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AMFEP Information sheet

Contribution of enzymes to reduce emissions - Feed applications

Enzymes are used in a variety of industrial and professional applications such as food & beverage, animal nutrition, detergents and/or textile production. They support and accelerate a number of bio-chemical reactions that drive environmental efficiency across many diverse EU sectors, in small to large companies.

The present document highlights the sustainability benefits of enzymes implementation when used in animal nutrition, to help release essential nutrients from the ingredients composing the feeds formulated for animals.

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1 From technical roles to sustainability assets

The function of enzymes in feed applications mainly consist in enhancing the digestive process done by animals, by cleaving feed substrate into smaller pieces, unleashing energy, minerals or protein for the animals. Feeds are made of cereals, pulses and legumes seeds as well as of by-products from starch or oil industries, to name the most important ones. Diverse enzymes exert diverse targeted effects on the feed matrices (in alphabetic order):

- **Amylases** release sugars from starch. It helps extracts energy from cereals making it available for milk production, for example. With the same amount of feed, added with amylase the cows can produce more milk, thereof reducing the carbon footprint of dairy products.

- **Cellulases and hemicellulases** (xylanses, glucanases, mannanase,…) help digest the macro molecules of arabinoxylan or glucans or mannans, which are major carbohydrate constituents of plants. These carbohydrases are essential aids for enhancing the energy value of cereal components in monogastric diets. Supplementing pig and poultry diets with Xylanases and/or glucanases and/or mannanases allow producing more with the same quantity of raw material, thereof reducing the overall carbon footprint of animal products.

- **Phytases** increases phosphorus availability in feed ingredients. They allow sparing the addition with mineral phosphate, to meet animal requirements for phosphorus. The valorization of plant phosphorus instead of the resorting to poorly available mineral phosphorus allow reducing drastically the eutrophication impact of livestock production.

- **Proteases** release amino acids from proteins present in plants. In feed formulation, they allow minimizing the resorting to imported soya bean meals and reducing the total amount of nitrogen in the feed. Thereby reducing the land use and eutrophication related impacts.

Enzymes are a special class of proteins produced either by fermentation of microorganisms or by extraction from animal or plant tissues. Enzymes are required by all living organisms, including humans, to conduct the physiological processes essential for growth and life. They act as catalysts that speed up the rate of specific chemical reactions.

All enzymes are readily biodegradable - only needed in very low concentrations to be effective. They generally exhibit no specific environmental toxicity Industrial enzymes have an excellent safety profile, with little ability to cause adverse responses in humans and in the environment and those risks are controlled. For detailed information about enzymes and their technical, food and animal feed uses, see here About enzymes: definition, how they work and more - AMFEP

Some enzymes also allow enhancing the quality of feed by reducing their load in mycotoxins (toxic metabolites from fungi proliferation on agricultural commodities grown and stored in non-optimal conditions).

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- **Fumonisin esterase** cleaves the fumonsin (a mycotoxin) in innocuous fractions and release the feed from the toxicity of the mycotoxins. The usage of fumonisin esterase allows securing the feed and supporting the gastro-intestinal health of the animals consuming it.

2 The assets of enzymes for sustainable livestock production

Supplementing feed with digestive enzymes help abate different environmental impacts of animal production, from climate change to water quality. As digestibility enhancers, enzymes enable valuing an extending set of by products in animal feeding, and by doing so contribute to circular economy. Enzymes are designed towards an efficient use of resources.

The LEAP initiative (Livestock Environmental Assessment and Performance) engaged by the UN FAO (Food and Agriculture Organization) worked out a set of globally applicable guidelines of how to measure the environmental footprint of livestock. The LEAP specifically developed a guidance to account for the contribution of feed additives (1), such as enzymes. This set of guidelines has been developed in full coherence with the European PEF (Product Environmental footprint) approach, especially when it comes to feed assessment (2).

2.1 Abate the carbon emission of animal production

Feed efficiency. Enzymes enhance the nutritive value of the feed, by enhancing its digestion. Thereof less quantity of feed is needed to achieve the same production performance, and/or animals reach faster their targeted weight. The mild but consistent improvement of feed efficiency, which is pivotal to determine the product carbon footprint of animal products (20, 3**Error! Reference source not found.**), allows diminishing the carbon impact of animal production, by the same extent as the efficiency improvement (17, 5, 13, 6, 14).

