4.3 Starch composition and physicochemical properties

Nitrogen supply can alter the proportion of amylose and amylopectin in sweet potato storage roots, but the response differs markedly among genotypes. In Jishu 25, for example, the highest amylose content was observed under 150 kg N/ha (N2), whereas the lowest value occurred under the zero-nitrogen treatment (Duan et al., 2019). Guo et al. (2020) evaluated nine sweet potato cultivars with different flesh colors and found that increasing nitrogen application reduced amylose content in the yellow-fleshed cultivar Sushu 16. In contrast, amylose content increased in the white-fleshed cultivar Sushu 29 and in the purple-fleshed cultivars Ningzishu 1 and Ningzishu 4, while no significant changes were observed in the other cultivars. Overexpression of IbVP1 increased total starch content by 20%-32% and amylose content by 27%-32% through the upregulation of AGPase and GBSSI (Fan et al., 2021). In addition, SnRK1 can increase total starch content through coordinated upregulation of genes involved in the starch biosynthetic pathway, while reducing the proportion of amylose and increasing starch granule size (Ren et al., 2019).

Nitrogen treatment can also influence starch granule size, pasting viscosity, and thermal properties, although the responses are not consistent among cultivars. In Jishu 25, nitrogen application had no significant effect on the starch granule size distribution parameters D[v, 0.9], D[4,3], and D[3,2] (Duan et al., 2019). By contrast, starch granule size decreased with increasing nitrogen application in Ningzishu 1, Sushu 28, and Sushu 29 (Guo et al., 2020). In Jishu 25, the 75 kg N/ha treatment produced a relatively high setback viscosity, whereas the 150 kg N/ha treatment increased peak viscosity, final viscosity, and setback viscosity. However, starch gelatinization temperature and pasting properties remain strongly dependent on cultivar and genetic background and cannot be attributed simply to nitrogen application rate. Likewise, starch crystalline structure and gelatinization enthalpy did not change substantially in different cultivars in response to nitrogen treatment. Overexpression of *IbVP1* can further affect starch structure, composition, and physicochemical properties by altering carbon metabolic flux and the expression of genes involved in related pathways (Fan et al., 2021).

5 Molecular and Metabolic Mechanisms Underlying Nitrogen Regulation of Storage Root Development and Starch Formation

5.1 Nitrogen sensing and signal transduction pathways

Roots must first recognize and absorb inorganic nitrogen. Twelve members of the IbAMT family have been identified in sweet potato. In a two-year experiment with nitrogen application rates of 0, 60, 120, and 180 kg N/ha, Meng et al. (2023) found that the 120 kg N/ha treatment generally resulted in relatively high expression levels of *IbAMT1.3* and *IbAMT1.5*, together with greater storage-root nitrogen content, nitrogen uptake efficiency, number of storage roots per plant, storage-root weight, and yield. The expression levels of these two genes were also significantly and positively correlated with nitrogen content in the storage roots. These results suggest that ammonium transport is not simply an uptake process, but is also closely associated with nitrogen utilization and storage-root formation.

Similar evidence has been obtained for nitrate nutrition. Duan et al. (2024) found that Jishu 26 and Xushu 32 responded differently to 0, 4, 8, and 16 mmol/L NO_3^-. High nitrate supply increased the expression of genes such as *NRT1.1*, *NR2*, and *NiR2*. However, the nitrogen-sensitive cultivar Jishu 26 simultaneously allocated more nitrogen to leaves and growing points and showed stronger negative responses of root length and root surface area to high nitrogen. These results illustrate that greater nitrogen uptake does not necessarily lead to better growth or storage-root production.

Within nutrient-signaling networks, relatively direct functional evidence is available for *SnRK1* in sweet potato. Alteration of *IbSnRK1* activity affects sugar metabolism, the starch-synthesizing enzyme system, and ultimately starch-related traits. The role of TOR, however, should be interpreted more cautiously. Based on current studies of nitrogen regulation and storage-root development in sweet potato, direct functional evidence linking TOR to specific nitrogen application levels, storage-root formation, and starch yield remains limited (Ren et al., 2024). TOR is therefore better regarded as a nutrient-signaling node that requires further experimental validation rather than as an established component of nitrogen regulation in sweet potato.