

New feeding strategies based on high-carotenoid and ketocarotenoid maize

Areas: Agriculture, Biotechnology, Animal Disease Control, Nutrition

Collaboration Opportunity: Available to license

Summary: A team of researchers at the University of Lleida, led by Dr. Paul Christou designed and produced genetically engineered (GE) varieties of maize, enriched in nutritionally important antioxidants. Particularly, extraordinary levels of carotenoids (β -carotene, lycopene, zeaxanthin and lutein) are present in Carolight™ corn and in second hybrid corn NSL76xBKT also rich in astaxanthin.



Feeding poultry, salmon, rainbow trout, etc. with these enriched crops may lead to specific benefits related to the increased intake of bioavailable antioxidants. For example, poultry raised on Carolight™ are healthy and show higher **resistance to coccidiosis**, due to substantially lower prevalence of pododermatitis and ulcers, and lower excretion of pathogen oocysts in feces. Moreover, carotenoids accumulate in several tissues (skin, dermis, muscles and fat), conferring **high nutritional value** and higher consumer preference. In another potential application, rainbow trout fed with high ketocarotenoid corn has similar pigmentation to fish reared with commercial additives. The same effect is seen in **eggs with strong golden yolk** when compared to eggs laid by hens reared on commercial additive-enriched feed.

Need: Poultry and fish producers have to include costly pigment supplements in feed preparations in order to meet consumer's preferences for meat/fish and eggs. These pigments can be obtained from different sources, but this increases the cost of production. Natural sources for carotenoids and ketocarotenoids are needed to address consumer preferences, and also to lower production costs. Different solutions can be provided for the poultry and aquaculture sectors with our methods based on engineered maize.

Market: Livestock obtain carotenoids from the diet since they cannot synthesize these products naturally. Carotenoid supplements are obtained from natural

sources (plant residues, industrial and post-harvest materials) or are synthesized chemically, and they increase the cost of production. The global carotenoid market size was valued at more than \$ 1.2 billion in 2015, and is likely to exceed \$ 1.6 billion by 2023, with estimated gains of more than 3.5% from 2016 to 2023. Beta-carotene is a mature market, fairly stable at about \$1 billion annually, worldwide and the natural beta-carotene sector commands two-to-three times the price of its synthetic counterpart. Moreover, most astaxanthin used in aquaculture (salmon, trout, and crustaceans) is of synthetic origin and only scarce biological sources are available. These sources are not sufficient to supply the global astaxanthin market, (ca: 300 tons per year).

Commercial Applications: Feed for poultry, salmon, rainbow trout, crustaceans, lobster, shrimp, and other animals with special carotenoid needs.

Additional pigment sources as food colouring agent or additive (i.e. confectionary).

Competitive Advantages:

- ✓ Cheaper and environmentally friendly strategy to deliver carotenoids and/or ketocarotenoids
- ✓ Applications as feed for poultry (hens) and feed supplement for rainbow trout, both validated in proof-of concept experiments.
- ✓ Exclusivity to commercialize as coccidiosis treatments adjuvant and yolk pigment
- ✓ Source of natural astaxanthin in aquaculture

Funding received: ERC Proof of Concept Grant (EU Funding)

Development status: concept validation

Intellectual Property:

1. Granted Spanish patents ES2340119, ES2558953, ES2501367
2. PCT filing PCT/ES2015/070435
3. Carolight - Registered Variety (Plant Breeders' Rights)
4. Literature cited:
 - C. Zhu et al (2008) Proc Natl Acad Sci USA 105: 18232-18237; doi: [10.1073/pnas.0809737105](https://doi.org/10.1073/pnas.0809737105)
 - C. Nogareda et al, (2016) Plant Biotechnol J 14: 160-168; doi: [10.1111/pbi.12369](https://doi.org/10.1111/pbi.12369)
 - JA Moreno et al., (under review)
 - Farre et al (under review)