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NATURAL VITAMINS IN ORGANIC LIVESTOCK

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SUMMARY

Vitamins are organic compounds essential for animal health and performance. Conventional farming uses synthetic vitamins to fulfil livestock requirements because they are cheaper and usually more stable than those from natural sources. The European regulation for organic livestock production indicates that vitamins in animal feed should correspond to those naturally occurring in feedstuff, with some exceptions to assure animal health. They also allow the use of algae and food industry by-products, which are relevant sources of vitamins and antioxidant compounds. Economically relevant by-products in the Mediterranean area are those from the olive oil, citrus, wine, and carob food industries. Based on scientific evidence from several research trials, the use of these products is a reasonable alternative to the use of synthetic vitamins to assure adequate vitamin intake of livestock and to ameliorate animals' oxidative status. However, there is very little information on the vitamin content characterisation of these products and very few studies have evaluated their impact on animals' performance and products such as milk, meat and eggs. This document briefly summarises the results available for this topic.

INTRODUCTION

Some vitamins must be included in animal diets and are considered dietary essentials, but the microbiota of some animal species are able to synthesise some of them at a sufficient level for them to be absorbed directly from the animals' gut mucosa surface. Thus, nutritional requirements differ between species. For instance, rumen microbiota in healthy adult cattle are able to synthesise adequate amounts of vitamin C and many B vitamins, fulfilling cows' requirements for those vitamins[1].

What does the European legislation say?

The origin of those vitamins that can be used in organic livestock production is regulated by Regulation (EU) 2018/848 of May 30th 2018. It establishes that animal diet supplementation with vitamins should correspond to those naturally occurring in feedstuff. However, it does allow for monogastrics to be given synthetic vitamins identical to natural vitamins; and for ruminants, the use of synthetic vitamins A, D, and E identical to natural vitamins with prior authorisation of the Member States, based on the assessment of the impossibility for organically raised ruminants to obtain the necessary quantities of the said vitamins through their regular feed. Also listed in Annex VIII are the food additives that could be

used in organic livestock farming, such as extracts from plants and products of animal origin. In Annex V, non-organic feed materials that could be used under certain conditions, which include food industry by-products from non-organic production, are listed. Important by-products in the Mediterranean region are those from the olive oil, citrus, wine, and carob food industries.

Why use food industry by-products?

The possibility of using food industry by-products opens a door to the philosophy underlying environmental sustainability and organic farming. Industry waste can be reduced, low value product are given a higher value – both from an economical and nutritional point of view –, carbon footprint is reduced by using local waste products, as well as the feed to food competition in livestock production[2]. However, food industry by-products have so far been investigated more for their potential in energy production than for their use as animal feed or diet additives[2].

BY-PRODUCTS AS VITAMIN ALTERNATIVES

Algae contain α-tocopherol (Vitamin E fraction), β-carotene (Vitamin A precursor), niacin and thiamine (Vitamin B-complex), and Vitamin C; and by-products have Vitamin C, α-tocopherol and carotenoids. Moreover, they are rich in polyphenols which have antioxidant properties and can simulate and enhance the antioxidant activity of Vitamin A, E and C, apart from exerting a sparing effect on them. **Table 1** summarises the animal species from which the effect of food industry by-products has been studied.

Table 1. Studies evaluating food industry by-products for use in animal feed.

By-product	species	n. of studies
Olive oil	cows, water buffalos, sheep, poultry, pigs, rabbits, fish	22 (50% of them in ruminants)
Citrus	beef, sheep	5
Wine	poultry	4
Carob	cow, lamb, pigs	6

Olive oil industry by-products

Olive groves (*Olea europaea* L.) are an important crop in the Mediterranean area which contains the world's 3 greatest olive producers. In 2017, 21 megatonnes of olives were produced globally (**Figure 1**)[3]. Of this total, 31% were from Spain, 13% from Greece and 12% from Italy. Almost all olives harvested are destined to produce oil.

The olive oil industry produces several by-products such as **olive oil mill wastewater**, **olive pomace**, **olive cake**, **olive leaves** and **olive stones**. Their chemical composition depends on the olive variety and the oil extraction method. In general, they have a low protein content but high energy, which could negatively affect animals' feed intake. Diet supplementation using some of these by-products has been evaluated in cows, water buffalos, sheep, poultry, pigs, rabbits and fish. The effect of supplementation with these by-products at a low level (<10%) resulted in an improvement in the fatty acid profile in milk and meat[4]. This

means a lower proportion of saturated than unsaturated fatty acids, usually without affecting animal productive performance. However, in rabbits it has also been reported to reduce feed intake as well as growth rate, carcass weight and dressing out percentage.

