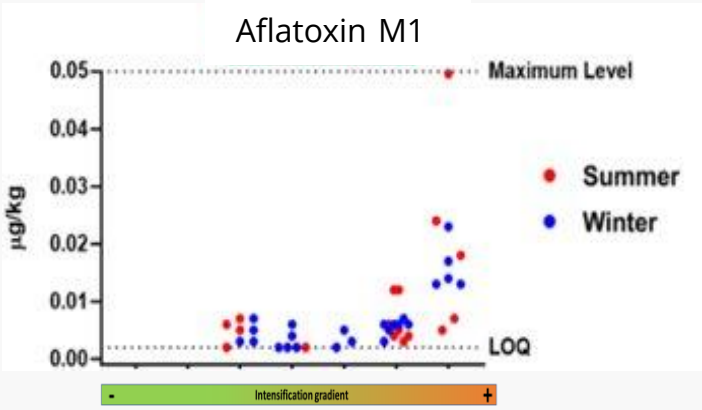

Fig. 5: Results of the mycotoxin Aflatoxin M1 in summer and winter tank milk (LOQ – limit of quantification)

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