

Sugarex[®]



**Improve performance and
productivity naturally**

Neohesperidin Dihydrochalcone (NHDC) more sustainable

Neohesperidin dihydrochalcone (NHDC) is an intensive sweetener and flavor enhancer, authorized as a food additive (E-959 for human nutrition and 2b959 for animal nutrition). It is obtained from neohesperidin, a natural compound belonging to the flavonoid group, characteristic of bitter citrus fruits.

Specifically, neohesperidin is a glycosylated flavonoid derived from hesperetin, a flavanone that constitutes the aglycone, or non-sugar portion, of neohesperidin.

While neohesperidin and naringin are primarily responsible for the bitter taste of fruits such as bitter orange (*Citrus aurantium*) and grapefruit (*Citrus paradisi*), their controlled transformation results in a molecule—neohesperidin dihydrochalcone—with exceptional sweetening power, between 1,500 and 1,800 times sweeter than sucrose. It is also notable for its strong synergy and additional properties, including flavor enhancement, offtaste masking, and antioxidant activity.

How is it produced?

NHDC production is based on the utilization of citrus-derived raw materials, primarily the peels obtained during juice processing, as well as directly from whole immature bitter oranges, which are rich in natural flavonoids such as neohesperidin and naringin. These plant fractions, once dried and milled, are used as raw material to extract and concentrate the bioactive compounds.

Through selective purification and concentration processes, a high-purity neohesperidin is obtained, which is subsequently transformed into NHDC under controlled conditions that guarantee the safety, stability and food quality of the final product.

The result is a highly pure white powder with a unique sensory profile: it enhances sweetness, softens bitter or metallic notes, and modulates the overall flavor of products. These properties make NHDC highly valued not only in food and beverages but also in animal nutrition, where it is used to improve the palatability of feeds and premixes, promoting better feed acceptance and thus contributing to improved nutrient utilization.

Furthermore, its production process is based on the use of renewable raw materials, circular economy principles, and has Upcycled® certification, thus positioning itself as a differentiated solution both for its effectiveness and for sustainable production and environmental commitment.

From a regulatory standpoint, NHDC is authorized for use in the European Union in piglets, fattening pigs, calves, sheep, fish, and dogs. Recommended dosages are up to 35 ppm in the EU and up to 15 ppm in the US, according to the AAFCO (Association of American Feed Control Officials).

Its thermal stability - including resistance to extrusion, pasteurization and UHT processes - along with its optimal performance in pH ranges 2–6, guarantee its functionality even under demanding processing conditions.

Sugarex®: Greater Palatability, Increased Intake, and Improved Productivity

Sugarex® is a range of premixed sweeteners from HTBA whose active ingredient is NHDC. Its use in animal nutrition has proven:

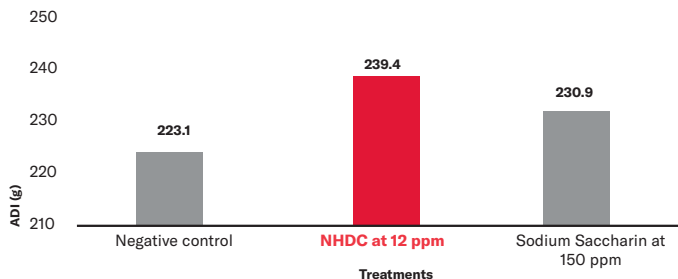
- ✓ Improve palatability.
- ✓ Increase intake.
- ✓ Promote productive parameters in piglets, fattening pigs, calves, sheep, dogs, and fish.



Proven effectiveness

Several scientific trials show that NHDC acts as a sensory enhancer capable of significantly increasing Average Daily Intake (ADI) and Average Daily Gain (ADG)¹.