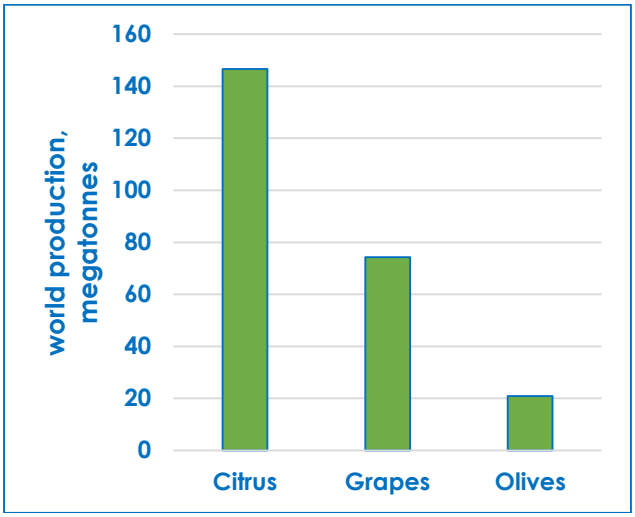

Figure 1. Citrus, grape and olive worldwide production in 2017. Data from FAOSTAT[3].

Citrus industry by-products

Citrus (*Citrus* spp.) are one of the most abundant fruit crops, with a worldwide production of 147 megatonnes in 2017 (**Figure 1**), with China (27%), Brazil (14%) and India (8%) the greatest producers[3]. About 18% of global citrus production is from Mediterranean countries[3].

The citrus industry produces a by-product named **citrus pulp** which comprises peel, pulp, pith and seeds. This by-product is rich in pectin and soluble carbohydrates; it has a high energy and a low protein content. This by-product has only been tested in lambs and beef. In lambs, it improved the meat fatty acid profile, meat oxidative stability and antioxidant status. In beef, it improved forage intake, digestion and ruminal pH.

Wine industry by-products

Grapes (*Vitis* spp.) are one of the most valued fruits in the world based on hectares cultivated and their economic value. Italy, France and Spain represent 24% of worldwide grape production (74 megatonnes in 2017; **Figure 1**), and are among the 5 greatest producers worldwide[3].

The wine industry produces a by-product named **grape pomace** which comprises skins, stems and seeds. The study of animal diet supplemented with grape pomace has focused on chickens showing its potential to reduce lipid oxidation of the meat during refrigerated storage. This is an important trait for the poultry industry because poultry meat is richer in polyunsaturated fatty acid compared with other species.

Carob industry by-products

Carob tree (*Ceratonia siliqua* L.) is a typical crop in the Mediterranean area. Carobs worldwide production in 2017 was 0.14 megatonnes, with the most productive countries being Portugal (31%), Italy (21%) and Morocco (16%)[3].

The processing of the pods produces **carob pulp** as a by-product. The carob pulp presents a high sugar content and low protein and fat contents. Moreover,

its fatty acid profile includes essential fatty acids for animal nutrition such as linoleic and α-linolenic acids. Diet supplementation with carob pulp has been investigated in cows, lambs and pigs showing an improved fatty acid profile of the meat; that is, a greater proportion of unsaturated than saturated fatty acid, and a reduction of n-6/n-3 ratio.

Conclusions

Algae, olive oil, citrus, wine and carob industry by-products contain Vitamin E and A's precursors, Vitamin C, some vitamins from the B-complex and polyphenols. Polyphenols have antioxidant properties and can simulate and enhance the antioxidant activity of Vitamin A, E and C. Although there is very little information on the vitamin characterisation of these products and their impact on animal performance and products. There is evidence that algae, olive oil, citrus, wine and carob industry by-products are a feasible alternative to the use of synthetic vitamins in assuring the adequate vitamin intake of livestock and to improve animals' oxidative status.

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TAKE HOME MESSAGES

- Food industry by-products seem a reasonable alternative to the use of synthetic vitamins to assure the adequate vitamin intake in livestock.
- By-products are rich in energy but have a low protein content.
- They enhance the antioxidant activity of Vitamins A, E and C.
- There is very little information available on the vitamin characterisation of by-products and their impact on animal performance and products.

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