By-products. Furthermore, enzymes allow valuing feed ingredients that have notable low carbon emissions because they are derived from the circular economy (9, 16). Such ingredients, known as by-products, are typically issued from the cereal industry (starch, milling,….) have their nutritive value greatly enhanced by enzymes. Their implementation in animal nutrition is supported by the use of feed enzymes and enable decreasing the carbon footprint of animal products (5,6).

Land Use. Enzymes also allow resorting to feedstuffs that have lower carbon emissions than others. This is the case for protease which allows valuing European grown protein meals (sunflower, rapeseed) thus repealing some of the soya meals having a high carbon because of a sizable land use change impact (8, 15, 19).

2.2 Reduction of water pollution

Phosphorus management. The nowadays systematic use of phytase in pig and poultry diets allows major reduction in eutrophication related impacts. Phytases allow substituting plant phytic

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phosphorus to mined mineral phosphorus. They enable a reduction of phosphorus input into farm systems, without compromising productivity and consequently phytases reduce phosphorus waste in manure and the related water eutrophication (4, 12, 13), in absence of sufficient absorption by the soil.

Nitrogen management. While phytases were designed to cleave the phytic phosphorus, an extended corpus of studies also establish that the enzymatic action is also releasing some protein compounds in the plant-based feedstuffs. Thus, phytases also spare nitrogen input into farm system, thereby reducing nitrogen waste in manure and the related water eutrophication, in absence of sufficient absorption by the soil.

Pollution prevention. The Directive which regulates, in EU, the pollution from industrial installations (IED), released in 2010 and now up for revision, is referring to enzyme feeding in the 2017 text focusing on livestock production (DECISION (EU) 2017/302), among other measures. The resorting to phytase and protease is specifically quoted as best nutritional management techniques for pollution prevention at the source.

2.3 Reduction of gaseous emissions

Ammonia reduction. The use of proteases allows reducing the protein level of the feed thereby reducing nitrogen excretion. Nitrogen excretion correlates directly with ammonia emissions from manure in absence of corrective systems such as air scrubbers.

2.4 Negligible footprint for enzyme use

Enzymes are active at very low dose, allowing 'doing more with less'. Less than a gram per kg feed suffices to deliver the effect. For reference, an inclusion rate of 0.01% is considered for phytase in the product environmental footprint (PEF) reference feed (**Error! Reference source not found.**). With such a low inclusion rate of , enzymes, as feed additives' have a negligible contribution to the PEF of animal products (22). With a negligible contribution and significant benefits, enzymes have a high return on investment, environmentally wise.

Enzymes are proteins which are readily biodegradable. They target their effect in the digestive tract and do not appear as residue in animal products nor in manure. Their life cycle ends in the digestive system of the animals, yet with carried over benefit for animal production.

3 Contribution to sustainability ambitions

3.1 Green Deal

Implementation of enzymes in animal nutrition supports

- The reduction of carbon emissions from livestock production [Farm to Fork, Climate law]

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- The reduction of nutrient leakage and thereof soil health and pollution control [Zero Pollution, Reduce by 50% nutrient losses, Limit Ammonia emissions]
- The resorting to an extended set of feedstuffs [Circularity Action plan]

3.2 Sustainable development goals

Implementation of enzymes in animal nutrition supports

- SGD2 [Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture] because enzymes in animal nutrition contribute to ensure sustainable food production systems by supporting productivity and production while protecting ecosystem through sparing nutrient leakage in areas with intensive livestock production [Target 2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality]
- SGD14 [Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development] because enzymes in animal nutrition contribute to spare nutrients leakages (P and N) and eutrophication in the water courses. [Target 14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution]
- SDG 12 [Goal 12. Ensure sustainable consumption and production patterns] because enzymes in animal nutrition contribute to
    - an efficient use of natural resources [Target 12.2: By 2030, achieve the sustainable management and efficient use of natural resources] and
    - support the re-cycling of food by products [Target 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses]
- SDG13 [Goal 13. Take urgent action to combat climate change and its impacts] because enzymes in animal nutrition contribute to the reduction of the carbon footprint of animal products

4 Enzymes are essential sustainability enablers for the feed industry

Enzymes are used for decades in the feed industry. They became essential to nowadays users for the technical performance they deliver, sparing raw materials and nutrients leakage, and adding quality traits to the feeds.

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They will become further critical for an extended number of feed producers to improve their environmental footprint and the one of the livestock production. Such improvement will happen, be it from a regulation push or from a consumer pull, be it in Europe or in other part of the world.

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