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Assessment of the application for renewal of authorisation of PHYZYME® XP 5000 G/L (6-phytase) for chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, weaned piglets, pigs for fattening and sows for reproduction

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Abstract

PHYZYME® XP 5000 G/L is a feed additive that contains 6-phytase produced by a genetically modified strain of *Schizosaccharomyces pombe.* The applicant requested for the renewal of the authorisation for PHYZYME® XP 5000 G and L to be used as a feed additive in chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, piglets (weaned), pigs for fattening and sows. This scientific opinion concerns the renewal of the authorisation of the additive for those species. To support the request, the applicant provided evidence that the additive in the market complies with the conditions of the authorisation. According to the information provided by the applicant, no new evidence has been identified that would make the FEEDAP Panel reconsider the previous conclusions regarding the safety for the target species, consumer, user and environment. The application for renewal of the authorisation did not include a proposal for amending or supplementing the conditions of the original authorisation that would have an impact on the efficacy of the additive. Therefore, there was no need for assessing the efficacy of the additive in the context of the renewal of the authorisation.

Keywords: zootechnical additives, digestibility enhancers, phytase, safety, efficacy, poultry, pigs

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1. Introduction

1.1. Background and Terms of Reference

Regulation (EC) No 1831/2003[1] establishes the rules governing the Community authorisation of additives for use in animal nutrition. In particular, Article 14(1) of that Regulation lays down that an application for renewal shall be sent to the Commission at the latest one year before the expiry date of the authorisation.

The European Commission received a request from Danisco Animal Nutrition[2] for renewal of the authorisation of the product PHYZYME® XP 5000 G/L (6-phytase), when used as a feed additive for chickens, turkeys and ducks for fattening, laying hens, weaned piglets, pigs for fattening and sows (category: zootechnical additives; functional group: digestibility enhancers).

According to Article 7(1) of Regulation (EC) No 1831/2003, the Commission forwarded the application to the European Food Safety Authority (EFSA) as an application under Article 14(1) (renewal of the authorisation). The particulars and documents in support of the application were considered valid by EFSA as of 24 October 2016.

According to Article 8 of Regulation (EC) No 1831/2003, EFSA, after verifying the particulars and documents submitted by the applicant, shall undertake an assessment in order to determine whether the feed additive complies with the conditions laid down in Article 5. EFSA shall deliver an opinion on the safety for the target animals, consumer, user and the environment and on the efficacy of the product PHYZYME® XP 5000 G/L (6-phytase), when used under the proposed conditions of use (see Section 3.2.1).

1.2. Additional information

The additive PHYZYME® XP 5000 G/L is a preparation of 6-phytase produced by a genetically modified strain of *Schizosaccharomyces pombe* (ATCC 5233). EFSA issued two opinions which considered the safety and efficacy of the enzyme preparation when used in chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, piglets (weaned), pigs for fattening and sows, which included the assessment of the safety for the consumer, the user and the environment, as well as the safety aspects of the genetic modification (EFSA, 2006a,b). A third opinion was adopted regarding the use of a more concentrated form, PHYZYME®XP 10000 G and L (EFSA, 2008), and a fourth opinion on the extension of use of the additive for minor poultry species was adopted in 2012 (EFSA FEEDAP Panel, 2012a).

PHYZYME® XP 5000 XP G/L is authorised for use in chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, piglets (weaned), pigs for fattening and sows[3,4] and all avian species.[5]

The applicant requested the renewal of the authorisation for PHYZYME® XP 5000 G and L to be used as a feed additive in chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, piglets (weaned), pigs for fattening and sows.

2. Data and methodologies

2.1. Data

The present assessment is based on data submitted by the applicant in the form of a technical dossier[6] in support of the authorisation request for the use of PHYZYME® XP 5000 G/L as a feed additive.