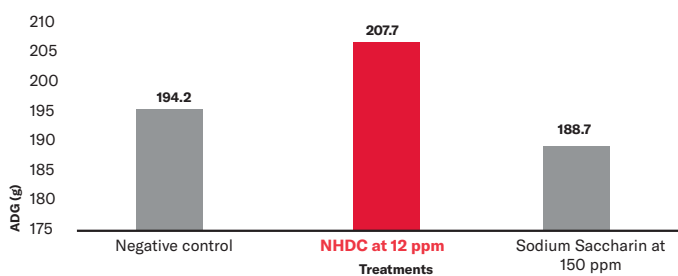
Average Daily Intake (ADI) in piglets 0-14 days post-weaning



There is a 7.3% improvement in Average Daily Intake (ADI) with NHDC compared to the control group, and a 3.7% improvement using our product compared to sodium saccharin at 150 ppm.

Source: SNIBA 2023¹

Average Daily Gain (ADG) in piglets 0-14 days post-weaning

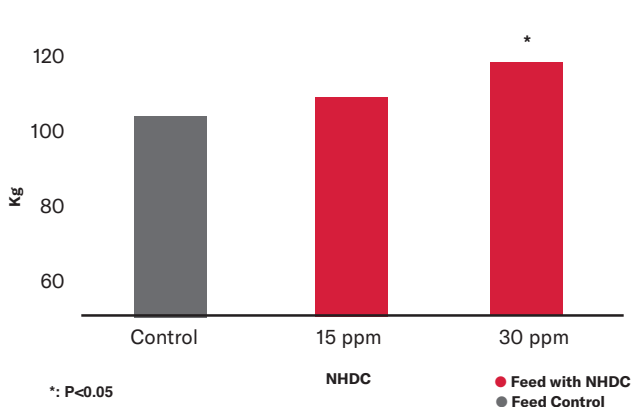


There is a 7% improvement in Average Daily Gain (ADG) with NHDC compared to the control group, and a 10% improvement using our product compared to sodium saccharin at 150 ppm.

Source: SNIBA 2023¹

Moreover, trials conducted in calves confirm a direct correlation between NHDC dosage, feed intake, and weight gain.²

Feed intake in calves



*: P<0.05

NHDC

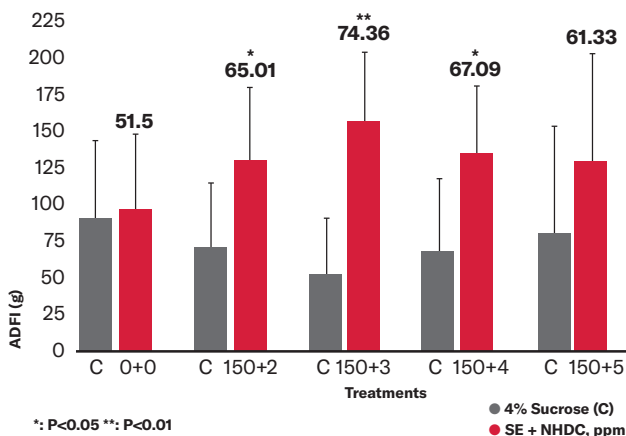
● Feed with NHDC
● Feed Control

At 30 ppm, statistically significant differences were observed compared to the control. This positive response is associated with the sweet-tasting effect, which, even at very low levels in the final mixture, is sufficient to stimulate consumption.

Costa-Batlioni 1994²

NHDC also exhibits strong synergy with stevia extracts (SE).³ Trials in piglets show that the combination of 150 ppm of stevia with 2–4 ppm of NHDC significantly increases preference compared to control diets containing sucrose, while smoothing the characteristic aftertaste of stevia. This synergistic effect makes NHDC and stevia extract-based **Sugarex**[®] premixes stand out as sensory modulators in flavoring agents and starter feeds.⁴

Feed intake and % preference for different diets of piglets including NHDC and stevia extracts (SE).



*: P<0.05 **: P<0.01

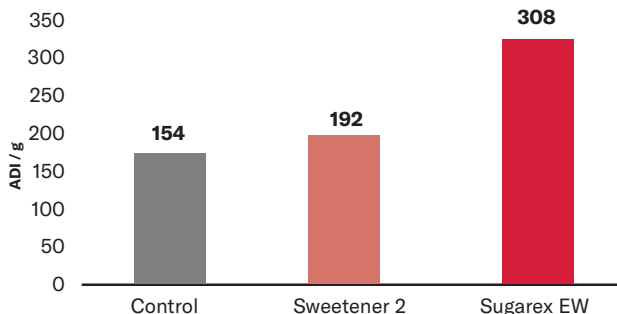
● 4% Sucrose (C)
● SE + NHDC, ppm

The combination of 150 ppm of stevia with 2–4 ppm of NHDC significantly increases preference over sucrose control diets, softening the residual notes characteristic of stevia.

