

Nitrate surveillance: Discussion

Evaluation of 2021 Results

The samples collected in the 2021/22 period continue to follow trends illustrated in previous years. Of primary note is that nitrate levels remain low in leafy salad products, with the proportion of samples exceeding the corresponding threshold remaining below 5% since 2014. The proportion of samples exceeding regulatory thresholds has varied between crop types since 2014: open air iceberg and rocket have been at 0% for a several successive years, whilst levels in non-iceberg types and spinach have remained marginally higher. Protected non-iceberg types generally show higher concentrations compared with open air iceberg and non-iceberg types. These results continue to show trends from previous years which indicate that risk factors for elevated nitrate concentrations are associated with variety, season and production method.

Nitrate levels vary significantly between product type, with iceberg lettuce typically showing lower concentrations than non-iceberg types, although there is significant variation from within both groups. Previous authors have reported strong correlations between variety and nitrate concentration (indicating that certain varieties may have an increased predisposition for accumulating excessive nitrate concentrations), although this may be linked to a range of other factors. Madar & Hájos (2021) noted that higher nitrate concentrations were seen in those varieties with dark leaf colour (e.g. Romaine) compared with light varieties (e.g. Lolla Bionda), indicating that greater chlorophyll concentration was linked with greater nitrate accumulation. Other factors such as differing dry matter accumulation (and achieved water content) may also impact the achieved nitrate concentration - Dapoigny et al. (2000) also reported that there was a strong correlation between nitrate content and water accumulation in lettuce, so it is likely that climate conditions (e.g. temperature and rainfall) would interact with varietal predispositions for high levels of nitrate accumulation.

Besides the influence of variety it is indicated that planting date will also have a significant impact on nitrate accumulation risk.

Behr & Wiebe (1992) reported that nitrate content in lettuce increased with lower rates of photosynthesis seen under reduced temperatures. They hypothesised that increased nitrogen concentrations were seen in plants that achieved lower levels of accumulated sugars (as a result of lower rates of photosynthesis) to act an osmoticum to help plants balance water uptake and cell turgidity. However, it is difficult to separate out the ability of plants to convert nitrates to amino acids under conditions where there are reduced rates of photosynthesis.

The impact of temperature, rainfall and light levels reflects a further continuation a trends seen in seasonal variation in nitrate concentrations. Nitrate concentrations are generally lower in the late spring/early summer period, with levels increasing in the late summer through to early autumn. As discussed in previous reports this may be an artifact of the cultivation process, with later crops being grown with greater soil N availability due to the carry over of residues from early crops. However, there is also likely to be some interplay between nitrate concentrations and climate conditions, particularly light levels in the 5-15 days before harvest (Weightman et al., 2006; Roques & Weightman, 2010).

Weather in late winter in January/February 2021 saw extended periods of wet weather, with early plantings of lettuce and early brassica crops planted in brief dry periods in March. Leafy salad

crops were also subject to low temperatures, with some crops being lost to late frosts in the East although conditions were generally cool in the spring. While the summer had higher temperatures, frequent rain ensured damp conditions particularly in the south where some crops were subject to flooding. Given the climate conditions in 2021, particularly the overly damp conditions, there is potential that the increased proportion of samples exceeding the threshold in 2021 relative to 2020 was seen.

This is likely to also interact with varietal effects - differing nitrate concentrations were seen in summer-grown vs. winter grown samples even within the same cultivar group (Escobar-Gutierrez et al., 2002). Given the potential impact of temperature, sunlight and soil moisture it is likely that environmental impacts are likely greater in significance compared to varietal choice – especially given that a broad range of cultivars were sampled in both periods to ensure that the diversity of variety choice is represented in the figures reported.

Overall, these data continue to contribute to a wider body of evidence that could be further examined to identify key risk factors associated with elevated nitrate concentrations.

Future Perspectives

Leafy salad production in the UK is currently subject to a several influences which may have an impact on nitrate levels both in 2021/22 and looking forward to further sampling years. Plantings of iceberg-type lettuce have been reduced since the onset of the covid-19 epidemic, particularly as a result of declines in the food service sector and increased popularity of bagged salad products. As growers increase proportions of non-iceberg types in cultivation this may feed forward into increased incidences of level exceedance given the predisposition of these varieties to accumulate nitrates to greater concentrations relative to iceberg.

In addition to changing consumer behaviour, the sector is becoming subject to increased prices in fertiliser and energy. Increased fertiliser prices as a result of the Ukrainian conflict are unlikely to lead to reductions in application, but growers may change how they are applying fertiliser to their crops which may in turn impact nitrate concentrations at harvest. Energy prices are likely to have an impact on overwintered protected production as growers may keep crops cooler or delay planting due to high costs of heating that will be incurred as a result of elevated gas prices. Given the potential relationship between temperature, light and nitrate accumulation this could feed forward into changes in recorded nitrate concentrations.