[1] Regulation (EC) No 1831/2003 of the European Parliament and of the Council of 22 September 2003 on additives for use in animal nutrition. OJ L 268, 18.10.2003, p. 29.
[2] Danisco (UK) Ltd., trading as Danisco Animal Nutrition, PO Box 777, SN8 1AA Marlborough, UK.
[3] Commission Regulation (EC) No 785/2007 of 4 July 2007 concerning the authorisation of 6-phytase EC 3.1.3.26 (Phyzyme XP 5000G Phyzyme XP 5000L) as a feed additive. OJ L 175, 25.7.2007, p.4.
[4] Commission Regulation (EC) No 379/2009 of 8 May 2009 concerning the authorisation of a new use of 6-phytase EC 3.1.3.26 as a feed additive for chickens for fattening, turkeys for fattening, laying hens, ducks for fattening, piglets (weaned), pigs for fattening and sows (holder of the authorisation Danisco Animal Nutrition, Legal Entity Danisco (UK) Limited. OJ L 116, 9.5.2009, p.6. Holder of the Authorisation modified to 'Danisco (UK) Ltd, trading as Danisco Animal Nutrition and represented by Genencor International B.V.' by Commission Implementing Regulation (EU) 2019/221 of 6 February 2019.
[5] Commission Implementing Regulation (EU) No 840/2012 of 18 September 2012 concerning the authorisation of 6-phytase (EC 3.1.3.26) produced by *Schizosaccharomyces pombe* (ATCC 5233) as a feed additive for all avian species for fattening other than chickens for fattening, turkeys for fattening and ducks for fattening and all avian species for laying other than laying hens (holder of authorisation Danisco Animal Nutrition). OJ L 252, 19.9.2012, p. 14. Holder of the Authorisation modified to 'Danisco (UK) Ltd, trading as Danisco Animal Nutrition and represented by Genencor International B.V.' by Commission Implementing Regulation (EU) 2019/221 of 6 February 2019.
[6] FEED dossier reference: FAD-2016-0045.

The European Union Reference Laboratory (EURL) considered that the conclusions and recommendations reached in the previous assessment regarding the methods used for the control of the active substance are valid and applicable for the current application.[7]

2.2. Methodologies

The approach followed by the FEEDAP Panel to assess the safety and the efficacy of PHYZYME® XP 5000 G/L is in line with the principles laid down in Regulation (EC) No 429/2008[8] and the relevant guidance documents: Guidance on the renewal of the authorisation of feed additives (EFSA FEEDAP Panel, 2013), Guidance on zootechnical additives (EFSA FEEDAP Panel, 2012a,b) and Guidance on the risk assessment of genetically modified microorganisms and their products intended for food and feed use (EFSA GMO Panel, 2011).

3. Assessment

The additive PHYZYME® XP 5000 G/L is a feed additive that contains 6-phytase produced by a genetically modified strain of *S. pombe* (ATCC 5233). This additive is authorised for use in all avian species for fattening and laying, weaned piglets, pigs for fattening and sows. This opinion deals with the renewal of the authorisation of PHYZYME® XP 5000 G/L as a zootechnical additive (functional group of digestibility enhancers) for chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, piglets (weaned), pigs for fattening and sows.

3.1. Characterisation of the additive

The additive is authorised in solid, PHYZYME® XP 5000 G, and liquid, PHYZYME® XP 5000 L, forms.

The information submitted regarding the manufacturing process lists a series of modifications applied during the last years to the fermentation and the enzyme recovery process. [redacted] The Panel considers that these modifications do not have an impact on the final product and data regarding the characterisation supports this conclusion. The applicant declared that no antibiotics are used during the manufacturing process.[10]

PHYZYME® XP 5000 G contains the phytase (solids 1.4–2.1%), calcium propionate (0.1–0.3%), citric acid (0.2–0.8%) and wheat flour (up to 100%). The composition of this formulation is basically the same as the one previously related with minor modifications on the amounts used (e.g. citric acid from 0.4–1.0% to 0.2–0.8%). PHYZYME® XP 5000 L contains the phytase (solids 1.5–2.3% in the final additive), sorbitol (2–8%), sodium chloride (11–17%), sodium citrate (0.5–1.0%), sodium benzoate (0.1–0.2%), potassium sorbate (0.07–0.11%) and water.