Source: Blavi et al. 2015⁴

When compared to other commercial sweeteners, **Sugarex**[®] demonstrates greater preference. Trials at the same dose (150 ppm) show that animals more consistently select feed containing **Sugarex**[®], far surpassing the acceptance of market alternatives. This result is linked to its homogeneous particle size, greater stability during processing, and a more balanced sensory release.

Sugarex vs. Commercial Sweetener



Trials at the same dose (150 ppm) show that animals more consistently select feed with Sugarex[®].

Source: Commercial Test 2003⁵

Green chemistry that makes a difference

While other producers of NHDC use naringin and isovanillin (of petrochemical origin) as raw materials, resulting in the generation of significant byproducts or waste, such as salts, unincorporated solvents, or unwanted secondary compounds, at HTBA we obtain neohesperidin directly from the natural flavonoids present in unripe bitter oranges that fall from the tree during the agricultural cycle, avoiding waste and generating value from an agricultural byproduct. These fruits undergo aqueous extraction processes and are integrated into a circular economy model where organic waste is transformed into compost and other byproducts are used as an energy source.

The Upcycled® certification guarantees the use of recycled raw materials, while carbon analysis shows that 100% of the carbon present in the molecule comes from plant sources, unlike other NHDCs on the market that use petrochemical precursors such as isovanillin.

Furthermore, applied green chemistry allows for the reduction of reaction steps, decreased use of solvents, and minimized waste, achieving 100% atomic economy, which means that no byproducts or waste are generated.

Overall, **Sugarex®** premixes based on NHDC of 100% plant origin are positioned as highly effective sensory ingredients, supported by field trials and scientific studies, and produced through sustainable practices aligned with current environmental standards. Their combination of technical performance, stability, versatility, and sustainability criteria makes them an essential tool for formulators seeking to improve productivity while respecting the principles of the circular economy and environmental responsibility.

- ✓ Upcycled® Certification: guarantees the use of valorized raw materials.
- ✓ 100% of the carbon present in the molecule comes from plant-based sources, with no petrochemical precursors.
- ✓ 100% atom efficiency thanks to the use of green chemistry, reducing reaction steps, lowering solvent use, and minimizing waste.

Competitors

- ✓ Manufactured using petroleum-derived byproducts: the naringin molecule is broken down and isovanillin—derived from petroleum—is added.
- ✓ Greater number of chemical steps.
- ✓ Increased use of solvents and reagents.
- ✓ Higher energy consumption.
- ✓ Limited use of renewable raw materials.
- ✓ Atomic economy: 83%.

HTBA Green Chemistry

- ✓ Neohesperidin is extracted from immature (“baby”) oranges and the molecule is subsequently hydrogenated.
- ✓ Fewer chemical steps.
- ✓ Reduced use of solvents and reagents.
- ✓ Lower energy consumption.
- ✓ Use of renewable raw materials.
- ✓ Atomic economy: 100%.

References

- 1: SNIBA 2023 trial “Dose response effect of NHDC supplementation in weanling diets for pigs”.
- 2: Costa-Batllo, P. 1994. Neohesperidin Dihydrochalcone (NHDC) as sweetener in feedstuffs for calves.
- 3: Schiffman, S.S., Booth, B.J., Carr, B.T. and Losee, M.L. 1995. Investigation of synergism in binary mixture of sweeteners.
- 4: Blavi, L., Solà-Oriol, D., Crespo, J., Serra, M. and Pérez, J.F. 2015. Neohesperidin Dihydrochalcone increases stevia preference in young piglets.
- 5: Field trial on a commercial farm, 2003.

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