Towards controlled lipid content in cereal starches

Our project set out to select European corn cultivars with the right kernel vitreousness for producing cornmeals geared to breakfast-cereal manufacture (cornflakes). Our research has shown that starch–lipid complexes, along with storage proteins, make excellent markers of corn endosperm (the seed's storage tissue) vitreousness. Here we studied the source of these lipids and the expression of the genes involved over the course of corn kernel endosperm development.

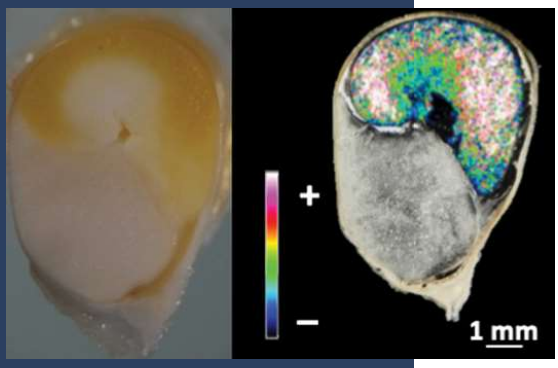
► RESULTS

Unlike starch from tubers and pulses (potatoes, beans, peas, and so on), cereal starches contain endogenous lipids, including a 1-acyl-group phospholipid called lysophosphatidylcholine (LysoPC). Although light in quantity (0.5–1% of dry-weight starch), this lipid, complexed deep inside amylose helices, has a heavy impact on the functional and nutritional properties of the starch.

Using matrix-assisted laser desorption/ionization–time-of-flight (MALDI-TOF) mass spectrometry imaging, we were able to specifically detect and quantify the LysoPC trapped in starch granules in sections of corn endosperm. This novel methodological development enabled us to show that the starch mostly traps the molecular species of LysoPC containing saturated fatty acids (chiefly palmitic acid). Furthermore, it revealed decreasing gradients in starch LysoPC concentrations from the periphery to the centre of developing maize endosperm. This gradient coincides with the gradients of storage protein accumulation and corn vitreousness. By coupling the MALDI imaging data with the spatiotemporal expression of genes involved in lipid metabolism in the developing seed, we were able to forge a scenario connecting lipid trafficking in the endosperm, storage protein biosynthesis, and lipid deposition in the starch. This scenario is tightly associated to the programmed cell death that characterizes endosperm development in corn and in cereal grains in general.

► FUTURE OUTLOOK

These findings set the stage for potential new strategies—on the farming practice front and on the varietal selection front (nitrogen nutrition, resistance to environmental stressors)—for controlling the lipid content of cereal-crop starches.



MALDI mass spectrometry imaging

Participants

This research was led by the INRA–BIA unit in tandem with the BIBS platform (Hélène Rogniaux, Mathieu Fanuel) as part of a PhD thesis by Mathieu Gayral and in collaboration with Limagrain (one-time cross-ministry funding package [*FUI*] GranoFlakes).

Read more

The spatiotemporal deposition of lysophosphatidylcholine within starch granules of maize endosperm and its relationships to the expression of genes involved in endoplasmic reticulum-amyloplast lipid trafficking and galactolipid synthesis
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