The two formulations ensure a minimum guaranteed enzyme activity of 5,000 FTU[11]/g. The batch-to-batch variation was studied in three recent batches of each formulation. The mean enzyme activity in the PHYZYME® XP 5000 G was 6,198 FTU/g (range 5,969–6,637 FTU/g) and in PHYZYME® XP 5000 L was 6,343 FTU/g (range 5,890–6,902).[12]

Purity specifications for the two formulations include chemical compounds lead (≤ 5 mg/kg), cadmium (≤ 0.5 mg/kg), mercury (≤ 0.1 mg/kg) and arsenic (≤ 2 mg/kg) as well as absence of coliform)per gram of product), and absence of *Escherichia coli* and *Salmonella* spp. (negative in 25 mL). Compliance with these specifications was demonstrated in at least three recent batches of each formulation.[13] Purity data submitted included also information on mycotoxins; aflatoxin B1

[7] The full report is available on the EURL website: https://ec.europa.eu/jrc/en/eurl/feed-additives/evaluation-reports/fad-2011-0015

[8] Commission Regulation (EC) No 429/2008 of 25 April 2008 on detailed rules for the implementation of Regulation (EC) No 1831/2003 of the European Parliament and of the Council as regards the preparation and the presentation of applications and the assessment and the authorisation of feed additives. OJ L 133, 22.5.2008, p. 1.

[redacted]

[10] Technical dossier/Supplementary information June 2018/Annex II.3.

[11] FTU: one unit of phytase is defined as the amount of enzyme which liberates one micromole of inorganic phosphate per minute from a sodium phytate substrate at 37°C and pH 5.5.

[12] Technical dossier/Section II/Annexes II.1 and II.2.

[13] Technical dossier/Section II/Annexes II.3 and II.4 and Supplementary information June 2018/Annex II.4.

(< 0.1 μg/kg for solid, < 1 μg/kg for the liquid), ochratoxin A (< 0.2 μg/kg for the solid and < 2 μg/kg for liquid), zearalenone (< 25 μg/kg), T2-toxin (< 10 μg/kg only in the solid), fumonisins (< 600 μg/kg only in the liquid) and deoxynivalenol (< 330 μg/kg). Microbiological purity also included total viable cells (< 1.7×10^5 colony forming units (CFU)/g solid formulation, < 7 CFU/g for liquid formulation). No antimicrobial activity was found in three batches of either formulation.[14]

The 6-phytase present in the additive is obtained by fermentation with a genetically modified strain of *S. pombe* which is deposited at the American Type Culture Collection under deposition number SD-5233.[15] The taxonomic classification of the strain as *S. pombe* was confirmed [redacted] The assessment of the genetic modification was performed in a previous opinion (EFSA, 2006a) and the Panel concluded that the genetic modification does not raise any safety concern. The production strain has not been subject to any further genetic modification.

The presence of viable cells of the production strain was investigated in three batches of the liquid formulation and three of the solid formulation (analysis of three samples for each batch in duplicate).[17] The samples of the liquid formulation were plated (1 mL) in a proprietary in-house medium appropriate for *S. pombe* and incubated at 30°C for 72 h. The samples of the solid formulation were first dissolved (approximately 1:10) and then 1 mL was plated in yeast extract glucose agar at 25°C for 120 h. No cells were detected. A positive control was included in the analysis.

The presence of recombinant DNA was analysed in triplicate in three batches of the liquid formulation.[18] The primers targeted the recombinant phytase gene, with an amplicon size of 1,182 bp and the methodology included a lysis step. The analysis showed no amplification in the samples (while positive polymerase chain reaction (PCR) control gave amplification). The limit of detection in samples spiked with DNA was < 1 ng/mL. The results in the liquid formulation apply also to the solid formulation.

3.1.1. Conditions of use

The additive is authorised at a minimum recommended level of 150 FTU/kg feed for laying hens, 250 FTU/kg feed for chickens, turkeys and ducks for fattening, weaned piglets and pigs for fattening, and at 500 FTU/kg feed for sows. The applicant does not ask for a modification of these conditions of use.

Under the other provisions, it is stated that 'in the directions for use of the additive and premixture, indicate the storage temperature, storage life, and stability to pelleting. For use in feed containing more than 0,23% phytin bound phosphorus. For piglets (weaned) up to 35 kg of body weight'.

3.2. Safety

3.2.1. Previous assessments

EFSA issued two opinions (EFSA, 2006a,b) which considered the safety and efficacy of the enzyme preparation when used in chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, piglets (weaned), pigs for fattening and sows, which included the assessment of the safety for the consumer, the user and the environment, as well as the safety aspects of the genetic modification. The Panel concluded that the additive is safe for the target species at the recommended conditions of use, that the genetic modification of the production strain is of no concern and the use of the product as a feed additive would be of no concern for the consumers of products derived from animals fed with the additive, or for the environment. Concerns for the user were limited to its potential as a respiratory sensitiser.

[14] Technical dossier/Supplementary information June 2018/Annex II.6.

[redacted]

[17] Technical dossier/Supplementary information August 2018/Annex 4.
[18] Technical dossier/Supplementary information August 2018/Annex 5.

3.2.2. Further evidence

In 2007, EFSA established the Qualified Presumption of Safety (QPS) approach to safety assessment for microorganisms (EFSA, 2007). The production strain of the additive belongs to a species, *S. pombe,* that is considered to qualify for the QPS approach to safety assessment (EFSA, 2007 and EFSA BIOHAZ Panel, 2017). The taxonomic classification of the strain has been unambiguously established and the genetic modification raised no concerns. Therefore, the fermentation product obtained from the production strain does not raise safety concerns for the consumer and the environment.

In line with the requirements established in the EFSA guidance on the renewal (EFSA FEEDAP Panel, 2013), the applicant performed a literature search in order to provide evidence that in the light of the current knowledge the additive remains safe under the approved conditions for target species, consumers, users and the environment. The literature search was conducted in July 2016 and covered the period from 2005 to 2016.[19] Search terms used, and the strategy followed were reported. The search terms included several key words including those for the production strain (*Schizosaccharomyces pombe* and deposit number), words related to safety (e.g. safe* and toxic*, poison*) as well as the target species. The search was conducted using three databases, CAB Abstracts, Veterinary Science Database and Medline. The literature search retrieved 38 publications but in none of these publications adverse events or safety issues concerning the additive were reported (See Appendix A).

The applicant claims that no adverse effects have been reported in the framework of its global monitoring plan.[20]

3.2.3. Conclusions on the safety

Based on the above and the fact that the additive and the conditions of use for the species/ categories for which the additive is authorised have not been modified, the Panel considers that there is no evidence to reconsider the conclusions reached in previous assessments. Therefore, the additive is safe for chickens, turkeys and ducks for fattening, laying hens, weaned piglets, pigs for fattening and sows, consumers of products from animals fed the additive and the environment but it is considered a potential respiratory sensitiser.

3.3. Efficacy

The present application for renewal of the authorisation does not include a proposal for amending or supplementing the conditions of the original authorisation that would have an impact on the efficacy of the additive. Therefore, there is no need for assessing the efficacy of the additive in the context of the renewal of the authorisation.

3.4. Post-market monitoring

The FEEDAP Panel considers that there is no need for specific requirements for a post-market monitoring plan other than those established in the Feed Hygiene Regulation[21] and Good Manufacturing Practice.

4. Conclusions

The additive currently in the market complies with the existing conditions of authorisation.

The FEEDAP Panel concludes that PHYZYME® 5000 G/L remains safe for chickens, turkeys and ducks for fattening, laying hens, weaned piglets, pigs for fattening and sows, consumers of products from animals fed the additive and the environment under the approved conditions of authorisation. The additive is a potential respiratory sensitiser.

There is no need for assessing the efficacy of the additive in the context of the renewal of the authorisation.

[19] Techincal dossier/Section III/References.
[20] Technical dossier/Section III/Annex III.1.
[21] Regulation (EC) No 183/2005 of the European Parliament and of the Council of 12 January 2005 laying down requirements for feed hygiene. OJ L 35, 8.2.2005, p. 1.

Documentation provided to EFSA/Chronology

Date	Event
01/08/2016	Dossier received by EFSA. PHYZYME® XP 5000 G/L Renewal. Submitted by Danisco Ltd.
12/09/2016	Reception mandate from the European Commission
24/10/2016	Application validated by EFSA – Start of the scientific assessment
07/04/2017	Request of supplementary information to the applicant in line with Article 8(1)(2) of Regulation (EC) No 1831/2003 – Scientific assessment suspended. *Issues: characterisation*
24/01/2017	Comments received from Member States
31/05/2018	Clarification teleconference during risk assessment with the applicant according to the "EFSA's Catalogue of support initiatives during the life-cycle of applications for regulated products"
15/06/2018	Reception of supplementary information from the applicant - Scientific assessment re-started
29/06/2018	Request of supplementary information to the applicant in line with Article 8(1)(2) of Regulation (EC) No 1831/2003 – Scientific assessment suspended *Issues: Characterisation*
27/08/2018	Reception of supplementary information from the applicant - Scientific assessment re-started
04/04/2019	Opinion adopted by the FEEDAP Panel. End of the Scientific assessment

References

EFSA (European Food Safety Authority), 2006a. Opinion of the Scientific Panel on Additives and Products or Substances used in Animal Feed and the Scientific Panel on Genetically Modified Organisms on the safety and efficacy of Phyzyme XP 5000 (G/L), 6-phytase) as a feed additive for chickens for fattening. EFSA Journal 2006;4(5):350, 14 pp. https://doi.org/10.2903/j.efsa.2006.350

EFSA (European Food Safety Authority), 2006b. Opinion of the Scientific Panel on Additives and Products or Substances used in Animal Feed and the Scientific Panel on Genetically Modified Organisms on the safety and efficacy of Phyzyme XP 5000 (G/L), 6-phytase) as a feed additive for chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, piglets (weaned), pigs for fattening and sows. EFSA Journal 2006;4 (10):404, 20 pp. https://doi.org/10.2903/j.efsa.2006.404

EFSA (European Food Safety Authority), 2007. Opinion of the Scientific Committee on a request from EFSA on the introduction of a Qualified Presumption of Safety (QPS) approach for assessment of selected microorganisms referred to EFSA. EFSA Journal 2007;5(12):587, 16 pp. https://doi.org/10.2903/j.efsa.2007.587

EFSA (European Food Safety Authority), 2008. Safety and efficacy of Phyzyme XP 10000 (TPT/L), 6-phytase as a feed additive for chickens for fattening, laying hens, turkeys for fattening, ducks for fattening, piglets (weaned), pigs for fattening and sows. EFSA Journal 2008;6(12):915, 10 pp. https://doi.org/10.2903/j.efsa.2008.915

EFSA BIOHAZ Panel (EFSA Panel on Biological Hazards), 2017. Scientific Opinion on the update of the list of QPS-recommended biological agents intentionally added to food or feed as notified to EFSA. EFSA Journal 2017;15 (3):4664, 177 pp. https://doi.org/10.2903/j.efsa.2017.4664

EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed), 2012a. Scientific Opinion on the safety and efficacy of Phyzyme XP (6-phytase) as a feed additive for minor poultry species. EFSA Journal 2012;10(3):2619, 9 pp. https://doi.org/10.2903/j.efsa.2012.2619

EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed), 2012b. Guidance for the preparation of dossiers for zootechnical additives. EFSA Journal 2012;10(1):2536, 19 pp. https://doi.org/10.2903/j.efsa.2012.2536

EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed), 2013. Guidance on the renewal of the authorisation of feed additives. EFSA Journal 2013;11(10):3431, 8 pp. https://doi.org/10.2903/j.efsa.2013.3431

EFSA GMO Panel (EFSA Panel on Genetically Modified Organisms), 2011. Scientific Opinion on Guidance on the risk assessment of genetically modified microorganisms and their products intended for food and feed use. EFSA Journal 2011;9(6):2193, 54 pp. https://doi.org/10.2903/j.efsa.2011.2193

Abbreviations

CFU	colony forming unit
EURL	European Union Reference Laboratory
FEEDAP	EFSA Panel on Additives and Products or Substances used in Animal Feed
PCR	polymerase chain reaction
QPS	Qualified Presumption of Safety

Appendix A – List of references retrieved from the literature search provided by the applicant to support the safety of the additive

Adeola O, 2010. Phosphorus equivalency value of an *Escherichia coli* phytase in the diets of White Pekin ducks. Poultry Science, 89, 1199–1206.

Bhuiyan MM, Islam AF and Iji PA, 2010. Response of broiler chickens to diets containing artificially dried high-moisture maize supplemented with microbial enzymes. South African Journal of Animal Science, 40, 348–362.

Brana DV, Ellis M, Castaneda EO, Sands JS and Baker DH, 2006. Effect of a novel phytase on growth performance, bone ash, and mineral digestibility in nursery and grower-finisher pigs. Journal of Animal Science, 84, 1839–1849.

Ciofalo V, Barton N, Kretz K, Baird J, Cook M and Shanahan D, 2003. Safety evaluation of a phytase, expressed in *Schizosaccharomyces pombe*, intended for use in animal feed. Regulatory Toxicology and Pharmacology, 37, 286–292.

Debicki-Garnier AM, Sands J, Peron A and Messager B, 2007. Efficacy and mode of action of a new phytase in poultry feed. Actes des 7emes Journees de la Recherche Avicole, Tours, France, 28 et 29 mars 2007, 150–153.

EFSA FEEDAP Panel (EFSA Panel on Additives and Products or Substances used in Animal Feed), 2012. Scientific Opinion on the safety and efficacy of Phyzyme XP (6-phytase) as a feed additive for minor poultry species. EFSA Journal 2012;10(3):2619, 9 pp. https://doi.org/10.2903/j.efsa.2012.2619

Ghazalah AA, Abd-Elsamee MO, El-Hakim ASA and Ibrahim MM, 2012. Evaluation of using distillers dried grains with solubles (DDGS) in broiler diets. Egyptian Poultry Science Journal, 32, 381–397.

Ghorbani MR, Fayazi J and Chaji M, 2009. Effect of dietary phytase and NSP-degrading enzymes in diets containing rape seed meal on broiler performance and carcass characteristic. Research Journal of Biological Sciences, 4, 258–264.

Graham AB, DeRouchey JM, Tokach MD, Goodband RD, Dritz SS, Nitikanchana S, de Jong JA and Nelssen JL, 2012. The interactive effects of easyzyme and phytase in diets containing high-fiber co-products on growth performance of nursery pigs. Kansas State University Swine Day 2012. Report of Progress 1074. p. 66–73.

Guggenbuhl P, Quintana AP and Nunes CS, 2011. Comparative effects of two types of phytase added to a diet with reduced nutrient and energy content on the performance and digestibility of minerals in the weaned piglet. Journées de la Recherche Porcine en France, 43, 213–214.

Guggenbuhl P, Wache Y, Nunes CS and Fru F, 2012. Comparative effects of three phytases on the phosphorus and calcium use in the weaned piglet. Journal of Animal Science, 90, 95–97.

Humer E, Wetscherek W, Schwarz C and Schedle K, 2013. Effect of maize conservation technique and phytase supplementation on total tract apparent digestibility of phosphorus, calcium, ash, dry matter, organic matter and crude protein in growing pigs. Animal Feed Science and Technology, 185, 70–77.

Jones CK, Tokach MD, Ratliff BW, Horn NL, Dritz SS, Goodband RD, DeRouchey JM and Nelssen JL, 2009. Efficacy of different commercial phytase sources and development of a phosphorus release curve. Kansas State University Swine Day 2009. Report of Progress 1020. p. 106–121.

Jones CK, Tokach MD, Dritz SS, Ratliff BW, Horn NL, Goodband RD, DeRouchey JM, Sulabo RC and Nelssen JL, 2010. Efficacy of different commercial phytase enzymes and development of an available phosphorus release curve for *Escherichia coli*-derived phytases in nursery pigs. Journal of Animal Science, 88, 3631–3644.

Joven M, Suárez-Belloch J, Latorre MA and Fondevila M, 2015. Effect of addition of phytases on in vitro digestibility of ingredients for pig feeding, XVI Jornadas sobre Producción Animal, 19 y 20 de mayo de 2015, Zaragoza, España. Tomo I & II, 2015, p. 293–295.

Kerr BJ, Weber TE, Miller PS and Southern LL, 2010. Effect of phytase on apparent total tract digestibility of phosphorus in corn-soybean meal diets fed to finishing pigs. Journal of Animal Science, 88, 238–247.

Khattak FM, Acamovic T and Cowieson AJ, 2009. The response of chicks, with prior exposure to low and high phytate diets, when subsequently fed diets supplemented with phytase and phytate. British Poultry Abstracts, 5, 35–36.

Kiarie E, Owusu-Asiedu A, Péron A, Simmins PH and Nyachoti CM, 2012. Efficacy of xylanase and β-glucanase blend in mixed grains and grain co-products-based diets for fattening pigs. Livestock Science, 148, 129–133.

Kiarie E, Owusu-Asiedu A, Peron A, Simmins PH and Nyachoti CM, 2012. Efficacy of xylanase and beta - glucanase blend in mixed grains and grain co-products-based diets for fattening pigs. Livestock Science, 148, 129–133.
Kiarie E, Owusu-Asiedu A, Simmins PH and Nyachoti CM, 2010. Influence of phytase and carbohydrase enzymes on apparent ileal nutrient and standardized ileal amino acid digestibility in growing pigs fed wheat and barley-based diets. Livestock Science, 134, 85–87.
Kumar A, Dingle JG and Sands J, 2009. Effect of phytase supplementation of a low phosphorus sorghum-soybean diet on layer performance. Proceedings of the 20th Australian Poultry Science Symposium, Sydney, New South Wales, Australia. 9–11th. 47-49. 2009, p. 47–49.
Manangi MK, Sands JS and Coon CN, 2009. Effect of adding phytase to broiler diets containing low and high phytate phosphorus: 1. Performance, phytate P hydrolysis, tibia ash, litter phosphorus and Ca and P digestion and retention. International Journal of Poultry Science, 2009, 8, 919–928.
Manangi MK, Sands JS and Coon CN, 2009. Effect of phytase on ileal amino acid digestibility, nitrogen retention and AMEN for broilers fed diets containing low and high phytate phosphorus. International Journal of Poultry Science, 8, 929–938.
Manangi MK and Coon CN, 2007. The effect of calcium carbonate particle size and solubility on the utilization of phosphorus from phytase for broilers. International Journal of Poultry Science, 6, 85–90.
Mansoori B, Modirsanei M and Kiaei SMM, 2007. Influence of calcium and non-phytate phosphorus deficient diets with phytase on the performance of broilers, serum concentrations of minerals and the activity of alanine transaminase, aspartate transaminase and lactate dehydrogenase. Journal of Veterinary Research, 62, 103–111, 167.
Mohebbifar A, Torki M and Ghasemi HA, 2015. Effect of phytase supplementation of diets with different levels of rice bran and non-phytate phosphorus on productive performance, egg quality traits, leukocytes profile and serum lipids of laying hens reared indoor under high environmental temperatures. Animal Feed Science and Technology, 207, 222–233.
Owusu-Asiedu A, Gilbert C, Simmins PH and Nyachoti CM, 2007. Effect of a new coating on the bioefficacy of a phytase product in broilers fed corn-soybean meal-based diets. World's Poultry Science Association (WPSA), Beekbergen, Netherlands, 591–594.
Pettitt M, Beltranena E and Sands JS, 2005. Australasian Pig Science Association, Werribee, Australia, Apparent digestibility of nutrients in sows fed wheat-based diets supplemented with phytase. Manipulating pig production X. Proceedings of the Tenth Biennial Conference of the Australasian Pig Science Association (APSA), held in Christchurch, New Zealand, 27–30th November, 2005, p. 232.
Ravindran V, Sands JS, Hruby M and Partridge GG, 2005. Influence of PhyzymeTM XP phytase on nutrient utilization in broilers fed diets containing graded levels of phytate. Proceedings of the 17th Australian Poultry Science Symposium, Sydney, New South Wales, Australia, 7–9 February 2005, p. 238–241.
Roşu M, Sărăndan H, Turcuş V and Sarandan M, 2012. Universitatea de Ştiinţe Agronomice şi Medicină Veterinară Bucureşti, Bucureşti, Romania, Nutritional and metabolic parameters in laying hens fed with different levels of calcium, phosphorus and phytases. Scientific Works – University of Agronomical Sciences and Veterinary Medicine, Bucharest Series C, Veterinary Medicine, 58, 152–161.
Roşu M, Sărăndan H, Turcuş V and Sărăndan R, 2013. The quality of eggshells in hens that produce eggs for consumption (GOC) and were fed with different levels of calcium, phosphorus and phytas. Studia Universitatis "Vasile Goldiş", Seria Ştiinţele Vieţii, 23, 5–10.
Sands JS and Kay RM, 2007. Phyzyme XP phytase improves growth performance and nutrient utilization in wheat-based diets fed to weaned pigs. Livestock Science, 109, 264–267.
dos Santos TT, Gomes GA, Walk CL, Freitas BV and Araujo LF, 2013. Effect of formaldehyde inclusion on phytase efficiency in broilers. The Journal of Applied Poultry Research, 22, 204–210.
Selle PH, Creswell DC, Cadogan DJ, Partridge GG and Scott T, 2006. Japan Poultry Science Association, Ibaraki, Japan, Phytase supplementation of wheat-based broiler diets reduces dependence on meat-and-bone meal. Journal of Poultry Science, 43, 330–338.
Silversides FG, Scott TA, Korver DR, Afsharmanesh M and Hruby M, 2006. A study on the interaction of xylanase and phytase enzymes in wheat-based diets fed to commercial white and brown egg laying hens. Poultry Science, 85, 297–305.
Sulabo RC, Jones CK, Tokach MD, Goodband RD, Dritz SS, Campbell DR, Ratliff BW, DeRouchey JM and Nelssen JL, 2010. Factors affecting storage stability of various commercial phytase sources. Journal of Animal Science, 2010, 273–289.

Wu G, Liu Z, Bryant MM and Roland DA, Sr, 2006. Comparison of natuphos and phyzyme as phytase sources for commercial layers fed corn-soy diet. Poultry Science, 85, 64–69.

Yakout HM, 2010. Comparison of two phytase sources in corn-soybean meal-based diets for commercial laying hens. Egyptian Poultry Science Journal, 30, 501–516.